



**VOLUME-II**  
**SECTION – 2.1**  
**400KV TRANSMISSION LINE SURVEY**



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## TABLE OF CONTENTS

1.0.0	ROUTE ALIGNMENT .....	3
2.0.0	DETAILED SURVEY .....	4
3.0.0	GEOTECHNICAL INVESTIGATIONS .....	10
4.0.0	STATUTORY REGULATIONS AND STANDARDS .....	14
ANNEXURE-A	GENERAL DESCRIPTION OF TOWERS FOR TRANSMISSION LINE .....	15



## SECTION – 2

### DETAILED TECHNICAL SPECIFICATION

#### 1.0.0 ROUTE ALIGNMENT

1.1.0 Route Alignment shall be done using satellite imageries of NRSA (PAN & LISS-III merged product of minimum resolution corresponding to 1:25,000 scale) and Survey of India topographical maps (scale 1: 50,000). In case the required Survey of India maps are available in digitized form, the same shall be procured and used by the Contractor. The Google Imageries shall also be used route alignment. The contractor shall suggest the route alignment between the terminal points in the prescribed route corridor by the Owner as the corridor for GIPCL/Owner transmission line is specified by the Local Military Authority.

#### 1.2.0 Requirement of Transmission Line Routing

- a) The alignment of the transmission line shall be most economical from the point of view of construction and maintenance. But, the contractor shall consider only the corridor prescribed by the Owner for the transmission line.
- b) Routing of transmission line through protected /reserved corridor should be only considered. The bidder shall note that there is no protected / reserved forest in the prescribed corridor area.
- c) Bidder shall consider the route of transmission line with road crossings wherever applicable within the Owner identified line corridor.
- d) The route should have minimum crossings of overhead EHV power lines and communication lines as much possible in the already identified corridor of transmission line provided by the Owner.
- e) The number of angle points shall be kept to a minimum considering the identified transmission line corridor.
- f) The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered and shall be within provided corridor by the Owner.
- g) Marshy and low-lying areas, salt marshes and earth slip zones within the identified corridor shall be avoided to minimize risk to the foundations and towers.
- h) It would be preferable to utilize level ground for the alignment.
- i) Crossing of power lines shall be minimum. Alignment shall be kept at a specified distance from existing lines considering ROW and tower falling distances.
- j) 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.
- k) Areas subjected to flooding such as natural nala if any shall be avoided.
- l) Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches, thus recommended to not consider beyond the identified corridor.



- m) All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year as much as possible within Owner identified corridor.
- n) Angle points should be selected such that shifting of the points within 100 m radius is possible within the Owner identified corridor at the time of construction of the line.
- o) The areas requiring special foundations and those prone to flooding should be avoided to the extent possible.

1.3.0 For examination of the of the most appropriate route within the Owner identified corridor, besides making use of information's /data /details available/extracted through Survey of India Topographical maps, Google Images and computer- aided processing of NRSA's satellite imagery, the contractor shall also carryout reconnaissance /walk over survey/ preliminary survey as may be required for verification & collection of additional information/data/details.

1.4.0 The contractor shall submit his preliminary observations & suggestions along with various information's/data/details collected and also processed satellite imagery data, topographical map data marked with the route within the Owner identified corridor. Digital terrain modeling using contour data from topographical maps as well as processed satellite data shall be done by the contractor for the route. A fly through perspective using suitable software(s) shall be developed for further refinement of the selected route, if required. Site visit and field verification shall be conducted by the Contractor jointly with the Owner's representative for the proposed route alignment within the Owner identified corridor.

1.5.0 Final digitized route alignment drawing with latest topographical and other details/features including all natural canals / nala, roads etc. up to maximum **1.0km** on either side of selected route alignment shall be submitted by the Contractor for Owner's approval along with report containing other information's/details as mentioned above. Changes in the route alignment, if any, during detailed survey, shall be incorporated in the final digitized route alignment drawing.

## **2.0.0 DETAILED SURVEY**

2.1.0 The detailed survey shall be carried out using DGPS, Total Stations, digital theodolites etc. along the approved route alignment. As an alternative, the contractor may also use ALTM (Air borne Laser Terrain Modeling) techniques of equal or better accuracy for the detailed survey.

2.2.0 **Soil resistivity**, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 mtrs. For calculating soil resistivity formula

$2 \pi \rho / a$  (where  $a = 50$  m and  $\rho =$  megger reading in ohms) shall be adopted. Measurement shall be made at every 2 KM along the length of route. In case the soil characteristics changes within 2 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.

## **2.3.0 Route Marking**

- a) The route of the transmission line shall be recorded using DGPS of positional accuracy less than 3mtr.
- b) The co-ordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using DGPS for easy relocating. In addition the angle point locations etc shall be marked using marking stones of size 200 x 200 x 1000 mm, with approved marks including painting above the ground level and yellow lettering and

marking the direction of incoming and outgoing lines are to be marked clearly on the top with red color. If the distance between such anchor points is more than 1KM one more directional stone is to be fixed. So also for the road crossings and nala / canal crossings on both the sides.

- c) At the starting point of the commencement of route survey the coordinates shall be recorded. 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 500 mtr. along the transmission line to be surveyed up to the next angle point shall also be recorded. Wherever the line alignment crosses the EHT 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 GIPCL markings shall be made and co-ordinates recorded.
- d) Geographical drawing to be developed indicating transmission co-corridor, PSS-1, PSS-2, KPS-2 etc. (From available AutoCAD drawing)

#### 2.4.0 Profiling

- a) The complete profiling along the route shall be carried out using modern surveying equipment viz, total stations, DGPS, digital theodolite, long range scanners etc. Reference levels at every 20 meters along the route are to be recorded. In case of hilly terrain/undulations RL shall also be measured for 10mtr on either side of center line in lateral direction (perpendicular to the line). R/L's at other undulations along the route as well as in the route plan and other enroute details viz. Crossings, building & structure, 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.
- b) The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided tower spotting software.
- c) A printed/plotted output of the digitized profiling shall be submitted by the contractor to Owner's site-in-charge for review before taking up computer-aided tower spotting.
- d) Tower spotting at PSS-1, PSS-2 and KPS-2 shall be done so as it is consistent with design of Gantry / Gantry Tower of respective S/s.
- e) On Type-I Road (of GIPCL North Plot RE Park) , tower spotting shall be carried out so that Hume pipe crossing , Culvert, other services etc are not disturbed. (Bidder shall refer drawings attached)
- f) Transmission line within north plot of GIPCL RE Park shall be constructed within "11 meter" corridor. (Bidder shall refer drawings attached).

#### 2.5.0 Optimization of Tower Location/Tower Spotting

- a) Optimization of tower locations shall be done by the contractor using computer- aided tower spotting software- PLS-CADD. In order to verify the results of computer aided tower spotting, **the contractor shall furnish sample calculations and manual tower spotting drawings for some typical sections.**
- b) The sag-tension characteristics of the conductor as well as tower spotting data shall be furnished by the contractor for the owner's approval before execution. Sag template curves, shall be prepared by the contractor **on rigid acrylic sheet (transparent) indicating cold curve, hot curve, ground clearance curve and support footing curve and the same shall be submitted to the owner. Two numbers approved**



**template, shall be provided by the Contractor to the Owner for the purpose of checking the tower spotting.**

## **2.6.0 Tower Spotting.**

While profiling and spotting the towers the following shall be borne in mind.

### **a) Span:**

The maximum length of a section shall be **4.00 Km or sum of 10 spans whichever is less.** A section point shall comprise of tension point with DB/B type or DC/C type or DD/D type towers as applicable. The normal span shall be considered as **400 Mtrs** maximum. However, considering Wind Velocity 47m/s and Seismic zone – V, the span may get reduce.

### **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 with respect to body /leg extensions, truncations shall be considered by the contractor 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 employed at such positions.

### **d) Road Crossing**

At all important road crossings, the tower shall be fitted with double suspension or tension insulator strings depending on the type of tower but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken on adjacent span, ground clearance of the conductor from the road surfaces shall not be less than **12.00 mtrs.** Tension towers shall be used at all road crossing and crossing span shall not be more than **250 meters.**

### **e) Railway Crossings**

Not Applicable.

### **f) Power line Crossings**

Where this line is to cross over another line of the same voltage or lower voltage, DD/D type tower with suitable extensions shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956/ Indian Electricity Act 2003 as amended up to date.

Minimum clearance between lines when crossing each other in Mtrs is as below:

Sl. No.	Nominal System Voltage	66/110/132 KV	220 KV	400 KV	765 KV
1.	66/110/132KV	3.05	4.58	5.49	7.94



2.	220 KV	4.58	4.58	5.49	7.94
3.	400 KV	5.49	5.49	5.49	7.94
4	765 kV	7.94	7.94	7.94	7.94

For power line crossings of voltage level of 66 KV and above, an angle towers shall be provided on either side of DD/D type tower which can be temporary dead-end condition with proper guying.

The angle of crossing has to be preferably 90 degree and at any time should not be below 60 degree.

#### **g) 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 and . the permission of the telecommunication authority to be obtained by the contractor.

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.

#### **h) Details Enroute**

All topographical details, permanent features, such as trees, bushes / (choti badi jhar), roads (NH/SH/any other type), land survey nos. etc. **23 mtr. on either side** of the alignment shall be detailed on the profile plan. All the topographical details (trees, bushes, permanent structures, including open land) survey no. wise shall be included in the report.

#### **2.7.0 Clearance from Ground, Trees etc.**

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 / Indian Electricity Act 2003 as amended up to date.

- a) The Contractor shall estimate/enumerate numbers of trees that are to be cut within right of way of transmission line along the proposed route alignment. Contractor may please note that Owner will not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's survey work.
- b) The trees and bushes existing within **23 mtr. on either side** of the central line alignment shall be estimated/enumerated by the contractor and marked with quality paint serially from angle point 1 (One) onwards. The trees list should contain the following:
  - i. Approx. Girth (circumference) measured at a height of 1 mtr. from Ground level.
  - ii. Approximate height of the tree with an accuracy of + 2 metres.
  - iii. Name of the type of the species/tree.
- c) The bushy and undergrowth encountered in the **23 mtr. belt on either side** of the central line alignment should also be evaluated with its type, height and girth clearly indicating in the tree /bush statement. The tree/bush statement should also approximately indicate the percentage area within right of way where tree/bush exist.





- d) The contractor shall also intimate the Owner, his assessment about the likely amount of tree & crop compensation etc. required to be paid by the Owner during execution stage **for trees in 46 mtr. belt**. This assessment shall be done considering prevailing practices/guidelines, local regulations and other inquiries from local authorities.
- e) The contractor shall also identify the **non-forest / deemed forest / private land / Government land** areas involved duly authenticated by concerned authorities.
  - i. A statement of forest areas with survey/compartments nos. (all type of forest /RF /PF Acquired forest/ Revenue forest/Private forest/forest as per dictionary meaning of forest etc.)
  - ii. A statement of non-forest areas with survey/compartments nos.
  - iii. Tree cutting details (Girth wise & species wise).
  - iv. Marking of forest areas with category on topo- sheets 1:250,000 showing complete line route, boundaries of various forest divisions and their areas involved.
  - v. Village forest maps of affected line and affected forest areas and marking of the same.
  - vi. Forest division map showing line and affected forest areas.
  - vii. The contractor shall furnish village Revenue survey map duly mentioning the survey nos., name of the owner (to be collected through RTC-record of rights and tenancy certificate) along the proposed corridor width.
  - viii. The village Revenue survey map is to be certified by Govt. Surveyor and countersigned by Revenue Inspector/Village Accountant.
  - ix. The village Revenue survey map is to be digitized and Geo referenced and superimposed on the selected corridor duly indicating the survey no of lands coming under the corridor.
- f) The contractor shall finalize the forest clearance proposal on the prescribed format duly completed in all respects and get to clearance form the forest department.

#### **2.8.0 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 Owner's site-in-charge.

#### **2.9.0 Detailed Survey of Tower Locations.**

- a) The detailed survey shall be conducted for spotting the tower locations on ground conforming to the approved profile and tower schedule.
- b) The co-ordinates of all the tower locations shall also be recorded using DGPS of positional accuracy less than 3mtr. For easy relocating. The position of all tower locations shall be marked in the final digitized route alignment drawing with relative distance from any permanent benchmark in the area.
- c) 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 and classify the suitable type of foundation at each location and detailed soil investigations carried out at selected locations etc.

#### **2.10.0 Contouring at undulated locations, if any**

- a) The levels up or down of each pit center with respect to center of tower location shall be recorded at intervals of **2 mtrs** using total stations / DGPS / digital theodolite and





digitized contour plans shall be made. Based on the digitized elevation plans, the quantities of benching & protection work vis-a-vis possible unequal leg extensions shall be optimized using suitable computer-aided techniques/ software's. Required tower and foundation details, cost data for comparative evaluation of benching & protection work vis-a-vis unequal leg extensions shall be provided by the contractor to the owner before execution stage.

- 2.11.0 The changes desired by the Owner 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 Owner.** 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, crossing & other details etc.

#### 2.12.0 Survey Methodology & Precision

- a) All elevations shall be referenced to benchmarks established by the survey of India. Leveling operations shall begin and end at benchmarks approved by the Owner.
- b) During the leveling of the profile, check surveys will be effected at suitable intervals. 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 3<sup>rd</sup> order surveys  $e \leq 24k$  where k is the distance between benchmarks in km and e is the difference between elevations in mm.
- c) 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 3<sup>rd</sup> order surveys as stated above.
- d) 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.

#### 2.13.0 Survey Report

- a) Complete BOQ of the transmission lines as per the technical specifications shall be furnished in the survey report.
- b) Each angle point locations shall be shown with detailed sketches showing existing in the close vicinity permanent land marks such as specific tree(s), bushes, electric pole/tower, telephone pole/tower, canal / natural nala, roads etc. The relative distance of land marks from the angle points and their bearings shall be indicated in the sketch. These details shall be included in the survey report.
- c) Information w.r.t. infrastructure details available enroute, identification and explanation of route constraints, etc shall also be furnished in the Survey report and shall inter-alia include the following:
  - i. Information regarding infrastructural facilities available along the final route alignment like access to roads, , construction material sources (like quarry points for stone, sand and availability of construction water), labour, existing transport facilities, fuel availability etc. shall be furnished in the survey report.
  - ii. 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.



- iii. Suggestions regarding the number of convenient zones (line segments/portions) in which the entire alignment can be divided keeping in view the convenience of line construction, operation, maintenance etc. are to be given.
  - iv. Suggestions regarding location for setting up stores during line construction in consultation with Owner representatives shall also be provided by the Contractor.
  - v. Working months available during various seasons along the final route alignment, with period, time of monsoon, sowing & harvesting of different type of crops and the importance attached to the crops shall be stated by the Contractor.
  - vi. Availability of labour of various categories and contractors of civil works shall also be reported.
  - vii. The line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, PGCIL, CEA, Divisional Forest Authorities, Military, Civil and Defense Authorities, any other authorities etc.
- d) All the requisite data for processing the case of statutory clearances such as PTCC, Forest and Highway Authority shall be provided along with the report.
- e) The contractor shall also collect & report details pertaining to pollution levels envisaged along the transmission line.
- f) Ten copies of survey reports (Hard & soft) and all documents shall be furnished by the contractor to the Owner.

### **3.0.0 GEOTECHNICAL INVESTIGATIONS**

#### **3.1.0 General**

- a) The scope of work includes detailed soil investigation at various selected tower locations as approved/desired by the owner such as selected angle points, road crossings, power line crossings, canal / nala crossings etc. In addition, soil investigation may be required to be carried out at other locations at the discretion of the Owner.
- b) These specifications provide general guidelines for geotechnical investigation of normal soils. Cases of marshy locations and those affected by salt water shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by Contractor and furnished to Owner.

#### **3.2.0 Scope**

- a) The scope of work includes detailed soil investigations and furnishing bore log data at various tower locations. However, during actual execution of work, the locations shall be decided by the Engineer-in-Charge, depending upon the soil strata, terrain and other factors. Based on the bore log data/soil parameter/soil investigation results, the Contractor shall recommend the type of foundations suitable for each locations and the same shall be got approved by the Owner.
- b) These specifications cover the technical requirements for a detailed Geotechnical investigation and submission of a detailed 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 require 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

forementioned work shall be supervised by a graduate in Civil Engineering having at least 5 years of site experience in geotechnical investigation work.

- c) Contractor shall make his own arrangements to establish the co-ordinate system required to position boreholes, tests pits and other field test locations. Contractor shall determine the reduced levels (R.L.'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 provide at site all required survey instruments to the satisfactions of the Owner 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 including maximum velocity discharge, highest flood level (H.F.L.), scour depth etc. of the concerned rivers, major streams and nalas (canals).
- d) The field and laboratory data shall be recorded on the proforma recommended in relevant Indian Standards. Contractor shall submit to Owner two copies of field bore logs and all the field records (countersigned by the Owner) soon after the completion of each boreholes/test.
- e) 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.
- f) One copy of all field records and laboratory test results shall be sent to Owner on a weekly basis. Owner may observe all the laboratory testing procedures.
- g) The Contractor shall interact with the Owner to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of towers in order to enable him to make specific recommendation for the depth, founding strata, type of foundation and the allowable bearing pressure.
- h) After reviewing Contractor's geotechnical investigation draft report. Owner 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 finalizing the report, traveling etc. shall be borne by EPC contractor.
- i) The Contractor shall prepare and submit soil profile along the transmission line route (in digitized form, with digitized route alignment drawing as base) indicating salient soil characteristics/features, water table etc. based on detailed soil investigations and other details/information collected during detailed survey.

### **3.3.0 General Requirements**

- a) Where ever possible, Contractor shall research and review existing local knowledge, records of test pits, bore holes etc. types of foundations adopted and the behavior of existing structures, particularly those similar to the present project.
- b) Contractor shall make use of information gathered from nearby quarries, unlined wells, excavation etc. Study of the general topography of the surrounding areas will often help in the delineation of different soil types.
- c) Contractor shall gather data regarding the removal of overburden in the project area either by performing test excavations, or by observing soil erosion or landslides in order to estimate reconsolidation of the soil strata. Similarly, data regarding recent landfills shall be studied to determine the characteristics of such landfills as well as the original soil strata.



- d) 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.
- e) It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the Owner 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 Owner. If the Owner desires to witness such tests, Contractor shall arrange for the same.

#### **3.4.0 Codes and Standards for Geotechnical Investigations.**

- a) The Geo-technical investigations and report shall conform to all standards, specifications and IS codes of practice (shall be the latest editions including all applicable official amendments and revision). 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.

#### **3.5.0 Field investigation for soils.**

Detailed soil investigation and tests like bores, auger boring, shell and auger boring, SPT, Vane shear test, Dynamic cone penetration test, etc. and other test not specifically mentioned and report of which are required for designing tower foundations shall be carried out by the contractor as per the relevant IS codes in force and detailed report shall be submitted to the owner for approval and records.

#### **3.6.0 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 owner progressively every week. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory tests 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 Owner within one week of completion of the first borehole.
- 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 are in good working conditions 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 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.

### **3.7.0 Geotechnical Investigation Report**

#### **a) General**

- i. Contractor shall submit a formal report containing geological information of the region, procedures adopted for geotechnical investigation, field observation, summarized test data, conclusions and recommendations. The report shall also include detailed bore logs, subsoil sections, field test results, laboratory observations and tests 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 Owner's review.
- ii. Contractor's Geotechnical engineer shall visit Owner's Corporate Office for a detailed review based on Owner'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. Ten copies of the detailed final approved report shall be submitted to Owner together with one set of reproducible of the graphs, tables etc.
- iii. 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.

#### **b) Data to be furnished:**

The report shall also include the following:

- i. A plot plant/location plan showing the locations and reduced levels of all field test e.g. boreholes trial pits etc. properly drawn to scale and dimensioned with reference to the established grid lines.
- ii. 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.
- iii. Geological information of the area including geomorphology, geological structure, lithology, stratigraphy and tectonics, core recovery and rock quality designation (RQD) etc.
- iv. Observations and data regarding change of course of rivers, velocity, scour depths, silt factor etc., and history of flood details for mid-stream and river bank locations.
- v. 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.
- vi. Results of all laboratory test summarized for each sample, for each layer, along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

#### **c) Recommendations**



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:

- i. The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors thereby avoiding rupture under ultimate loads.
- ii. Movement of the foundation, including short and long term components under transient and permanent loading, shall be strictly controlled with regard to settlement, uplift, lateral translation and rotation.

### **3.8.0 Additional Requirements**

The contractor's quoted rate 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.

### **4.0.0 STATUTORY REGULATIONS AND STANDARDS**

- 4.1.0 Contractor is required to follow statutory regulations stipulated in Electricity (Supply) Act 1948, Indian Electricity Rules, Indian Electricity Act 2003 and other local rules & regulations.
- 4.2.0 The codes and standards referred to in these specifications shall govern. In case of a conflict between such codes/standards and these specifications, the stringent shall prevail. Such codes, standards referred to shall mean latest revisions, amendments, changes adopted and published by relevant agencies.
- 4.3.0 Other Internationally acceptable standards which ensure equivalent or better performance than those specified shall also be acceptable.



**ANNEXURE-A**  
**GENERAL DESCRIPTION OF TOWERS FOR TRANSMISSION LINE**

**1.0 Type of Towers**

**(a) 400 KV D/C Transmission lines**

Type of Tower	Deviation Limit	Typical Use	
DA/A	0 deg – 2 deg	a)	To be used as tangent/Suspension tower
DB/B	0 deg – 15 deg	a)	Angle tower/Tension tower with tension insulator string
	0 deg	b)	To be used as section tower
		C	To be used where towers are subject to Uplift loads
DC/C	15 deg – 30 deg	a)	Medium angle tower with tension insulator string.
		b)	To be used for transposition of transmission line, if required.
DD/D	30 deg – 60 deg	a)	Large angle tower with tension insulator string.
		b)	Anchor tower for river crossing with 0 deg. Deviations on crossing side and 0 deg. To 30 deg. Deviation on line side.
DDE/DE	0 deg	a)	Complete dead end.
		b)	Dead end with 0 deg to 15 deg deviation both on line and substation side (slack span)

**(b) 400 KV M/C Transmission lines**

Type of Tower	Deviation Limit	Typical Use	
MA/A	0 deg – 2 deg	a)	To be used as tangent tower
MB/B	0 deg – 15 deg	a)	Angle tower with tension insulator string
		b)	To be used as section tower
MC/C	15 deg – 30 deg	a)	Medium angle tower with tension insulator string.
		b)	To be used for transposition of transmission line, if required.





MD/D	30 deg – 60 deg	a)	Large angle tower with tension insulator string.
		b)	Anchor tower for river crossing with 0 deg. Deviations on crossing side and 0 deg. To 30 deg. Deviation on line side.

- (c) Special type of towers/higher voltage class towers, wherever required shall also provide by the bidder under the contract at no extra cost. (Depending upon site requirements)

**(d) Towers for Major Crossings**

The above towers (DB, DC & DD) shall also be used with suitable modifications for very long spans (spans more than given above) which cannot be crossed by normal tower with extensions like valley and river crossings etc. These Towers shall be developed by strengthening the above DB, DC and DD type towers as per the site requirement.