

Nepal Electricity Authority

(A Government of Nepal Undertaking)

Distribution and Consumer Service Directorate

Butwal Regional office

Lamahi-Jaluke 33 kV Transmission Line Project



Bidding Document

For

**Supply and Delivery Installation testing and Commissioning
of 33kV Line Lattice Tower with Stringing Conductor Across
Rapti River at Bhalubang.**

BRO-2074/2075-16

Volume-II of II

March, 2018

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**SECTION VI
SPECIFICATION**

**Scope of Works and General Technical
Specifications**

1. SCOPE OF WORK & GENERAL TECHNICAL SPECIFICATIONS

1. General Scope:

This section outlines all major work to be carried out by the Contractor construction of 2 lattice tower , string of double circuit and join with existing 33 kV line and dismantling 33kV dog conductor .All engineering design and materials shall be subject to the Employer/Employer's Representative approval.

1.1 Scope

The scope of work shall include the following:

- The design, testing, supply and erection of 33kV double circuit, support structures including cross arm, bolts, nuts and washers;.
- The supply of conductors, insulator, hardware, earth wire, joints, connectors and all other conductor and earth wire clamps and accessories;
- Design selection and installation of foundation and other structures required for the lines

For river crossing the contractor shall prepare the crossing plan and profile and shall carryout soil investigations. Based on this information he shall propose an optimum location for river crossing and dimension for its sub spans.

1.2 General

The whole of the works shall be designed to ensure satisfactory operation. All reasonable precautions shall be taken in the design of equipment and of the works, to ensure the safety of personnel concerned with the operation and maintenance of the works, and of the public.

All workmanship shall be of the highest class throughout and the design dimensions and materials of all parts shall be such that the stresses to which they are subjected shall not render them liable to distortion or damage under the most severe conditions encountered in service.

The detailed design shall be such as to facilitate inspection, cleaning and repairs and simplicity of operation and maintenance. All apparatus shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing in the areas where the line is to be built and under such variations of load and voltage as may occur under the working conditions of the system. The design of all line supports, conductors, insulators and fittings shall be such as to minimize the risk of damage in service of any part of the lines.

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No welding, plugging or filling of defective parts shall be carried out without the prior sanction in writing of the Employer.

Anything mentioned in the Specifications and not shown on the drawings or shown on the drawings and not mentioned in the Specifications shall have the effect as if shown or mentioned in both. In case of difference between drawings and Specifications, the Specifications shall prevail. In case of difference between scaled dimensions and figures on drawings, the figures shall prevail.

Corresponding parts of equipment liable to renewal shall be interchangeable and the Contractor will be required to demonstrate this feature to the Employer's satisfaction.

Locally available goods, construction materials including fuel, lubricating oil, cement, timber, iron and steel goods, etc. shall be procured locally and tax-reimbursement for such items shall not be provided.

Field Works shall be scheduled as per work-site availability without the Employer having to incur additional cost.

1.3 Current Ratings

Every current carrying part of the equipment including conductors, connections and joints shall be capable of carrying their rated current continuously under the site conditions as specified.

1.4 Labels, Ratings and Nameplates

1.4.1. General

All labels, circuit name and rating plates shall be inscribed in both Nepali and the English language. The material used and inscription size of all lettering shall be to the approval of the Employer.

Labels using adhesive backed plastic materials will not be permitted.

1.4.2. Labels

All equipment and apparatus there on shall be clearly labeled in an approved manner.

1.5 Castings

All castings shall be as free from blowholes, flaws and cracks as is practicable. No welding, filling or plugging of defective parts shall be done without the sanction of the Employer and then only with his approval in writing.

1.6 Welding

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In all cases where fabrication welds are liable to be highly stressed, such as may be the case in parts subjected to reversals of stresses in operation, the Contractor is to supply the Employer with a general arrangement drawing of the fabrication and, at a later date but before fabrication commences, a detailed drawing of all proposed weld preparations on the fabrication.

Before such welding commences the Contractor is to satisfy the Employer that the welders or welding operators are qualified in accordance with the requirements of the appropriate section of BS 2654 or such other standard as may be approved.

After examining the general arrangement and welding detail drawings, the Employer will inform the Contractor of the stages at which inspection will be required. It will be the Contractor's responsibility to notify Employer when one or more of the inspection stages will be reached and no further work is to be carried out until, the specified stage has passed the Employer's inspection.

In addition to the above, the Employer or his representative reserves the right to visit the Contractor's Works at any reasonable time during fabrication of the items of plant and to familiarize him with the progress made and the quality of work to date.

In the event of the Contractor wishing to alter any part of the weld preparation, he shall first submit to the Employer a copy of the revised drawing showing the amended preparation in detail and then await confirmation of acceptance or non-acceptance.

1.7 Galvanizing

All iron and steel used in the construction of the Contract Works shall be galvanized after all sawing, shearing, drilling, punching, filling, bending and machining is completed. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. Galvanizing shall be applied by the hot dip process and, for all parts other than steel wires; shall consist of a coating of at least 610 grams of zinc per square meter of surface and be not less than 0.086 mm in thickness, and shall withstand the tests set out in ISO/R1459, 1460 and 1461 or such other standards as may be approved. Steel tower materials shall be treated with Sodium Dichromate solution after galvanizing and before shipment.

All steel wires shall be galvanized by an approved process before stranding. The zinc shall be smooth, clean, of uniform thickness, and free from defects and shall withstand the tests set out in IEC Publication 209 or such other standard as may be approved.

The preparation for galvanizing and the galvanizing itself shall not distort or adversely affect the mechanical properties of the material. After galvanizing, holes shall be free from nodules of spelter.

If any galvanized part is found to be imperfect, it shall be replaced. The whole of the expense involved in the replacement of the imperfect part shall be borne by the Contractor.

If in the opinion of the Employer, the extent of damage found on site to a galvanized part appears capable of repair, the Contractor may, after receiving such agreement in writing

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attempt to such repair by approved methods. The agreement to attempt repair shall not bind the Employer to accept the repaired part when this is re-offered for inspection. The Contractor has the responsibility to take care and protect properly all material on the shipment overseas.

1.10 Bolts and Nuts

Members of lattice steel structures shall be secured by means of bolts and nuts with approved spring washers conforming to ASA B27.1. All bolts and nuts shall conform to ASTM A394 or BS 916. Nuts and heads of all bolts shall be of the hexagonal type. Nuts (except lock nuts) shall be full bearing on one side.

Minimum size of bolts for all structural connections shall be 16 mm diameter.

All bolts and screwed rods shall be galvanized including the threaded portions. All nuts shall be galvanized with the exception of the threads, which shall be oiled. The nuts of all bolts attaching insulator set droppers, U bolts and earth conductor clamps to the structures shall be locked in an approved manner. The screwed thread of any bolts or studs shall not form part of a shearing plane between members. When in position, all bolts or screwed rods shall project through the corresponding nuts for at least a full turn but such projection shall not exceed 10 mm.

Where for any type of support high tensile steel bolts are employed, then bolts for this type are to be used for all connection for every type of support on that line in order to avoid the use of mild steel bolts in error where high tensile type should be employed.

Nuts shall be finger tight on the bolt and will be rejected if they are, in the opinion of the Employer, considered to have an excessively loose or tight fit. Bolts with threads re-tied after galvanizing will be rejected.

The Contractor shall request his Supplier to select two samples of each type of bolt and nut to be used in the Contract and send these two samples to the Employer at his Head Office for approval within one month of the date of issuing the sub-order. The Employer will then reject bolt consignments, which fall in any respect below the standard of samples submitted and approved.

1.11. LIMITS OF INSTALLATIONS AND DRAWINGS

1.11.1 Introduction

This section defines the terminal points for equipment to be supplied under substation contract. All equipment within these terminal points shall be supplied by the Bidder.

1.11.2 Terminal Points

The overhead lines shall terminate in existing line-telescopic pole.

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Provision of jumpers from the pole of sufficient length (min. 6m) to terminate on the appropriate line/substation equipment shall be included under this contract together with clamps to connect the jumpers to the pole. The connection of the jumpers to the electrical equipment together with the necessary clamps will be the responsibility of others.

1.11.3 Specification Tender and Contract Drawings

1.11.3.1 Specification drawings

The drawings issued by the Employer with the specification and forming part of the documents for tendering purposes are intended to be descriptive of the character of the works and used in conjunction with the requirements of the specification and shall in no way limit the responsibility of the contractor to supply all plant, equipment and materials etc. to fulfill the requirements of the contract works covered by this specification. The Contractor shall investigate the Site and design accordingly without any additional cost to the Employer. Any omission from both drawing and the specification or any express reference to any detail or work necessary and obviously intended shall not relieve the Contractor of his responsibility to include that detail of work in his supply and price.

The specification drawings issued by Employer for tendering purposes are contained at the end of this Volume.

1.11.3.2 Tender drawings

Typical drawings are to be submitted with the Tender showing all essential details of construction of the various items of supply.

The following drawings must be prepared by Bidders and accompany copy of their tender:

- **Outline and general arrangements for all basic types of lattice steel structure with tower loading diagrams (including load tree) and loading calculations for normal and broken wire conditions.**
- Details of types of foundations with volume of earthwork, concrete and rebar.
- Conductor tension clamps and jumper terminals.
- Earth tension clamps and jumper terminals.
- Conductor non-tension joints.
- Tension Insulator strings and clamps with all fittings.
- Vibration dampers.
- Arcing horn
- Conductor final tension charts.
- Drawings and/or other data indicating the method of stringing to be adopted.
- Drawing and/or details of Tools and Equipment.

Drawings need have leading dimensions only. Structure and drawings should have provisional dimensions of principal members and shall indicate the necessary clearance dimensions for structures for still air and maximum swing of insulator

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strings and jumpers called for in this specification. The conductor tension charts are to show final sags and tensions for a range of equivalent spans between those approximately 50 percent higher and lower than the basic span given, in still air at maximum, every day and minimum temperature and the tension at minimum temperature at full wind.

The successful Bidder will be required, at the time of letting of the Contract, to supply additional copies of the above drawings as may be selected by the Employer. These drawings, together with such drawings originally issued with the Tender Documents will then form part of the Contract Document and be signed both by the Employer and the Contractor for identification purposes.

1.11.3.3 Contract Drawings and Documents for Approval

1.11.3.3.1 General

All designs and drawings submitted with the successful Bid shall be considered preliminary only and not to be considered as approved. Prior to commencement of the work, the Contractor shall submit drawings and data to the Engineer for approval. Should the Engineer direct that modifications be made in order to satisfy the requirements of the Specifications, the Contractor shall submit revised drawings for approval. Alteration in the Contract price shall not be allowed by reason of the drawing modifications.

The Contractor shall submit the following drawings and data to the Engineer for approval:

- (a) Survey drawings, including:
- 2 Centre-line plans and profiles of each line with L/R profile in undulation.
 - 3 Optimized tower spotting drawings
 - 4 Soils survey map identifying foundation type selected for each individual tower.
 - 5 Detailed design drawings and calculations for tower and leg extension; tower loading calculations (with load tree) and diagrams.
 - 6 Detailed design drawings including tower framing, size and length of each member; spacing holes in each member; number, size and lengths of bolts and fillers at each joint, detail of bolts, nuts, locknuts, fillers, washers and spring washers, and detail showing attachments of insulator assemblies and overhead ground wire assemblies and tower signs.
 - (7) Tower foundation drawings consisting of design drawings, calculations, volumes and weight of re-bar.
 - 8) Detailed drawings of grounding materials and ground connection consisting of ground electrodes, ground connecting strip, ground connecting bolts, counterpoise and list of ground electrodes for each tower.

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- 9) Initial sag and tension tables for conductors and overhead ground wire including details of calculations necessary for stringing

Approval of the Contractor's drawings shall not in any way relieve the Contractor of any part of his obligation to meet all the requirements of the Contract or of the responsibility for the correction of the drawings.

i. CD ROM of final/as-built drawings

- 2 each within 30 days before the issuance of the Operational Acceptance Certificate.

X. Test reports

Shop tests and field tests:

- 2 copies immediately, but not later than 15 days after completion of tests.

XI. Instruction manuals and lists of operation and maintenance tools

- 2 sets not later than 15 days before shipment.

1.11.3.2 Drawings: Titles and Sizes

The title of the drawing, Contract Number, the signature of the Contractor's engineer and the date shall appear in the bottom right-hand corner of each drawing. The Contractor shall use any one of the following sizes for the preparation of drawings.

AO	841 x 1189 mm	(33.11 x 46.81 in)
A1	594 x 841 mm	(33.39 x 33.11 in)
A2	420 x 594 mm	(16.54 x 23.39 in)
A3	297 x 420 mm	(11.69 x 16.54 in)
A4	210 x 297 mm	(8.27 x 11.69 in)

1.11.3.3 Employer approval

The Employer will approve each drawing within seven (7) days after receipt at his office. One print of each of the drawings submitted for approval will be returned by the Employer or its designated engineer marked either "APPROVED", "APPROVED EXCEPT AS NOTED", or "RETURNED FOR CORRECTION".

The notations "APPROVED" or "APPROVED EXCEPT AS NOTED" will authorize the contractor to proceed with the manufacturing drawings, subject to the corrections, if any, indicated thereon. The notation "RETURNED FOR CORRECTION" shall require the Contractor to make the necessary revisions on

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the drawings and submit for approval within thirty-five (35) days in the same manner as before.

Approval of the Contractor's drawings shall not in any way relieve the Contractor of any part of his obligation to meet all the requirements of the Contract or of the responsibility for the correction of the drawings.

Reproducible (CD-ROM): CD-ROM of all final approved drawings shall be submitted.

1.12 Site Data

All plant and equipment supplied under the contract shall be entirely suitable for the climatic conditions prevailing at site.

Between June and August low-lying areas are subject to flooding.

Horizontal seismic coefficient is 0.15.

Atmospheric pollution is low and special insulator design or washing is not required.

Maximum ambient shade temperature	45 degree C
Minimum ambient shade temperature	0 degree C
Annual average temperature	32 degree C
Wind Zone (as per IS: 875)	4
Basic Wind Speed	47 m/sec
Terrain category	I
Rainfall	1,000 mm/annum
Monsoon season	June-August
Relative humidity,	maximum 100 %
	minimum 20 %
Ice & snow thickness	0 mm
Atmospheric pollution	Light
Isokeraunic level (thunderstorm days)	50

The information in this Clause is given solely for the general assistance of Bidders and no responsibility for it will be accepted or will any claim based on this Clause be considered.

The Bidder is advised to survey the sites covered under this Contract to acquaint himself with site conditions.

1.13 Applicable Standard

All equipment, materials, fabrication and tests under these specifications shall conform to the latest applicable standards, manuals and standards contained in the following list or to standards, manuals and specifications approved as equal by the Employer. Any details not specifically covered by these standards and specifications shall be subject to approval of the

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Employer. In the event of contradictory requirements between the standards and these specification requirements, the terms of the specifications shall apply.

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standard Institute, Inc.
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWS	American Welding Society
BS	British Standard Institution
EI	Edison Electric Institute
IEC	International Electro technical Commission
NEMA	National Electric Manufacturers Association
AASHTO	American Association of State Highway Officials
IEEE	Institute of Electrical and Electronics Engineers
IS	Bureau of Indian Standard
ISO	International Organization for Standardization
CSA	Canadian Standard Association
DIN	Deutsches Institute Für Normung

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CHAPTER -1

TRANSMISSION LINE TOWER

1.1 GENERAL DESCRIPTION OF THE TOWER

- 1.1.1 The towers shall be self-supporting, hot dip galvanized, latticed steel type & designed to carry the line conductors with necessary insulators, Earth wire and all fittings under all loading conditions. Outline diagram of towers are enclosed with the Specification.
- 1.1.2 The tower shall be fully galvanized using mild steel or high tensile steel sections as specified in clause no. 1.6 Bolts and nuts with spring washer are to be used for connections.

1.2 TYPE OF TOWERS

- DDE 30 - 60 deg
- a) Angle tower with tension insulator string.
 - b) Also to be used for uplift forces resulting from an uplift span up to 600m under broken wire condition.

Notes

- i) Above towers (DDE) shall be designed for double circuit strung condition only considering that all conductors of both circuits would be placed on both sides of tower and single Earth wire on top of the tower.
- ii) All above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance.

1.2.1 Towers for Major Crossings

The above towers (DDE) shall be used with 450m long spans These Towers shall be developed by strengthening as per the site requirement. Additional weight of tower due to strengthening shall be paid on prorata basis derived from the quoted price and final weight of the standard (+/- 0) tower after successful testing.

1.2.2 Extensions

- 1.2.2.1 The Double Circuit towers shall be designed so as to be suitable for adding extensions for maintaining adequate ground clearances without reducing the factor of safety (actual stress /allowable stress) available for the members of tested extensions in any manner. Reference drawings for leg extension arrangement are enclosed in the Bid Document.
- 1.2.2.2
- 1.2.2.3 The towers shall be designed for providing unequal extensions These unequal extensions to be provided in the design shall be used during tower execution stage to optimize the benching/revetment requirement.

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1.3 SPANS

The Span the line is **450m** for 33kV transmission line crossing the river.

1.4 ELECTRICAL CLEARANCES

1.4.1 Ground Clearance

The minimum ground clearance from the bottom conductor shall not be less than **6100 mm** for 33 kV lines at the maximum sag conditions i.e. at 80°C and still air.

- a) An allowance of 150 mm shall be provided to account for errors in stringing.
- b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 20°C, lower than the stringing temperature for ACSR “Wolf” for 33 kV transmission lines.

1.4.2 Live Metal Clearance

The minimum live metal clearance to be provided between the live parts and steel work of superstructure shall be as given in Table 1.2(alternative clearance may acceptable)

TABLE 1.2

DESCRIPTION	SWING ANGLE	LIVE METAL CLEARANCE
Tension String	10 Degree	1530 mm
(Single / Double)	20 Degree	1070 mm
Jumper	30 Degree	1070 mm

NOTE: IN CASE OF PILOT INSULATOR STRINGS, THE ANGLE OF SWING OF THE JUMPER ALONGWITH THE PILOT STRING SHALL BE CONSIDERED AS 15 DEG.

- 1.4.3 Bidder shall adopt the same cross arm design where jumper is projecting outside of cross-arm for DD/DE type towers, used as dead end and angle tower.
- 1.4.4 For computing the live metal clearances the dimensions of Single Tension and Double Tension strings shall be taken as given in enclosed drawings. The design of the tower shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings. The Contractor may use & supply insulator strings with disc insulators and the tower design shall be such that it satisfies the clearance requirements in that particular case.
- 1.4.5 Cross arm projections for Dead end towers shall be fixed in such a way that it can accommodate a condition of 15 degree deviation of conductors towards tower at both Left and Right side cross arms on slack span side and 0-15 degrees deviation on line side.
- 1.4.6 Conductor and Earthwire clearance

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For all supports the clearances from conductors, arc horns jumper loops and all live metal to the structure or earthen steel work shall not be less than 1500mm. Where uplift conditions occur at tension tower positions detail should be provided to show that the above requirements are not infringed.

The length of angle structure cross-arm shall be such as to ensure that the distances between conductors from straight line structures are maintained in a plain normal conductor.

The phase distance: the minimum distance between testing point at insulators shall set as per standard practice at IEC or any other standards. Allowance shall be made for increasing or decreasing the length and varying the arrangement of all terminal tower cross arms to enable span connections to be made in any desire phase sequence.

Angle of Shielding

The angle of shielding is defined as the angle formed by the line joining the centre lines of the Earth wire and outer power conductor in still air at tower supports, to the vertical line through the centre line of the Earth wire. Bidders shall design the tower in such a way that the angle of shielding does not **exceed 30⁰** to the vertical at the support and at any point of span. The drop of the Earth wire clamp equal to **150 mm** should be considered while calculating the minimum angle of protection.

1.4.7.2 Clearance between phases

The clearance between the line conductors and ground in still air under the maximum specified temperature and final tension shall not be less than the figure stated

the minimum clearances between live conductors and ground across the river crossing maximum conductor sag conditions is 6100mm.

An additional clearance of **0.5 m** is required to allow for long term conductor creep, which shall be included in the calculation of tower heights.

Where obstruction of other types is met requiring special clearance the clearance shall be approved by the employer. If after the survey and profile is approved any factors likely to cause infringement of clearance become apparent the contractor shall inform the Employer immediately.

The sag of the earth wire for the basic span at the highest temperature still air shall be 80 percent of the phase conductors. The distance between conductors belonging to different circuits shall be **1.20 times** the distance belonging to the same circuit. However, the distance shall not be smaller than 2 m.

1.4.8 Erection loads

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Bidders shall fully consider the loading conditions for the towers and provide adequate margins of strength in the designs for unbalanced erection loadings. The Bidder shall indicate on Tender drawings to which points on the towers to be proposed to use back stays when stringing conductors and shall state what factors of safety are obtained under these conditions.

1.4.8.1 Design

The design of all supports, conductors, insulators and fittings shall be such as to minimize the risk of damage or deterioration in service of any part of the transmission lines due to vibration.

The calculation procedures applied for support and foundation design shall be showed by Bidder.

1.4.9 Mid Span Clearance

The minimum vertical mid span clearance between the Earth wire and the nearest power conductor shall not be less than **2.5 meters** which shall mean the vertical clearance between Earth wire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the Earth wire and power conductor shall be so coordinated that the sag of Earth wire shall be at least 10% less than that of power conductors under all temperature loading conditions.

1.5 LOADING CONDITIONS

1.5.1 The conductors, insulators, accessories and towers shall withstand the following load combinations

1. Minimum temperature

This combination includes:

- the weight of structures, conductors and accessories
- the conductor loads in min. temperature condition

2. Maximum wind

This combination includes:

- the weight of structures, conductors and accessories
- the conductor loads in max. wind conditions
- the wind load on the structure, conductors and accessories

3. Broken wire

This combination includes:

- the weight of the structures, conductors and accessories
- the load due to breakage of one conductor or earth wire tension reduced to **60 %** of the max. working tension
- other loads as in normal condition at EDS temperature

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4. Conductor stringing

This combination includes:

- the weight of the structures, conductors and accessories
- the loads due to stringing of the conductors in the stringing conditions

Loading diagrams for each condition shall be submitted with bid document.

1.5.1 Wind Loads on Tower Body

The wind load on tower body shall be calculated by the Contractor. The following loading data and method shall be applicable for calculating the wind load on tower body.

- a) Dynamic reference wind pressure $P_d = 0.6 \times V_d^2$
where;

P_d = Design wind pressure in N/m²

V_d = Design wind speed in m/sec

$$V_d = V_R \times K_1 \times K_2$$

Where; V_R – reference wind speed in m/sec 47m/s

K_1 – Risk coefficient (for 50 years return period $K_1 = 1.0$)

K_2 - Terrain roughness coefficient, 1.08

- b) The angle of incidence of Wind θ (Theta) = 0 Degree.
- c) The resultant ultimate wind load on a panel under consideration for wind normal to the longitudinal face of towers on the panel height applied at centre of gravity of the panel shall be given by

$$F_{wt} = P_d \times C_{dt} \times A_e \times G_T$$

where,

A_e = total net surface area of the legs, bracings, cross arms and redundant members projected normal to the face.

C_{dt} = drag coefficient shall be as given in Table 1.5.

TABLE 1.5

SOLIDITY RATIO	C_{dt}
Up to 0.05	3.6
0.1	3.4
0.2	2.9
0.3	2.5
0.4	2.2

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0.5 and above 2.0

NOTE

- * Solidity ratio is equal to the effective area (projected area of all the individual elements) of a panel normal to the wind direction divided by the area enclosed by the boundary of the panel normal to the wind.
- * Intermediate values may be linearly interpolated.
- * Drag coefficient takes into account the shielding effect of wind on the leeward face of the tower. However, in case the bracing on the leeward face is not shielded from the windward face, then the projected area of the leeward face of the bracing should also be taken into consideration.

G_T = gust response factor shall be as given in Table 1.6.

TABLE 1.6

HEIGHT ABOVE GROUND (m)	G_T
Up to 10	1.70
20	1.85
30	1.96
40	2.07
50	2.13
60	2.20

NOTE

- * Intermediate values may be linearly interpolated.

5.1.1.1.1. Wind loads on tower body F_{wt} shall be applied on the tower at Earth wire peak and cross arm levels and any one convenient level between bottom cross arm and ground level for normal tower. In case of tower with extensions, one more application level shall be taken at top end of extension. Tower body wind loads shall be equally distributed to top and bottom points of application.

1.5.1.2 Strength Factors Related to Quality

To account for reduction in strength due to dimensional tolerance of the structural sections and yield strength of steel used, the following strength factors shall be considered:

- a) if steel with minimum guaranteed yield strength is used for fabrication of tower, the estimated loads shall be increased by a factor of 1.02.

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- b) if steel with minimum guaranteed yield strength is not used for fabrication of tower, the estimated loads shall be increased by a factor of 1.05, in addition to the provision of (a) above.

1.5.2 Maximum Tension

1.5.2.1 Max. tension shall be based on either

- a) at 0 deg C with 36 percent full wind pressure, or
b) at 15 deg C with full wind pressure whichever is more stringent.

1.5.3 Limiting Tensions of Conductor & Earth wire

The ultimate tension of conductor and Earth wire shall not exceed 70 per cent of the ultimate tensile strengths.

1.5.4 Broken Wire Condition

1.5.4.1 Tower Type DD/DE

Breakage of all the three phases on the same side and on the same span or breakage of two phases and one Earth wire on the same side and on the same span, whichever combination is more stringent for a particular member.

1.6 DESIGN OF TOWERS

1.6.1 Design Criteria

Towers shall be designed based on spans and clearances as per Clause 1.3 & 1.4 and loading conditions as per Clause 1.5 above.

1.6.2 Design Temperatures

The following temperature range for the conductors and OPG wires shall be adopted for line design:

- i) Minimum Temperature: 0 deg.C
ii) Every day temperature of conductor: 32 deg.C
iii) Max. temperature of
a) Conductor: 80 deg.C
b) Earthwire exposed to sun: 53 deg.C

1.6.3 Conductor and Earth wire Configuration

For double circuit towers the three phases shall be in vertical formation. The phase to phase spacing for conductors shall be not less than 2 meters for DDE towers. However, the minimum horizontal separation between phase conductors of two circuits shall be minimum 5 meters. In double circuit suspension towers single suspension vertical (I-type) or double suspension vertical (II type) insulator strings shall be used.

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The Earthwire configuration shall be such that the conductor is to be shielded in all cases within the specified shielding angle.

1.6.4 Redundant Design

- 1.6.4.1 All redundant in the tower are to be triangulated.
- 1.6.4.2 All bracing and redundant members of the towers which are horizontal or inclined up to 15° from horizontal shall be designed to withstand an ultimate vertical load of 1500 N considered acting at centre independent of all other loads. The bending moment for designing of redundant members shall be considered as WL/4 irrespective of end connections and continuity. The Contractor has to furnish the calculations for the same (where W is ultimate load of 1.5 kN and 'L' is the length of redundant from bolt to bolt).
- 1.6.4.3 All redundant shall be designed individually for 2.5% of maximum axial load of connecting members (i.e. leg members, bracing members etc.). The Contractor has to furnish the calculations for the same.
- 1.6.4.4 Connection of single Redundant to leg member having a section of 110 x 110 x 10 and above, shall be done with minimum of 2 bolts.

1.6.5 Thickness of Members

The minimum thickness of angle sections used in the design of towers, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:

MINIMUM THICKNESS AND SIZE OF STEEL MEMBERS

Minimum thickness of steel members of structures shall be as follows:- For leg members and compressive chords in Gantries: 6 mm

For other members without calculated stress: 5 mm

For redundant members without calculated stress: 5 mm Gusset plates: 6 mm Minimum

bolt diameter for main members: 16 mm carrying calculated stress

Minimum bolt diameter for bracing member: 12 mm without calculated stress.

In computing the net section of tension members, the diameter of the bolt holes shall be taken as 1.5 mm. greater than the nominal diameter of the bolts.

- 1.6.5.1 For the purpose of calculating shearing stress and bearing stress for bolts clause 5.4 of IS: 802 (Part-1/Sec 2):1992 shall be referred.

1.6.6 Slenderness Ratio

Slenderness ratio for members shall be computed in accordance with clause 6.4 of IS: 802 (Part-1/Sec 2):1992.

- 1.6.6.1 Slenderness ratio for compression and tension members shall not exceed the values specified therein.
- 1.6.6.2 The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:

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- | | | |
|----|--|-----|
| a) | For main corner leg members including the corner members of Earth wire peak and the lower corner members of the cross-arms | 120 |
| b) | For other members having calculated stresses | 200 |
| c) | For redundant members | 250 |
| d) | For members having tensile stress only | 375 |

1.6.7 Erection Stress

Where erection stress combined with other permissible co-existent stresses could produce a working stress in any members appreciably above the specified working stress, such other provision are to be made as may be necessary to bring the working stress within the specified limit.

1.6.8 Structural Arrangement of Members in a Tower

1.6.8.1 Internal angle between two members shall not be less than 15 degrees.

1.6.9 Design Calculation and Drawings

1.6.9.1 The following design calculation and drawings are required to be furnished to the Employer:

A) ALONGWITH THE BID:

Detailed design calculations and drawings for DDE type towers.

The Contractor shall submit detailed design of tower & extension along with stress diagram / computer output together with sample calculations for few critical members etc., stub templates and loading / rigging arrangement of tower testing to enable the Employer to make a preliminary check regarding structural stability of tower (before) tests.

- Detailed design calculation and drawing for towers and foundations.
- Detailed structural drawings indicating section size, length of members, sizes of plates along with hole to hole distance & joint details etc.

1.7 MATERIALS

1.7.1 Tower Steel Sections

IS Steel Sections of tested quality of conformity with IS: 2062 (Designated Y.S. 250 MPa) or / and IS: 8500 grade 490 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stub and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards. However, use of steel grade having designated yield strength

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more than that of EN 10025 grade 355 JR /JO is not permissible. The Bidders are permitted to opt for not more than one (1) grade of steel in the package.

Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS : 1079 -1994 (Grade -0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz. gusset plates , joint splices etc. the same shall conform to IS:2062 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to Fe-410 or above grade (designated yield strength not more than 355 MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength and metallurgical properties may also be used in place of plates for packing plates/packing washers. The chequered plates shall conform to IS: 3502-1994.

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

1.7.2 Fasteners: Bolts, Nuts and Washers

- 1.7.2.1 All tower members shall be joined together with Bolts and nuts. All hexagonal bolts and nuts shall conform to IS-12427. They shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.
- 1.7.2.2 All bolts and nuts shall be galvanized as per IS:1367 (Part-13) / IS:2629 .
- 1.7.2.3 The bolt shall be of 16 / 24 mm diameter and of property class 5.6 as specified in IS:1367 (Part-III) and matching nut of property class 5.0 as specified in IS:1367 (Part-VI).
- 1.7.2.4 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MPa minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 (Part-I) to ensure proper bearing.
- 1.7.2.5 Nuts for hexagonal bolts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.
- 1.7.2.6 Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.
- 1.7.2.7 All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.
- 1.7.2.8 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro-galvanised,

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positive lock type and 3.5mm in thickness for 16mm dia bolt and 4.5mm for 24mm bolt.

- 1.7.2.9 **To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.**
- 1.7.2.10 **The bolt positions in assembled towers shall be as per IS:5613 (Part-II / Section 2) -1976 .**
- 1.7.2.11 **Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.**
- 1.7.2.12 **To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS:14000 series Quality System Standard.**

1.8 TOWER ACCESSORIES

Arrangement shall be provided for fixing of all tower accessories to the tower at a height between 2.5 meters and 3.5 meters above the ground level.

1.8.1 Step Bolts & Ladders

Each tower shall be provided with step bolts conforming to IS : 10238 of not less than 16mm diameter and 175mm long, spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top of the tower. However, the head diameter shall be 50mm as indicated in the enclosed drawing. For double circuit tower the step bolt shall be fixed on two diagonally opposite legs up to top of the towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special towers, where the height of the super structure exceeds 50 meters, ladders along with protection rings as per the Employer's approved design shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 2.5m to 30m height of super structure step bolts shall be provided. Suitable platform using 6mm thick perforated chequered plates along with suitable railing for access from step bolts to the ladder and from the ladder to each cross-arm tip and the Earth wire support shall also to be provided. The platform shall be fixed on tower by using counter-sunk bolts.

1.8.2 Insulator String Attachments

- a) For the attachment of suspension Insulator string, a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-shackles etc. as required and considered in the design of the tower shall have minimum ultimate tensile strength of 140 KN for double suspension string for 132 kV suspension towers. The design and supply of hanger, D-shackles, strain plates etc. are also in the scope of the Contractor.
- b) At tension towers, strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details

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of the attachments shall be provided by the Contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor.

1.8.3 Earth wire Clamp Attachments

- a) Suspension Clamps
Earth wire suspension clamps will be supplied by the Contractor. The detailed drawing shall be submitted by the Contractor for the Employer's approval. The Contractor shall also supply U- bolts, D-shackles wherever required.
- b) Tension Clamps
Earth wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The Contractor shall also supply the U-bolts wherever required and take the Employer's approval for details of the attachments before the mass fabrication.

1.8.4 Anti Climbing Device

Barbed wire type anti climbing device shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS-278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS:1340.

1.8.5 Danger, Number, Circuit and Phase plate

Danger plates, Number plates, Circuit plates and Phase plates shall be provided and installed by the Contractor.

- a) Each tower shall be fitted with a danger plate, number plate and one (1) set of phase plates for double circuit tower. Circuit plates shall be provided on all the Double Circuit towers.
- b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS-2551 and shall be in a signal red on the front of the plate.
- c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.
- d) The letters of number and circuit plates shall be red enameled with white enameled background.

1.9 TOWER FABRICATION

The fabrication of towers shall be in conformity with the following:

- 1.9.1 Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.
- 1.9.2 Butt splices shall be used and the inside angle and outside plate shall be designed to transmit the load. Inside cleat angle shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal sizes and the inside angle of lap splice shall be rounded at the heel to fit the root radius of the outside angle. All the splices shall develop full strength in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main

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panel point as possible.

- 1.9.2.1 Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacers plates may be used in conformity with modern practices. The thickness of the gusset plates, required to transit stress shall not be less than that of members connected.
- 1.9.2.2 The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.
- 1.9.3 The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.
- 1.9.4 No angle member shall have the two leg flanges brought together by closing the angle.
- 1.9.5 The diameter of the hole shall be equal to the diameter of bolt plus 1.5 mm.
- 1.9.6 The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.
- 1.9.7 All identical parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.
- 1.9.8 **Drilling and Punching**
- 1.9.8.1 Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.
- 1.9.8.2 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness up to 16mm. Tolerances regarding punched holes are as follows:-
- Holes must be perfectly circular and no tolerances in this respect are permissible.
 - The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.
 - Holes must be square with the plates or angles and have their walls parallel.
- 1.9.8.3 All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.
- 1.9.9 **Erection mark**

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1.9.9.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing.

1.9.9.2 Erection Mark shall be A-BB-CC-DDD

A = The Employer's code assigned to the Contractors - Alphabet

BB = The Contractor's Mark-Numerical

CC = Tower Type Alphabet.

DDD = Number mark to be assigned by the Contractor - Numerical.

Erection mark for high tensile steel members shall be prefixed by the letter "H".

1.10 QUANTITIES AND WEIGHTS

1.10.1 The provisional quantity of towers & extensions are mentioned in the respective Schedule of Prices. Final quantities shall be determined after completion and approval of the tower spotting & check survey. The final quantities of tower shall be confirmed by the Employer based on the required quantities of various towers & extensions furnished by the Contractor after completion of final tower spotting & check survey. Hence it will be responsibility of the Contractor to intimate the exact requirements of all towers and various line materials required for line immediately after the tower spotting & check survey.

The Employer reserves the right to order the final quantities including reasonable quantities of spares for which the rates quoted in the Bid shall be valid. Regarding quantity variation the provisions of relevant clauses of SCC shall apply.

1.10.2 The estimated unit weight of each type of galvanized towers, stubs and leg extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un galvanized) weight of steel members of the size indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weights due to holes, notches and bevel cuts etc. but taking into consideration the weight of the ant climbing devices, D shackles, hangers, strain plates, pack plates, gusset plates and pack washers etc. The weight of gusset plates shall mean the weight of its circumscribing rectangle, without taking into consideration the reduction in weights due to holes, notches etc. For bolts and nuts along with spring washers and step bolts, the weight per tower shall be calculated from the bolt schedule applicable to each type of towers, stubs and leg extensions as approved by the Employer. The rate quoted by the bidder for supply of tower / tower parts is deemed to be inclusive of galvanizing charges including the cost of zinc.

1.10.3 The Contractor is permitted to get inspected and supply up to 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.

1.11 GALVANIZING

1.11.1 Fabricated Tower Parts & Stubs

The tower parts, stubs and pack washers shall be hot dip galvanized .The galvanization shall be done as per requirements of IS 4759 after all fabrication work is completed. The Contractor shall also take guidelines from the recommended practices for hot dip

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galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

The preparation for galvanizing and galvanizing itself shall not distort or adversely affect the mechanical properties of the material.

For all parts other than steel wires, the coating shall consist of at least 610 grams of zinc per square meter of surface and be not less than 0.086 mm in thickness.

The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black bare spots, ash rust stains, bulky white deposits / wet storage stains and blisters.

1.11.2 Fasteners

For fasteners, the galvanizing shall conform to IS-1367(Part-13). The galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts, may however be tapped (threaded) or rerun after galvanizing and the threads oiled .The threads of bolts & nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts. Spring washers shall be electro galvanized as per Grade-IV of IS-1573.

1.12 EARTHING

The Contractor shall measure the tower footing resistance (TFR) of each tower after it has been erected and before the stringing of the earth wire during dry weather. Each tower shall be earthed. The tower footing resistance shall not exceed 10 ohms. Pipe type earthing and counter poise type earthing wherein required shall be done in accordance with the latest additions and revisions of:

IS: 3043 Code of practice for Earthing.
IS:5613 Code of practice for Design, Installation and maintenance
(Part-II/Section-2) of overhead power lines.

1.12.1 **The details for pipe & counterpoise type earthing are given in the drawings enclosed with these specifications.**

1.12.2 **For counterpoise type earthing the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30m counterpoise wire. Otherwise, for soil resistivity greater than 1500 ohms meter earthing shall be established by providing 4 length of 70m counterpoise wire. In case resistivity does not come down less than 10 ohms even after providing 70 m counterpoise wire, the Contractor shall submit a statement in this regard to the Employer to know further course of action.**

1.12.3 **The provisional quantities for pipe type earthing and counterpoise earthing are furnished in the Price Schedule. The bidders are required to quote unit rates for the same in appropriate Price Schedule. The quoted price shall include fabrication, supply and installation of earthing material including supply of coke, salt etc. In case of counterpoise type earthing, the quotation shall be based on 120 meters of wire per tower.**

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1.13 INSPECTION AND TESTS

1.13.1 General

All standard tests, including quality control tests, in accordance with appropriate Indian / International Standard, shall be carried out unless otherwise specified herein.

1.13.2 Inspection

In addition to the provision of GCC the following shall also apply:

1.13.2.1

- a) The Contractor shall keep the Purchaser informed in advance about the time of starting and of the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.
- b) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

1.13.2.2 The Employer or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Employer's material for satisfying himself that the fabrication is being done in accordance with the provisions of the Specification.

1.13.2.3 Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be concluded so as not to interfere unnecessarily with the operation of the work.

1.13.2.4 Should any member of the structure be found not to comply with the supplied design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Purchaser or his authorized representative considers that the defects can be rectified.

1.13.2.5 Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the Employer.

1.13.2.6 All gauges and templates necessary to satisfy the Purchaser shall be supplied by the Contractor.

1.13.2.7 The specified grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.

1.14 PACKING

1.14.1 Angle section shall be wire bundled.

1.14.2 Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tied and bolted together in multiples or securely wired through holes.

1.14.3 Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents.

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1.14.4 **The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked.**

1.15 STANDARDS

1.15.1 **The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following Indian Standards (IS) / International Standards which shall mean latest revisions, with amendments / changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.**

1.15.2 **The material and services covered under these specifications shall be performed as per requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.**

Sl. No.	Indian Standards (IS)	Title	Internationally recognized Standards/Guides
1.	IS:209-1992	Specification for Zinc	ISO/R/752 ASTM B6
2.	IS 278-1991	Galvanized Steel Barbed wire	ASTM A131
3.	IS 800-1991	Code of Practice for General Building Construction in Steel	CSA 6.1
4.(a)	IS:802(Part1) Sec 1-1995 & Sec 2-1995	Code of Practice for Use of Structural Steel in Overhead Transmission Line Towers : Materials, loads and Permissible Stresses. Section 1 Materials and loads Section 2 Permissible stresses.	ASCE 52 IEC 826 BS 8100
4.(b)	IS:802-1990 (Part 2)	Code of Practice for Use of Structural Steel in Overhead Transmission Line Towers : Fabrication, Galvanizing, Inspection and Packing	ASCE 52
4. (c)	IS:802-1990 (Part 3)	Code of Practice for Use of Structural Steel in Overhead Transmission Line Towers : Testing	ASCE 52 IEC 652

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5.	IS:808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
6.	IS:875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
7.	IS:1363-1990	HexagonNuts size range M5 to M36)	
8.	IS:1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
9.	IS:1477-1990	Code of practice for Painting of Ferrous Metals in Buildings: Part-I Pre-treatment. Part-II Painting.	
10.	IS:1573-1991	Electro-Plated Coatings of zinc on iron and Steel.	
11.	IS:1852-1993	Rolling and Cutting Tolerances of Hot Rolled Steel Products	
12.	IS-1893-1991	Criteria for Earthquake Resistant Design of Structures	IEEE 693
13.	IS:2016-1992	Plain Washers ISO/R887	ANSIB18-22.1
14.	IS:2062-1992	Steel for general structural purposes	
15.	IS:2074-1992	Ready Mixed Paint. Air Drying, Red Oxide, Zinc Chrome, Priming Specification.	
16.	IS:2551-1990	Danger Notice Plates	
17.	IS:2629-1990	Recommended Practice for Hot Dip Galvanising of iron and steel.	
18.	IS:2633-1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	ASTM A123 CSA G164
19.	IS:3043-1991	Code of Practice for Earthing	
20.	IS:3063-1994	Single coil Rectangular section Spring Washers for	DIN-127

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Bolts, Nuts Screws

- | | | | |
|-----|---------------|--|-----------|
| 21. | IS:3757-1992 | High Strength Structural Bolts | |
| 22. | IS:4759-1990 | Specification for Hot zinc coatings on structural steel and other Allied products | |
| 23. | IS:5369-1991 | General Requirements for Plain Washers | |
| 24. | IS:5613-1993 | Code of Practice for Design installation and Maintenance of Overhead Power Lines Section 1 Design Part 2, Section 2 Installation and Maintenance | |
| 25. | IS:6610-1991 | Specification for Heavy Washers for Steel structures. | |
| 26. | IS:6623-1992 | High Strength Structural Nuts | |
| 27. | IS:6639-1990 | Hexagon Bolts for Steel Structure. CSA B334 | ASTM A394 |
| 28. | IS:6745-1990 | Method for Determination of weight of Zinc coated iron and Steel Articles. | ASTM A90 |
| 29. | IS:8500-1992 | Specification for Weldable Structural Steel (Medium & High Strength Qualities) | |
| 30. | IS:10238-1989 | Step Bolts for Steel Structures | |
| 31. | IS:12427-1988 | Bolts for Transmission Line Towers | |

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CHAPTER 2

LINE CONDUCTORS AND ACCESSORIES

General

The scope of work comprises of manufacture, factory test, supply, stringing and commissioning of ACSR "Wolf" conductor with Earthwire as follows;

- (a) Construction of 33kV double-circuit Rapti river crossing

2. PARTICULAR TECHNICAL SPECIFICATIONS

2.1 Line Conductors, Insulators & Fittings and GW

2.1.1 Conductor specification

All conductors shall be of aluminum conductor steel reinforced (ACSR) construction and shall be manufactured in strict conformity with **BS215 Part 2**.

The steel core and the first layer of aluminum of ACSR conductors shall be greased. The grease shall be of neutral type and at a temperature of 100 degree C the grease shall neither flow within nor extrude from the conductor.

The grease shall retain its properties as resistance to oxidization and chemical stability, at all service temperatures.

The steel strands of ACSR conductors shall be performed so that they remain inert and do not move relative to each other when the conductor is cut. The outermost layer of all conductors shall be stranded with right hand lay.

The correct tension must be maintained on the stranding machine when spinning the cable to avoid the possibility of bird caging during stringing. Any conductor not complying may be rejected at the discretion of the Employer.

The purity of the aluminum shall be the highest commercially available and not less than 99.5%, the copper content not exceeding 0.04%. The Contractor shall submit certificates of analysis giving the percentage and nature of any impurities in the metal from which the wires are made. Aluminum wires shall be made **to B.S. 2627** and steel wires to **B.S. 4565**.

Precautions shall be taken during the manufacture, storage and erection of steel-cored aluminum conductors to prevent the possibility of contamination by copper or other materials which may adversely affect the aluminum. The manufacture of steel-cored aluminum conductors shall be carried out in a portion of the factory specially set aside for

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such purposes. Machinery previously used in the manufacture of copper or copper bearing conductors shall not be used for the manufacture of these aluminum or steel wires.

2.1.2 Conductor size

The size and composition of all phase conductors shall be as stated in

Item	Description	Unit	Data
1.	wolf "wolf"		
1.1	Conductor size	mm ²	150
1.2	Conductor type	ACSR	Wolf
1.3	Number and size of wires		
1.3.1	Aluminum	No dia. mm	30 2.59
1.3.2	Steel	No. dia.mm	7 2.59
1.4	Cross section		
1.4.1	Aluminum	mm	158.1
1.4.2	Steel	mm	33.88
1.4.3	Total	mm	194.9
1.5	Conductor diameter	mm	18.13
1.6	Ultimate strength	kg	6734
1.7	Modulus of elasticity final	kg/mm	
1.8	Coefficient of linear expansion	per ⁰ C	17.8x10-6
1.9	Standard mass of conductor	kg/km	726
1.10	Electrical D.C. resistance at 20 degree C	Ohm/km	0.1828
1.11	Standard unjointed length on reel	m	2,000
1.12	Every day stress	N/mm ²	60
1.13	Standards	BS 215 PART 2	

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All other accessories such as preformed armour rods, mid span compression joints, repair sleeves, flexible copper bonds, vibration dampers, suspension and tension clamps shall be as per drawing/requirements.

2.1.3 Conductor drum lengths

Conductors shall be supplied on drums of approved construction and the drums shall be securely battened to protect the conductor. Drum battens shall not be removed until the drum is properly mounted at the drum station on the line and battens shall be immediately refitted to the drum if any surplus conductor is left thereon.

Each drum shall be marked the length and size of the conductor and in addition, the conductor manufacturing batch number shall be inscribed on the drum. Empty drums shall become the property of the NEA and be returned by the Contractor to the NEA's stores nominated by the NEA. The maximum length of conductor shall not be exceed 2 km per drum

2.2 **TESTS**

2.2.1 The manufactured conductor shall be tested in full compliance with the governing standard and a certified test report shall be produced for all tests conducted.

2.2.2 All conductors shall be packaged in non-returnable wooden reels and shall be protected against damage in handling, shipping, and storage by heavy wood lagging securely applied to each reel. All reels shall be sufficiently sturdy to with stand shipment, storage, and field construction operations without or distortion of disintegration.

2.2.3 All reels shall be legibly marked in paint with the following information.

- a) Size of conductor.
- b) Type of conductor.
- c) Length in meters.
- d) Net weight of conductor.
- e) Direction of rolling.

2.3. **BID DOCUMENTATION**

2.3.1 The BIDDER shall provide with the Bid Two (2) clear copies of the Standard governing fabrication of the conductor and two (2) clear copies of all other specifications referenced therein as relevant to the fabrication and testing of the ACSR conductor.

2.3.2 The BIDDER shall provide the name and the address of the manufacturers of the cable being offered and the length of the cable in the manufacturer's standard reels including net and gross weights.

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2.3.3 The SUPPLIER shall also provide with the Certificate of compliance, as specified in Paragraph 4.3 of BS 2015, Part2:1970, at the time of shipment of each lot of conductor, or as required by the appropriate section of the equivalent national standard.

2.3.4 All data supplied shall be bound separately from the Bid Document.

2.2.7 Vibration dampers

Each conductor including the earth wire shall be fitted with vibration dampers. Except for particularly long spans, two dampers per conductor and one damper for earth wire shall be erected in one side of each span at suspension and tension positions.

The dampers shall be of an approved type, shall have conductor clamps of aluminum alloy, and shall be attached to the conductors in such a manner as will prevent damage to the conductors and to individual strands thereof.

Evidence of the adequacy of the dampers shall be provided by copies of typical Vibration Recorder Tests carried out by the damper manufacturer.

The manufacturer shall calculate the number of dampers per span, the position and the maximum span length for each damper size. The calculation shall be based on the following data:

- a) Conductor and conductor arrangement, armour rods
- b) Equivalent span lengths
- c) Conductor height above ground

The calculations shall be made for the following three terrain conditions, if not indicated otherwise or instructed by the NEA:

- a) Hilly terrain, with trees and obstructions
- b) Flat terrain, no trees, no obstructions
- c) Undulating, relatively open country with some trees

2.2.8 Armor rod

Armor rod shall be of the preformed type and shall be made of a material compatible to that of the conductor and shield wire. Rod shall be shaped in such a way that they will grip the conductor and shield wire tightly. The rod shall be capable of being installed by hand without the use of special tools. The length of the rod shall be determined by the manufacturer of vibration dampers.

2.4. EARTH WIRE

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- a. The isokeraunic level in the project area is reported to be high, so that good lightning protection with one or more overhead ground wires is necessary for avoiding direct a lightning stroke to the conductor.
- b. For the 33 kV transmission lines of this project, one ground wire is to be strung above the line conductors to protect the line conductor from lightning strokes. The maximum angle of shade protection of the ground wire to any top conductor shall not be greater than 30° to the vertical at the support and at any point in the span.

Two ground wires are installed in each slack span of the 33kV line between the dead end tower and the adjacent substation steel structure, in order to cope with enlargement of the horizontal space of the line conductors.

The ground wire is a galvanized steel wire with 7 strands, which has a strong corrosion resistance.

- c. The vertical separation between the ground wire and the line conductor at mid-span must be larger than that at the towers, so as to prevent line-to-ground flashovers in mid-span. Therefore, the ground wire is so strung as to give a ground wire dip which is approximately 80 percent of the conductor dip at 0oC, and the maximum working tension of the ground wire at the severest condition is determined based on such a dip requirement.
- d. The following ground wire is selected in accordance with the mechanical requirements described in the preceding paragraph. Detailed data of the ground wire is shown in Table 8.
- e. The factor of safety applied for earth wire in design works shall be as follows:

Earth wire based on earth wire Ultimate tensile strength	4.0
Earth wire at still air everyday temperature based on earth wire ultimate tensile strength	6.
Complete tension assembly at earth wire maximum working tension	4.0
Complete suspension assembly at	4.0

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Table 8. Earth wire data

Item	Description	Unit	Data
1	E.H.S.Galvanized Steel Wire		7/3.35
1.1	Nominal sectional area	mm ²	61.7
1.2	Number and diameter of component	No	7 Wire
1.3	Weight of wire	kg/km	483
1.4	Overall diameter	mm	10.05
1.5	Ultimate breaking strength	kg	7,400
1.6	Modulus of elasticity final	kg/mm	19000
1.7	Coefficient of linear expansion	per C	1.5x10 ⁻⁵
1.8	Electrical D.C resistance at 20 C	ohm/km	
1.9	Standard unjointed length on reel	m	2,000
1.10	Standards		BS 183, IEC 209

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Chapter 3 : INSULATOR AND ACCESSORIES

3.1 Composite Long Rod Insulator

The Insulator strings consist of Composite long rod insulators (HT-Silicon Rubber) for a three phase, 50 Hz, effectively earthed 33 kV transmission systems in a lightly polluted atmosphere. Coupling shall be ball and socket type. The composite insulator shall generally conform to latest standards as listed in annexure.

Bidder shall quote such composite insulators which have proven use under foggy/humid operational conditions. The Bidder shall furnish evidence in the form of certification from the power utilities that the similar type of product supplied to them had been performing satisfactory. The Bidder shall also submit certified test report for an accelerated ageing test of 5000 hours such as that described in Appendix-C of IEC-61109

The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware fittings shall be as follows:

Type of insulator : long rod insulator

Nominal system voltage : 33 kV (rms)

Highest system voltage : 36 kV (rms)

Visible discharge test voltage : 27 kV (rms)

Wet power frequency withstand voltage : 75 kv (rms)

Impulse withstand voltage: 170 kV(rms)

Minimum creepage distance : 900 (mm)

Center to center distance between tongue and clevis : 550(mm)

Min failing load : 70(kN)

Shed diameter min : 100(mm)

Note: The bidder shall offer composite long rod insulators of suitable core dia to meet specified E&M strength requirements. Bidder shall submit the overall string length and other details with the Bid.

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3.2 Pin and Cap

Pin and Cap shall be designed to transmit the mechanical stresses and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric, of such design that it will not yield or distort under load conditions.

The design shall be such as to permit easy removal or replacement of either insulator units or fittings under the live line conditions.

3.3 Security Clip

Security clip for use with ball and socket coupling shall be of R-shaped hump type which shall provide positive locking of the coupling as per IS: 2486-(Part-III)/IEC: 372. The legs of the security clips shall be spread after installation to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall locking device allow separation of insulator units or fittings.

The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required to pull the security clip into its unlocked position shall not be less than 50N (5 kg) or more than 500N (50 kg).

3.4 Ball and Socket Designation

The dimensions of the balls and sockets shall be of 16 mm designation for 90 kN & 20 mm designation for 160 kN disc insulator in accordance with the standard dimensions stated in IS: 2486 - (Part - II)/IEC:120.

3.5 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows:

$\pm (0.04d+1.5)$ mm when $d \leq 300$ mm.

$\pm (0.025d+6)$ mm when $d > 300$ mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance.

3.6 Interchangeability

The composite long rod insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant Indian/IEC Standards.

3.7 Corona and RI Performance

All surfaces must be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator metal parts shall be so designed and manufactured that it shall not generate any Radio Interference beyond specified limit and not produce any noise generating corona formation under the operating conditions.

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3.8 Maintenance

The long rod insulators offered shall be suitable for employment of hot line maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

3.9 Materials

Polymeric Insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions. Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:- (a) Core- the internal insulating part (b) Housing- the external insulating part
(c) Metal end fittings.

3.9.1 Core

It shall be a glass-fiber reinforced (FRP rod) epoxy resin rod of high strength. Glass fibers and resin shall be optimized. The rod shall be electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

3.9.2 Housing & Weathersheds

The FRP rod shall be covered by a seamless sheath of a HT-silicone rubber compound of a thickness of minimum 3mm. The housing & weathersheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be furnished along with the bid. The details for this shall be finalized during detailed engineering and finalization of MQP.

The weathersheds of the insulators shall be of alternate shed profile. The weathersheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

3.9.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron spheroid graphite or forged steel. They shall be connected to the rod by means of a controlled compression

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technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The sealing must be humidity proof and durable with time.

3.10 Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the extra high voltage field. Suppliers shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for Transmission lines specified and will give continued good service.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners to limit corona and radio interference.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

The core shall be sound and free of cracks and voids that may adversely affect the insulators.

Weathersheds shall be uniform in quality. They shall be clean, sound, smooth and free from gross defects and excessive flashing at parting lines.

End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 600 gm/sq.m and shall be in accordance with the requirement of IS:2629 and shall satisfy the tests mentioned in IS:2633. The zinc used for galvanizing shall be of Grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

3.12 Bid Drawings

The Bidder shall furnish full description and illustration of the material offered.

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The Bidder shall furnish along with the bid the outline drawing (2 copies) of each insulator unit including a cross sectional view of the insulator shell. The drawing shall include but not limited to the following information:

- a) Long rod diameter and ball to ball spacing with manufacturing tolerances
- b) Minimum Creepage distance with positive tolerance
- c) Protected creepage distance
- d) Eccentricity of the long rod unit
- e) Axial run out
- f) Radial run out
- g) Unit mechanical and electrical characteristics
- h) Size and weight of ball and socket parts
- i) Weight of composite long rod units
- j) Materials
- k) Identification mark
- l) Manufacturer's catalogue number

After placement of award, the Contractor shall submit full dimensioned insulator drawings containing all the details, in four (4) copies to Employer for approval. After getting approval from Employer and successful completion of all the type tests, the Supplier shall submit 10 more copies of the same drawing to the Employer for further distribution and field use at Employer's end.

After placement of award the Contractor shall also submit fully dimensioned insulator crate drawing for different type of insulators.

3.13 Tests

3.13.1 Type Tests

The equipment should be offered type tested. The Bidder shall submit type test reports as specified in section-2 of this specified along with the bid.

On the complete composite Long Rod Insulator String with Hardware Fittings

- | | | |
|-----|--|-----------------------------|
| (a) | Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition | IEC:383-1993/
Annexure A |
| (b) | Switching surge voltage withstand test under wet condition | IEC:383-1993 |
| (c) | Impulse voltage withstand test under dry condition | IEC:383-1993 |
| (d) | Corona and RIV test under dry condition | Annexure-A |
| (e) | Mechanical Strength test | Annexure-A |
| (f) | Vibration test | Annexure-A |
| (g) | Salt-fog pollution withstand test | Annexure-A |

All the type test given above shall be conducted on Single 'I' suspension, Single Tension, Double tension, Double 'I' suspension insulator string along with hardware fittings.

On Composite Insulator Units

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- | | | |
|-----|---|------------|
| (a) | Tests on interfaces and connections of metal fittings (Tests to be performed on the same samples in the sequence given below) | IEC: 61109 |
| | i. Dry power frequency voltage test | |
| | ii. Sudden load release test | |
| | iii. Thermal mechanical test | |
| | iv. Water immersion test | |
| | v. Steep front impulse voltage test | |
| | vi. Dry power frequency voltage test | |
| (b) | Assembled core load time test | IEC: 61109 |
| | i. Determination of the average failing load of the core of the assembled unit | |
| | ii. Control of the slope of the strength time curve of the insulator | |
| (c) | Brittle fracture resistance test | Annexure-A |
| (d) | Test of housing, Tracking and erosion test | IEC: 61109 |
| (e) | Tests for the core material | IEC:61109 |
| | i. Dye penetration test | |
| | ii. Water diffusion test | |
| (f) | Flammability test | IEC:61109 |
| (g) | Recovery of Hydrophobicity test | Annexure-A |
| (h) | Mechanical Load Time test and test of tightness between end firings and insulator housing | IEC:61109 |
| (i) | Silicone content test | Annexure-A |
| (j) | High Pressure washing test | Annexure-A |

3.13.2 Acceptance Tests:

For Composite Long Rod Insulators

- | | | |
|-----|--|-------------|
| (a) | Verification of dimensions | IEC : 61109 |
| (b) | Galvanising test | IEC : 60383 |
| (c) | Verification of locking system | IEC : 60383 |
| (d) | Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load | IEC : 61109 |
| (e) | Recovery of Hydrophobicity | Annexure-A |
| (f) | Silicone content test | Annexure-A |

In the event of failure of the sample to satisfy the acceptance test(s) specified in above, the retest procedure shall be as per clause 7.6 of IEC 61109.

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3.13.3 Routine Tests

For Composite Long Rod Insulator Units

- a) Visual Inspection As per IEC : 61109
- b) Mechanical routine test As per IEC : 61109

3.13.4 Tests during Manufacture

On all components as applicable

- a) Chemical analysis of zinc used for galvanizing As per Annexure-A
- b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings. As per Annexure-A
- c) Chemical analysis hardness tests and magnetic particle inspection for forgings As per Annexure-A
- d) Tracking and erosion test on insulating material IEC 60587

3.13.5 Testing Expenses

The entire cost of testing for type, acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/CIF Price.

In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/ Employer's representative shall be deducted from the contract price. Also if on receipt of the Supplier's notice of testing, the Employer's representative does not find 'plant' to be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

3.13.6 Sample Batch for Type Testing

The Supplier shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Employer. The Supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Employer.

Before sample selection for type testing, the Supplier shall be required to conduct all the acceptance tests successfully in presence of Employer's representative.

3.13.7 Schedule of Testing

The Bidder has to indicate the schedule of following activities in their bids:

- a) Submission of drawing for approval.
- b) Submission of Quality Assurance Programme for approval.
- c) Offering of material for sample selection for type tests.
- d) Type testing.

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3.13.8 Repeat E&M Strength Test

The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the Specifications.

The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or correction of deficiencies or replacement of defective items, all without any extra cost to the Employer.

3.13.9 Co-ordinate for testing

The Contractor/ Supplier shall have to co-ordinate testing of insulators with hardware fittings to be supplied by other Supplier and shall have to guarantee overall satisfactory performance of the insulators with the hardware fittings.

3.13.10 Guarantee

The Contractor/ Supplier of insulators shall guarantee overall satisfactory performance of the insulators with the hardware fittings.

3.13.11 Test Reports

Copies of type test reports shall be furnished in at least six (6) copies along with one original. One copy shall be returned duly certified by the Employer only after which the commercial production of the concerned material shall start.

Copies of acceptance test reports shall be furnished in at least six (6) copies. One copy shall be returned duly certified by the Employer, only after which the material shall be dispatched.

Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Employer's representative.

Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Employer.

3.13.12 Inspection

The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

The material for final inspection shall be offered by the Supplier only under packed condition.

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The Employer shall select samples at random from the packed lot for carrying out acceptance tests. Insulators shall normally be offered for inspection in lots not exceeding 2000 nos. for disc insulator. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

The Supplier shall keep the Employer informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Employer in writing. In the latter case also the material shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

The acceptance of any quantity of material shall be no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

3.14 Packing and Marking

All insulators shall be packed in suitable PVC/ plastic tubes/any other suitable packing along with temporary wrap-on shields/shrouds for each insulator unit. The packing shall provide protection against rodent. The shields/shrouds shall be for protection during transport and for preventing bird pecking during erection. Further, the shields/shrouds shall be made of opaque, weather proof material of adequate strength and shall be colour coded. The shields/shrouds shall have smaller diameter than the insulator to stay in place against winds & weather and shall be designed so as to leave only the end fittings exposed for attachment of insulator to tower and line hardware until line construction is complete. The shield/shroud shall have suitable pull off loop for easy detachment just prior to charging of the line without causing any damage to the insulator. The bidder/Supplier shall furnish detailed design of the packing and shield/shroud along with attachment and detachment procedure in this regard. For marine transportation, crates shall be palletted.

The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

The Supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation, handling, storage and installation due to improper packing.

All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each case/crate shall have all the markings stenciled on it in indelible ink.

3.15 Standards

The insulator strings and its components shall conform to the following Indian/ International Standards which shall mean latest revision, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

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In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS: 3436
2.	IS: 406-1991	Method of Chemical Analysis of Slab Zinc	BS: 3436
3.	IS: 731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS: 137- (I&II) IEC: 60383
4.	IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS: 2486 Part- I-1993 Part- II-1989 Part-III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	BS: 3288 IEC: 60120 IEC: 60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:3188-1988	Dimensions for Disc Insulators	IEC: 60305
9.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS: 433-1969 ISO:1460-1973
10.	IS:8263-1990	Methods of RI Test of HV insulators	IEC: 60437 NEMA PublicationNo.07/ 1964/ CISPR
11.	IS:8269-1990	Methods for Switching Impulse test on HV insulators	IEC: 60506
12.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
13.		Salt Fog Pollution Voltage Withstand Test	IEC: 60507
14.		Residual Strength of String Insulator Units of Glass or Ceramic Material for Overhead Lines after Mechanical Damage of the Dielectric	IEC: 60797

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Sl. No.	Indian Standard	Title	International Standard
15.		Guide for the selection of insulators in respect of polluted conditions	IEC:60815

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CHAPTER -4

PRELIMINARY WORK

- 4.1 River Crossings
In case of major river crossings towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be DE type tower. Clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to highest flood level (HFL).
- 4.1 Preliminary Tower Schedule**
The profile sheets, duly spotted, along with preliminary schedules indicating type of towers, type of foundations, wind span, weight span, angle of deviation, river / road crossing and other details shall be submitted for the approval of the Employer. After approval the Contractor shall submit four more sets of the approved reports along with one soft copy on CD of final profile drawings to the Employer for record purpose.
- 4.2 Environmental Conditions**
- 4.2.1 **Forest**
The line route passing through forest stretches covered under this specification shall be furnished to the successful Bidder.
- 4.2.2 **General Climatic Conditions**
Climatic conditions shall be as indicated in this Specification.
- 4.3 Statutory Regulations and Standards**
- 4.3.1 **Statutory Regulations**
The Contractor is required to follow local statutory regulations stipulated in Electricity Regulations of Nepal, 2050 as amended and other local rules and regulations referred in this Specification.
- 4.3.2 Reference Standard
- 4.3.2.1 The Codes and/or standards referred to in the specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions, amendments/changes adopted and published by the relevant agencies unless otherwise specified.
- 4.3.2.2 Other internationally accepted standards which ensure equal or better performance than those specified shall also be accepted, subject to prior approval by the Employer.
- 4.4 Geotechnical Investigations**
- 4.4.1 General

4.4.1.1 The Employer desires that a detailed 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 selected/designed rationally. The entire soil investigation work at river crossing locations (if required) shall be carried out by the Employer. The range of load intensities from the various structures is expected to be between 100 KN/sq. m and 500 KN/sq.m.

4.4.2 **All geotechnical investigation and foundation design work shall be carried out in accordance with the following Indian Standards, Codes and Manual:**

Indian Standards (IS)	Title	International and Internationally Recognized Standard/Code
IS: 1080-1990	Codes of Practice for Design and Construction of Simple Spread Foundations	
IS: 1498-1992	Classification and Identification of Soils for General Engineering purposes.	ASTM D 2487/ ASTM D 2488
IS: 1888- 1982	Method of load tests on soil	
IS: 1892-1992	Code of Practice for Subsurface Investigation for Foundation	
IS: 1904-1986	Code of Practice for Design and Construction of foundation in Soils: General Requirements.	
IS: 2131-1992	Method of Standard Penetration Soils	ASTM D 1586
IS: 2132-1992	Code of Practice for Thin Walled Sampling of Soils	ASTM D 1587
IS: 2720-1992	Method of Test for Soils (Relevant Parts)	ASTM D 420
IS: 2809-1991	Glossary of Terms and symbols Relating to Soil Engineering	ASTM D 653
IS: 2810- 1979	Glossary of terms and symbols related to soil dynamics	

IS: 2911-1980	Code of Practice for Design and construction of pile Foundations (Relevant Parts).	
IS: 3025	Methods of Sampling and Testing (Physical and Chemical) for water used in industry.	
IS: 3043-1991	Code of Practice for Earthing.	
IS: 4078-1990	Code of Practice for Indexing and Storage of Drill Cores.	
IS: 4091-1987	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.	
IS: 4434-1992	Code of Practice for in-situ Vane Shear Test for Soils.	ASTM D 2573/ ASTM D 4648
IS: 4453-1992	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts.	
IS: 4464-1990	Code of Practice for Presentation of Drilling Information and core description in Foundation Investigation	
IS: 4968-(Part-II)-1992	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry	
IS: 5313-1989	Guide for Core Drilling observations.	
IS: 6403-1990	Code Practice for Determination of Allowable Bearing Pressure on Shallow. Foundation	ASTM D 194
IS: 6926-1990	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects.	
IS: 6935-1989	Method of Determination of Water level in a Bore Hole.	
IS: 7422-1990	Symbols and Abbreviations for use in Geological Maps	

	Sections and subsurface Exploratory Logs (Relevant parts).	
IS: 8009 (Part-I)-1993	Code of Practice for Calculation of Settlements of Foundations (Shallow Foundations subjected to symmetrical Vertical Loads).	
IS: 8764-1991	Method of Determination of Point Load Strength Index of Rocks.	
IS: 9143-1991	Method of Determination of Unconfined Compressive Strength of Rock Materials.	ASTM D 2938
IS: 9179-1991	Method of Preparation of Rock Specimen for Laboratory. Testing	ASTM D 4543
IS: 9259-1992	Specification for Liquid Limit Apparatus.	ASTM D 4318
IS: 9640-1992	Specification for Split Spoon Sampler.	ASTM D 1586
IS: 10050-1992	Method of Determination of Slake Durability Index of Rocks.	ASTM D 4644
IS: 11315- (Part-II)-1991	Description of Discontinuities in Rock Mass-Core Recovery and Rock Quality.	
	CBIP Manual on Transmission Line Towers, Chapter – 10 Foundations	

TABLE 4.1

SUMMARY OF RESFULTS OF LABORATORY TESTS ON SOIL
AND WATER SAMPLES

1. Bore hole/ test pit. no
2. Depth (m)
3. Type of sample
4. Density (kg/m³)
 - a) Bulk
 - b) Dry.



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- c) Submerged
5. Water content (%)
6. Particle Size (%)
 - a) Gravel
 - b) Sand
 - c) Silt
 - d) Clay
7. Consistency properties
 - a) LL
 - b) PL
 - c) PI
 - d) L1
8. Soil
 - a) Classification-IS
 - b) Description
 - c) Specific gravity
9. Strength Test
 - a) Type
 - b) c (Cohesion)
 - c) ϕ (angle of internal friction)
10. Consolidation Test
 - a) e_0
 - b) P_c
 - c) C_c
 - d) DP
 - e) M_v
 - f) C_v
11. Shrinkage limit (%)
12. Swell Test
 - a) S.Pr
 - b) FS
13. Relative Density (%)
14. Remarks

Notations:

- I. For type of Sample:
 - DB - Disturbed bulk soil sample.
 - DP - Disturbed samples from cutting edge of undisturbed soil sample.
 - Rm - Remolded soil sample
 - UB - Undisturbed block soil sample
 - US - Undisturbed soil sample by sampler
 - W - Water sample
- II. For Strength Test:
 - SCPT - Static Cone Penetration Test
 - UCC - Unconfined Compression Test
 - VST - Vane Shear Test
 - Tuu - Unconsolidated Undrained Triaxial Test
 - Note: Replace T by D for Direct Shear Test
 - Tod - Consolidation Drained Triaxial Test

III. For Others:

- LL - Liquid Limit (%)
- PL - Plastic Limit
- PI - Plasticity Index
- LI - Liquidity Index
- C - Cohesion (kPa)
- Φ - Angle of Internal Friction (degrees)
- S - Pr. - Swelling Pressure (kPa)
- e₀ - Initial Void Ratio
- P_c - Reconsolidation Pressure (kPa)
- C_c - Compression Index
- DP - Change in pressure (kPa)
- mv - Coefficient of Volume Compressibility (m²/KN)
- C_v - Coefficient of Consolidation (m²/hr)

IV. For Chemical Test

As per Specifications - Clause 4.16.4 of this Chapter.

Rock samples

1. Drill hole no., location
2. Depth
3. Method of drilling
4. Mineral composition
5. Density
6. Moisture content
7. Specific gravity
8. Hardness
9. Sonic wave velocity
10. Slake durability index
11. Unconfined compressive strength, σ_c
 - Saturated
 - In situ water content
12. Modulus of Elasticity, E_t
13. Poisson's ratio, ν
14. Brazilian tensile strength, σ_{tp}
15. Point load strength, σ_{tp}
16. Shear strength parameter, c, ϕ (Triaxial compression)
17. Rock joint parameters
18. Percentage core recovery
19. RQD (Rock Quality Designation)

4.4.3 **Recommendations**

- 4.4.3.1 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.

- a) The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors specified in this Specification all the while experiencing small deformations throughout, thereby avoiding rupture under ultimate loads;
- b) 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;
- c) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

Cone resistance, fractional total resistance, relation between core resistance, Standard Penetration Test No value, and settlement analysis for different sizes of foundation based on static cone penetration test.

- d) For locations where use of shallow foundation may be required the following shall be indicated with comprehensive supporting calculations:
 - i) Net Safe allowable bearing pressure for isolated square footing of sizes 2.0, 3.0, and 4.0 m at three different founding depths of 1.0, 2.0 and 3.0 m below ground level considering both shear failure and settlement criteria giving reasons for type of shear failure adopted in the calculation.
 - ii) Net safe allowable bearing pressure for raft foundations of widths greater than 5m at 2.0, 3.0 and 4.0 m 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, modulus of sub grade reaction, modulus of elasticity from plate load test results along with time settlement curves in both natural and log graph, variation of Modulus of sub grade reaction with size, shape and depth of foundation.
- 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. The loading of the foundations shall not compromise the stability of the surrounding subsurface materials and the stability of the foundation shall be ensured against sliding or overturning.
- f) Depending on the subsurface material, water table level and tower type, either reinforced concrete isolated pad and chimney or any other type of foundations shall be installed at a given location.
- g) Net Safe allowable bearing pressure and uplift resistance 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, and rotation) shall also be given.

- h) In cases where normal open cast 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.
- i) Where the subsoil water and soil properties are found to be chemically aggressive. The Contractor shall take suitable precautions during construction including any protective coating to be applied on the foundations; susceptibility of soil to termite action and remedial measures for the same shall be dealt with;
- j) Suitability of locally available soils at site for filling, backfilling and adequate compaction shall be investigated.
- k) If expansive soil such as block 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;
- i) Susceptibility of subsoil strata to liquefaction in the even of earthquake and remedial measures, if required, shall be considered.
- m) Any other information of special significance such as dewatering schemes, etc., which may have a bearing on the design and construction, shall be provided.
- n) Recommendations for additional soil investigations, beyond the scope of the present work, shall be given if the Contractor considers such investigations necessary.

4.5 Rates and Measurements

4.5.1 Rate

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

CHAPTER-5

TOWER FOUNDATION AND CIVIL WORKS

5.1 Foundations

Reinforced cement concrete footing shall be used for all types of towers in conformity with the present day practices followed in the country and the specification laid herein. Footings for all the four legs (without unequal chimney extension) of the tower and their extension shall be similar, irrespective of down thrust and uplift.

Foundation includes supply of all labour, tools & machineries, materials such as cement, sand, coarse aggregates and reinforcement steel. Rates quoted for foundations in appropriate schedules shall include transportation of construction materials to Site, excavation, stub setting, concreting, reinforcement, shoring, shuttering, dewatering, stock piling, dressing, curing, backfilling the foundation after concreting with excavated / borrowed earth (irrespective of leads), consolidation of earth and carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activities related to completion of foundation works.

5.2 Type of Foundations

The Bidder shall offer open type of foundation (i.e. slab and chimney) with maximum depth of foundation as 3.5 meter for above classification of foundations depending on economy and feasibility of construction at site.

Bidder has to furnish along with the bid one sample calculation for each type of foundation for verification of correctness of design procedure adopted by the Bidder.

5.3 Soil Investigation

The Contractor shall undertake soil investigation as per CHAPTER 4 of the specification at tower locations as approved by the Employer. The provisional number of soil testing locations is furnished in Schedule of Prices. Unit rates for the same are to be furnished by the bidder in appropriate Schedules of Price, for adjustment purpose with actual quantities required for soil testing.

5.4 Loads on Foundations

The foundations shall be designed to withstand the specific loads of the superstructure and for the full footing reactions obtained from the structural stress analysis in conformity with the relevant factors of safety.

The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:

- a) Max. tension or uplift along the leg slope.
- b) Max. compression or down-thrust along the leg slope.
- c) Max. horizontal shear or side thrusts.



5.9.1 Overload Factor for Foundation Loads

The overload factor for foundation loads shall be considered as 1.1 i.e. the reaction on the foundations shall be increased by 10 percent.

5.5 Stability Analysis

In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

The following primary types of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:

A) RESISTANCE AGAINST UPLIFT

The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth as per formula given in the specification on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-imposed each other, the earth frustum will be assumed truncated by a vertical plane passing through the centre line of the tower base.

B) RESISTANCE AGAINST DOWN THRUST

The down-thrust loads combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

C) RESISTANCE AGAINST SIDE-THRUST

The lateral load capacity of a chimney foundation shall be based on chimney acting as a cantilever aided by passive earth resistance developed 500 mm below the ground level.

The chimney shaft shall be reinforced for the combined action of axial force, tension and compression and the associated maximum bending moment. In these calculations, the tensile strength of concrete shall be ignored. Similarly, since stub angle is embedded in the centre of the chimney, its effectiveness in the reinforcement calculation is to be ignored.

The increase in vertical toe pressure due to maximum bending moment at the bottom of the slab shall be taken into account and the base itself shall be designed for structural adequacy. In this case, the allowable vertical toe pressure may be increased by 25%. The unit weight of reinforced



concrete is stipulated in Table 3.1.

5.6 Properties of Concrete

The cement concrete used for the foundations shall be of grade M-20 corresponding to 1:1.5:3 nominal mix ratio with 20 mm coarse aggregate for chimney portion and 40 mm coarse aggregate for pyramid or slab portion. All the properties of concrete regarding its strength under compression tension, shear, punching and bend etc. as well as workmanship will conform to IS: 456:2002.

5.9.1 The weight of concrete to be considered for design of foundations is given in TABLE 3.1.

TABLE 3.1

TYPE OF CONCRETE	WEIGHT OF CONCRETE kN / m ³ (kg/m ³)	
	DRY REGION	IN PRESENCE SUB-SOIL WATER
Plain Concrete	21.96 (2240)	12.16 (1240)
Reinforced Concrete	23.54 (2400)	13.73 (1400)

5.9.2

- a) Cement used shall be ordinary Portland Cement, unless mentioned otherwise, conforming to the latest Indian Standard Code IS:269 or IS:8112 or IS:12269.
- b) Alternatively, other varieties of cement other than ordinary Portland Cement such as Portland Pozzolana Cement conforming to IS:1489 (latest edition) or Portland Slag Cement conforming to IS:455 (Latest edition) can also be used. The Contractor shall submit the manufacturer's certificate, for each consignment of cement procured, to the Employer. However the Employer reserves the right to direct the Contractor to conduct tests for each batch/lot of cement used by the Contractor and the Contractor will conduct those tests free of cost at the laboratory so directed by the Employer. The Contractor shall also have no claim towards suspension of work due to time taken in conducting tests in the laboratory. Changing of brand or type of cement within the same structure shall not be permitted without the prior approval of the Employer. Sulphate Resistant Cement shall be used if sulphate content is more than the limits specified in IS:456, as per Geotechnical investigation report.

The curing time of cement will be decided at the time of execution of the work under the contract based on the certificate from a reputed laboratory which will be obtained and submitted by the Contractor.

5.9.3 Concrete aggregates shall conform to IS: 383-1970.

5.9.4 The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is



generally preferred.

5.9.5 Reinforcement shall conform to IS: 432-1966 for M.S bars and hard drawn steel wires and to IS: 1138-1966 and IS: 1786-1966 for deformed and cold twisted bars respectively. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coatings, which may destroy or reduce bond. The Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out intent of drawings and specifications.

5.7 Design of Foundations

5.9.1 Structural design of the foundations shall be done by Limit State Method.

5.9.2 As per IS: 456-2002 Partial safety factor shall be considered 1.5 for concrete and 1.15 for steel.

5.9.3 The physical properties of soil under various conditions are furnished in TABLE 3.2 to be considered for the design of foundations. These types of foundations correspond to list of foundations furnished in Price Schedule.

The composite rates quoted in Price Schedule shall be payable for foundations developed based on above soil properties and classified as Clause 3.2 of this Chapter. The composite rate shall be paid to the Contractor for above foundations irrespective of change in approved design volumes in comparison to estimated Volumes. No extra payment shall be payable on account of increase in concrete volume, excavation volume, and at the same time no recovery shall be made from the composite foundation rates when the approved foundation volumes are less than quoted volumes. Further, once the foundations are classified based on the preponderant soil, the payment shall be made based on composite rate and extra claim is not admissible for excavation in different kinds of soil encountered inside the pit.

However, it may be noted that the soil properties furnished in TABLE 3.2 are tentative in nature. After soil investigations, if it is found that the foundations listed in Price Schedule cannot be used at that location; new foundation design shall be developed by the Contractor based on properties furnished in soil report. The payment for these foundations shall be made based on unit rate quoted for excavation, concreting and reinforcement.

5.9.4 Particulars of the foundations, along with the estimated volumes of concrete, weight of reinforcing bars and excavation volumes for the various types of towers shall be given in the bid. The foundation shall be designed such as to satisfy the following conditions:

5.9.5 The thickness of concrete in the chimney portion of the tower footing would be such that it provides



minimum cover of not less than 100 mm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations limiting the minimum section of chimney to 300 mm square. In respect of all wet location, the chimney should have all around clearance of 150 mm from any part of stub angle limiting to 450 mm square minimum.

- 5.9.6 The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended up to lower most joint level between the bottom lattices and the main corner legs of the tower.
- 5.9.7 The centroidal axis of slab shall coincide with the axis of the chimney and pass through the center of foundation base. The design of the foundation (base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliances of this requirement.
- 5.9.8 At least 100 mm thick pad of size equal to the base of slab with its sides vertical will be provided below the slab for R.C.C. type foundations.
- 5.9.9 In case of reinforced concrete slab, the slab thickness should not be less than 300 mm.
- 5.9.10 The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100 mm or more than 150 mm in case of dry locations and not less than 150 mm or more than 200 mm in case of wet locations.
- 5.9.11 The total depth of open type foundations below the ground level shall not be less than 1.5 meters and more than 3.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, almost the same depths of foundations shall be used for different types of foundations.
- 5.9.12 The portion of the stub in the slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and slab concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design. Bolted cleat angles evenly spaced in sets of 4 along all sides of embedded portion of the stub shall be provided to act as shear connector with sufficient number of bolts.
- 5.9.13 In case of R.C.C. foundations having steel reinforcement in base slab, at least 50 mm. thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.



5.9.14 The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.

5.9.15 The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.

TABLE 3.2
PROPERTIES OF EARTH

1. Normal Soil		
PROPERTIES OF SOIL	ULTIMATE BEARING CAPACITY kN/m ² (kg/m ² .)	ANGLE OF REPOSE DEGREE
a) Normal Dry Soil	268 (27350)	25
b) Wet Soil Due to Presence of Subsoil/Surface Water	134 (13675)	15
c) Sandy Soil	268 (27350)	15
2. Weight of Earth for Normal Soil		
PROPERTIES OF SOIL	UNIT	VALUE
a) Dry	kN/m ³ (kg/m ³ .)	14.12 (1440)
b) In presence of Surface Water	kN/m ³ (kg/m ³ .)	14.12 (1440)
c) In presence of Subsoil Water	kN/m ³ (kg/m ³ .)	9.22 (940)
3. Fissured Rock		
PROPERTIES OF SOIL	ULTIMATE BEARING CAPACITY kN/m ² (kg/m ² .)	ANGLE OF REPOSE DEGREE
a) Dry	498 (50800)	20
b) In presence of Subsoil Water	498 (50800)	10
4. Weight of Earth for Fissured Rock		
PROPERTIES OF SOIL	UNIT	VALUE
a) Dry	kN/m ³ (kg/m ³ .)	14.12 (1440)
b) In presence of Subsoil Water	kN/m ³ (kg/m ³ .)	9.22 (940)
5. Hard Rock		
PROPERTIES OF SOIL	ULTIMATE BEARING CAPACITY kN/m ² (kg/m ² .)	ULTIMATE BOND BETWEEN STEEL AND CONCRETE kN/m ² (kg/m ² .)
Hard Rock	1225.83 (125000)	0.147 (15)



The above soil properties of the earth will be measured by the Contractor at the various locations in conformity with the standard method of testing and the foundation design will be revised suiting the site conditions from such tests.

5.8 Measurement, Unit Rates and Payment for Foundation

5.9.1 Measurement

3.8.1.1 The indicative shape of foundations is enclosed in this Specification. The bidder is required to quote the unit rates for different foundation types for a particular tower in the relevant Price Schedule.

3.8.1.2 The Bidder has to provide in the Bid the guaranteed foundation quantities (i.e. Excavation volume, Concrete volumes and Weight of Reinforcements) and unit rates for excavation, concreting and reinforcement for each type of foundation

3.8.1.3 The concrete volume and dimensions of the foundation shall be determined from the drawing approved. Measurement of concrete volume shall be in cubic meters and shall be worked out to the second place of decimal

3.8.1.4 The excavation volumes for each tower footing shall be estimated assuming the faces of surrounding earth as vertical keeping a distance of 150 mm clearances from the extreme edge of the base slab of footing. For footings with undercut, excavation volumes shall be calculated as per drawings without any side clearance.

3.8.1.5 The steel required for reinforcement of foundation shall be provided by the Contractor. Measurement will be based on the calculated weights of actually used in tonnes corrected to third place of decimal, no allowance being made for wastage. No payments will be made for wire required for binding the reinforcement, chairs, bolsters and spacers, as the cost of these is deemed to be included in the unit rate quoted for the item of reinforcement.

5.9.2 Unit Rate

3.8.2.1 The unit rates of excavation for each type of soil shall include



excavation along with all associated activities like shoring, shuttering, dewatering till completion of foundation work stock piling, dressing, back filling of foundations after concreting with excavated/borrowed earth (irrespective of lead) and consolidation of earth, carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activity related to completion foundation work in all respect.

3.8.2.2 Form boxes shall be used for casting of foundations. The unit rate of concreting shall include the cost of supply, fabrication and placement of form boxes, cement, water, coarse and fine aggregates mixing and placing of concrete, curing of concrete and any other activities related to completion of concreting works of foundation.

3.8.2.3 The unit rate of 'Reinforcement Steel' shall include supply and placement of reinforcement steel, tie bars, wire for binding the reinforcement, chairs, bolsters and spacers etc. as required to complete the foundation work.

5.9.3 Payment for Foundation

3.8.3.1 Normal Foundations

Payment of normal foundations classified under Clause 3.2 of this Chapter shall be made as described in Clause 3.8.3 of this Chapter. The rate of foundation per tower shall include transportation of construction materials to the Site, excavation, concreting, reinforcement, shoring, shuttering, dewatering, stock piling, dressing, curing, backfilling the foundation after concreting with excavated / borrowed earth (irrespective of leads), consolidation of earth and carriage of surplus earth to the suitable point of disposal as required by the Employer or any other activities related to completion of foundation works.

5.9 Construction of Tower Foundation

5.9.1 Testing of Soil

The Contractor shall be required to undertake testing of soil for the tower locations in the manner specified under **Chapter 4** of this Specification and shall submit his report about the subsoil water table, type of soil encountered, bearing capacity of soil, possibility of submergence and other soil properties required for the design of foundations. The Contractor shall also furnish soil resistivity values to the Employer along the line alignment.



5.9.2 Excavation

3.9.2.1 The excavation work for foundations shall be taken up by the Contractor after obtaining approval from the Employer for the proposed stretch wise / section wise tower schedule, profile etc. prepared during Check / Detailed survey along the approved route alignment.

3.9.2.2 Except as specifically otherwise provided, all excavation for footings shall be made to the lines and grades of the foundations. The excavation wall shall be vertical and the pit dimensions shall be based on an assumed clearance of 150mm on all sides of the foundation pad. For footings with undercut, care shall be taken to carry out excavation as per drawings without any side clearance. All excavation shall be protected so as to maintain a clean sub grade and provide worker safety until the footing is placed, using timbering, shoring, shuttering, dewatering etc. as approved by the Employer. The Contractor shall especially avoid disturbing the bearing surface of the pad. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit or borehole shall be removed by the Contractor before placing concrete.

3.9.2.3 The soil to be excavated for tower foundations shall be classified as follows depending upon the physical state of the soil at the time of excavation irrespective of the type of foundation installed:

- a) Dry Soil
Soil removable either manually, means of a spade and shovel or mechanically by proclains, excavator etc. Excavation done in dry soil for wet and fully submerged type of foundations shall also be covered under this.
- b) Wet Soil
Where the subsoil water table is encountered within the range of foundation depth or land where pumping or bailing out of water is required due to presence of surface water shall be treated as wet soil. The excavation done in wet soil in case of wet and fully submerged type of foundation shall also be covered under this.
- c) Dry Fissured Rock
Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition which can be quarried or split with crowbars, wedges, pickaxes or by mechanical shovels etc. However, if required, light blasting may be resorted to for loosening the material but this will not in any way



entitle the material to be classified as hard rock.

d) Wet Fissured Rock

Above fissured rock, when encountered with subsoil water within the range of foundation depth or land where pumping or bailing out of water is required, shall be treated as wet fissured rock.

e) Hard Rock

Any rock excavation, other than specified under fissured rock above, for which blasting, drilling, chiseling are required. The unit rate quoted for hard rock excavation shall be inclusive of all costs for such drilling (including drilling required for anchoring), chiseling and blasting, etc.

3.9.2.4 However, where soil is of composite in nature, classification of foundation shall be according to the type of soil predominant in the footing and payment shall be made accordingly.

3.9.2.5 No extra payment shall be admitted for the removal of fallen earth into a pit or borehole once excavated. Shoring and timbering / shuttering as approved by authorized representative of the Employer shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.

3.9.2.6 Where rock is encountered, the holes for tower footings shall preferably be drilled. Blasting where resorted to as an economy measure, if permitted by the Employer, shall be done with utmost care to minimize fracturing of rock and using extra concrete for filling the blasted area. All necessary precautions for handling and use of blasting materials shall be taken. In cases where unnecessarily large quantities are excavated / blasted, resulting in placement of large volumes of concrete, payment of concrete shall be limited to design volumes of excavation, concreting, reinforcement etc. In case where drilling is done, the stubs may be shortened suitably with the approval of the Employer or his authorized representatives.

3.9.2.7 The Contractor shall arrange & supply requisite blasting material, and be responsible for its storage and use, without any extra cost to the Purchaser.

5.9.3 Setting of Stubs

For all towers the  Contractor shall submit for

approval the proposed method for setting of stubs.

3.9.3.1 The stubs shall be set correctly and precisely in accordance with approved method at the exact location, alignment and levels with the help of stub setting templates and leveling instruments. Stubs setting shall be done in the presence of the Employer's representative available at site where required and for which adequate advance intimation shall be given to the Employer by the Contractor. Tolerances as per provisions of IS:5613 shall be allowed for stub setting.

3.9.3.2 Setting of stub at each location shall be approved by the Employer.

3.9.3.3 However, in hilly region for towers with unequal leg extensions props may be used with complete accuracy and high skilled supervision, subject to prior approval from the Employer.

3.9.3.4 As per the schedule testing of all towers must be completed before the start of casting foundations. However, for any reason if the testing of tower gets delayed the Contractor shall not hold the casting of foundation work and shall cast the foundations with the stub of untested tower as per the design at his own risk and cast. Accordingly the Contractor shall keep enough safety while choosing the section for the stub /leg of last panel of tower to ensure that that the section for stub / leg of last panel shall not change during completion of tower testing.

5.9.4 Stub Setting Templates / Props

3.9.4.1 Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without body extension. Stub templates for standard towers and towers with body extension up to 9 M shall be of adjustable type. The Contractor shall also arrange for props for setting of stubs at specific locations where use of prop is approved by the Employer. Stub templates / props should be painted.

3.9.4.2 The Contractor shall deploy sufficient number of templates / props (where ever required) for timely completion of the line without



any extra cost to the Employer.

3.9.4.3 One set of each type of stub setting template / props (if used) shall be supplied to the Employer, on completion of the project, at no extra cost to the Employer.

3.9.4.4 Generally for a transmission line following number of stub setting templates shall be deployed by the Contractor:

Templates for tower type	Nos. to be deployed
ii) For each type of DD/DE and SP	1

However, if the Employer feels that more templates are required for timely completion of the lines, the Contractor shall have to deploy the same without any extra cost to the Employer.

The number of sets of prop (if permitted) to be supplied, will depend as per actual site condition and completion schedule of line.

5.9.5 Mixing, Placing and Compacting of Concrete

3.9.5.1 The concrete shall be mixed in the mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of the Employer. The water for mixing concrete shall be potable i.e. fresh, clean and free from oil, acids and alkalis. Salty or blackish water shall not be used.

3.9.5.2 Mixing shall be continued until there is uniform distribution of material and mix is uniform in colour and consistency, but in no case the mixing be carried out for less than two minutes. Normal mixing shall be done close to the foundation but exceptionally, in difficult terrain, the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

3.9.5.3 To avoid the possibility of reinforcement rods being exposed due

to



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unevenness of the bottom of the excavated pit, a pad of lean concrete 50 mm thick and corresponding to a 1:3:6 nominal mix shall be provided at the bottom of the pad.

3.9.5.4 Form boxes shall be used for casting all types of foundations except at an undercut interface for which the adjoining subsurface material shall provide adequate support.

3.9.5.5 The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works, up to the top and no honey-combing occurs in the concrete. A mechanical vibrator shall be employed for compacting the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of the Employer. Monolithic casting of foundations must be carried out. However, in case of unavoidable circumstances, a key construction joint can be provided at the chimney-pad interface subject to approval of the Employer. However nothing extra shall be paid to the Contractor for providing such construction joints. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge for draining rain water.

3.9.5.6 Wet locations shall be kept completely dewatered, both during and 24 hours after placing the concrete, without disturbance of the concrete.

3.9.5.7 If minor defects in concrete surface is found after the form work is removed, the damage shall be repaired with a rich cement sand mortar to the satisfaction of the Employer before the foundation is back filled.

5.9.6 Curing

The concrete shall be cured by maintaining the concrete wet continuously for a period of at least 10 days after placing. Once the concrete has set for 24 hours the pit may be backfilled with selected moistened soil and well consolidated in layers not exceeding 200 mm thickness and thereafter both the backfill earth and exposed chimney shall be kept wet for the remainder of the prescribed 10 days. The exposed concrete chimney shall also be kept wet by wrapping empty gunny bags around it and wetting the bags continuously during the critical 10 days period.

5.9.7 Backfilling and Removal of

Stub Templates



3.9.7.1 After opening of formwork and removal of shoring, timbering, etc., backfilling shall be started after repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless it is a clay type or it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80-mm. At locations where borrowed earth is required for backfilling, the Contractor shall bear the cost irrespective of leads & lift.

3.9.7.2 The backfilling materials shall be clean and free from organic or other foreign materials. A clay type soil with a grain size distribution of 50% or more passing the number 200 sieve as well as a black cotton soil is unacceptable for backfilling. The earth shall be deposited in maximum 200mm layers, leveled, wetted if necessary and compacted properly before another layer is deposited. The moisture content for compaction shall be based on the Proctor compaction test results given in the Geo-technical Report, Clause 4.9 of Chapter 4. The density of the compacted backfill material may further be verified to the satisfaction of the Employer based on the sand-cone method described in the ASTM D1556-82 standard.

3.9.7.3 The backfilling and grading shall be carried to an elevation of about 75mm above the finished ground level to drain out water. After backfilling 50mm high, earthen embankment (Bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilling earth for at least 24 hours. After the pits have been backfilled to full depth the stub template can be removed.

5.9.8 Benching

When the line passes through hilly / undulated terrain, leveling the ground may be required for casting of tower footings. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Employer. Benching shall be resorted to only after approval from the Employer. Volume of the earth to be cut shall be measured before cutting and approved by the Employer for payment purposes. Further, to minimize benching, unequal leg extensions shall be considered and provided if found economical. If the levels of the pit centers be in sharp contrast with the level of tower centre, suitable leg extensions may be deployed as required. The proposal shall be submitted by the Contractor with detailed justification to the Employer.

5.9.9 Protection of Tower and

Tower Footing



3.9.9.1 Tower shall be spotted such that the quantity of revetment is optimum. For tower locations in undulated terrain such as hill / mountain slopes, options like use of unequal leg extensions for towers, unequal chimney extensions etc. shall be explored by the Contractor for optimizing the need for revetment & benching.

3.9.9.2 The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in small water streams (Nalas), river bank / bed, undulated terrain, protection of up hill / down hill slopes required for protection of tower etc., including suitable revetment or galvanized wire netting and meshing packed with boulders. The top cover of stone revetment shall be sealed with M-15 concrete (1:2:4 mix). The Contractor shall recommend protection at such locations wherever required. Details of protection of tower/tower footing are given in drawing enclosed with these specifications for reference purpose only.

3.9.9.3 In protection of tower footings works the backfilling shall generally be done using soil excavated at site unless deemed unsuitable for backfilling. In the latter case, backfilling shall be done with borrowed earth of suitable quality irrespective of leads and lift. The unit rate for backfilling quoted in Price Schedules shall include the required lead and consolidation and leveling of earth after backfilling.

3.9.9.4 The provisional quantities for protection work of foundations are furnished in Price Schedule of Bid. The unit rates shall also be applicable for adjusting the actual quantities of protection works done. These unit rates shall hold good for protection work carried out on down hills or up hills slopes applicable for the tower locations.

3.9.9.5 The unit rates for random rubble masonry revetment quoted in price schedule shall also include excavation & (1:4) random masonry and unit rate for top sealing with M-15 concrete. For payment purposes the volume of random rubble masonry revetment shall be measured from bottom to top sealing coat and paid at the quoted rates indicated in price schedule.

No extra rates shall be paid



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for allied work such as

excavation, for revetment, packed stone at head of weep holes etc. However, no deduction shall be made for the volume enclosed by weep holes. The locations where both benching and protection of tower footing are envisaged; an economy got to be established against providing unequal leg extension.

3.9.9.6 For some of the locations in small water streams (Nalas), river bed or undulated terrain etc., boulders of minimum. 150mm size bounded and packed in galvanized wire net/mesh of 8 SWG wire and 152 square (maximum.) mesh are to be provided. These stones shall be provided in crates size of 2.0mx2.0m or as deemed suitable for a particular location. Measurement shall be taken in cubic meters and 15% deduction will be made for void from cage/stack measurements.



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CHAPTER 6

ERECTION, STRINGING AND MISCELLANEOUS WORKS

6.1 Erection of Steel Towers

All towers shall be vertical under the stresses set up by the completed overhead line.

Precautions shall be taken to ensure that no parts of the structures are strained or damaged in any way during erection and drifting shall not be allowed.

Support members, which arrive on Site with slight distortions due to handling in transit, shall be straightened by the Contractor using an approved means and offered to the Employer for inspection and subsequent acceptance or rejection before erection commences.

Suitable ladders shall be used whenever necessary during erection but such ladders and removable step bolts shall be removed when erection is not in progress.

Spanners used during erection shall be well shaped and fit closely on the hexagon to avoid damaging nuts and bolt head.

Reaming or drilling for correction of mismatched holes will not be allowed without the written approval of the Employer.

The Contractor shall ensure that a rigid bolt-checking program is carried out on all supports. On completion of initial assembly of towers, an organized bolt checking team shall check all bolts for tightness from the structure top downwards.

Bolt checking shall be carried out with a torque-wrench within one week from the time the support is erected. Bolt tightening shall be as follows:

<u>Size of Bolt (mm)</u>	<u>Tightening Torque (kg-cm)</u>
16	1000-1200

Throughout the course of support erection the Contractor shall ensure that unbraced members are adequately supported by stays or guys or temporary struts prior to being braced.

The bracing of all four sides of the support shall be completed before guys are removed and before any erection of a higher section of the tower is commenced.

In no case the tower structure shall be erected until **seven days** after completing the foundation concrete work, and until proper backfilling and compaction.

The inspection and correction of defects if any shall be done complete before the start of the stringing operation.

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Damaged galvanizing may be repaired on site in accordance of General Technical Specification.

All bolts and nuts below the Anti climbing device shall be properly punched such as to provide safety against opening of the nut-bolts even with a wrench set. The punched area shall immediately be coated with zinc paint.

Payment for the contract item Steel tower erection will be made at the unit price bid "Galvanized steel tower with required extensions and stubs". Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, tools, labors etc. for erection work related to this item.

6.2 Conductor (including Ground-wire) Stringing

The Contractor shall submit to the Employer a detailed account of his proposed stringing procedure which should include details of temporary support stays and compensation for initial stretch and long term creep of the conductors.

No mid span joint shall be permitted in river crossing

Double tension insulator-strings shall be used on both sides of towers over rivers,

Conductor repair sleeves shall not be used without the permission of the Employer.

The conductors, joints and clamps shall be erected using the approved tools and in such a manner that no bird caging, over tensioning of individual wires or layers or other deformation or damage to the conductors occurs. Clamps or other devices used in erection shall be of approved design and shall allow no relative movement of strands or layers of the conductors.

The Contractor shall keep a record of all conductor joints giving the location, the date of assembly and the name of the lineman responsible for the jointing. Where records of joints made by a particular lineman show a repeated performance below that required, the Contractor shall cease to employ the lineman on jointing operations and shall immediately replace him with other qualified personnel.

Phase conductors and Earthwire shall be erected with such sags that at everyday temperature in still air, the final tensions shall provide sufficient factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for conductor & ground-wire. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0 degree C, 32 degree C, and 80 degree C in still air conditions. They shall also show details of conductor size, conductor breaking load, and conditions of loading.

In calculating the sags and tensions, allowance shall be made for the elasticity and coefficients of expansion of the conductor materials.

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The term "final tension" shall mean the tension existing in a line conductor, for any given condition of loading after sufficient period in service to allow for "bedding down" stretch and creep to take place. For purposes of calculating creep-allowance, this shall be taken as ten years from erection.

The "equivalent span" method shall be used, in which the tension in any section length is that which would apply to a single span equal to the square root of the length arrived at by dividing the sum of the cubes of the individual span lengths, in the section considered, by their sum. The calculated tensions at the time of initial erection shall be increased by an approved amount to allow for settling of the conductors, other means may be adopted subject to the approval of the Employer.

At the end of the guarantee period, the specified ground clearance plus the conductor creepage allowance shall not be infringed.

Where required by the Employer, prior to the issue of the Operational Acceptance Certificate, the Contractor shall be responsible for checking that the relative sags of the conductors are within the specified tolerance. Such checks shall be carried out at selected point along the route as required by the Employer. Clearances between conductors and ground and between jumpers and structures shall be checked by the Contractor during erection and before handing over the line.

The Contractor shall provide dynamometers, sighting boards and levels suitably mounted for clamping to support steelworks and other approved apparatus necessary for the proper checking of the work. When required by the Employer, dynamometers shall be tested and if necessary recalibrated at the Contractor's expense.

During the progress of the work, the Contractor shall record on approved schedules the particulars of the sagging of conductors on each section of the route. These schedules shall show the support numbers of the section, individual span lengths, the equivalent span, the design and erection sags, together with the mean actual sag of the phase conductor as well as the temperature, and the dates of the stringing and checking. At the end of the Contract, six sets of these schedules shall be handed to the Employer.

Blocks for running out conductors shall be of approved type and shall be robust and full running. The wheel of the running out block shall have a diameter of not less than 20 times the outside diameter of the conductor and shall be fabricated from aluminum.

The Contractor shall provide as a minimum sufficient running blocks commensurate with stringing the longest section of the project.

Jumper-loops shall be cut to length such that the loop arcs at the points of departure from tension-clamp are naturally tangential to the tension -clamp departure angle.

All conductor, connections and clamps shall be treated with approved jointing grease to prevent galvanic corrosion between dissimilar metals and to inhibit aluminum surface oxidation.

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After the line conductors have been finally tensioned to their correct sags, the Contractor shall erect vibration dampers at the recommended distance from the conductor clamps.

Payment for the contract item conductor stringing and ground-wire stringing will be made at the unit price bid. Therefore, in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, equipment and labor related to this item.

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Chapter 7: INSPECTION, TESTING AND COMMISSIONING

7.1 Scope

The whole of the Works supplied under the Contract shall be subject to inspection and test by the Employer or their Representative during manufacture, erection and after completion. The inspection and tests shall include, but not be limited to, the requirements of this Chapter of the Specification.

All appliances, apparatus, supervision, labour and services necessary to carry out all tests shall be provided by the Contractor unless specifically stated otherwise.

All expenses related to the factory tests of steel structures, conductor and insulator string shall be borne by the Contractor.

7.2 Quality, Assurance, Inspection and Testing

To assure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Site or at any other place of work are in accordance with the Specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of the Contract. A quality assurance program of the Contractor shall generally cover, but not be limited to the following:

- a. His organization structure for the management and implementation of the proposed quality assurance program.
- b. Documentation control system.
- c. Qualification data for bidder's key personnel.
- d. The procedure for purchases of materials, parts, components, and selection of sub-contractors' services including vendor analysis, source inspection, incoming raw materials inspection, verification of materials purchases.
- e. System for shop manufacturing including process controls and fabrication and assembly controls.
- f. Control of non-conforming items and system for corrective actions,
- g. Control of calibration and testing of measuring and testing equipment.
- h. Inspection and test procedure for manufacture.
- i. System for indication and appraisal of inspection status.
- j. System for quality audits.
- k. System for authorizing release of manufactured products to the Employer.
- l. System for maintenance of records.
- m. System for handling storage and delivery.
- n. A quality plan detailing out the specific quality control procedure adopting for controlling the quality characteristics relevant to each item of supply.

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The quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

7.2.1 Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance documents as stipulated in the Quality Plan at the time of Employer's inspection of material/equipment.

The Employer, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and the procedures of the Contractor's and the subcontractor's Quality Management and Control Activities.

7.2.2 Inspection, Testing and Inspection Certificates

The provisions of the clauses on Test and Inspection of the GCC and SCC shall be applicable to the supply and erection portions of the Works. The Employer shall have the right to re-inspect at his expenses any material though previously inspected and approved by him at the Contractor's works, before and after the same are inspected at Site following the latter, material is found defective, then the Contractor shall bear the cost of this inspection and reinstatement according to specification.

7.3 Guarantees

Bidders shall state and guarantee the technical particulars listed in the Schedules of Technical Particulars and Guarantees forming a part of the other sections. These guarantees shall be binding and shall not be departed from without the written permission of the Employer. The tolerances permitted in the BS, ISO or ANSI will apply unless stated otherwise.

7.4 Test at Manufacturers Works

7.4.1 General

Where no specific test is specified then the various items of materials and equipment shall be tested in accordance with the relevant, Indian, British, IEC, or American Standards. Where no appropriate standard is available, tests shall be carried out in accordance with the makers standard practice which must meet with the approval of the Employer.

At least fourteen days (14) notice in writing or by e-mail shall be given to the Employer of the readiness of plant for test or inspection and every facility shall be provided by the Contractor and sub-Contractor(s) to enable the Employer or their Representative to carry out the inspections and witness the tests. This includes progress, test rig and packing inspection.

Inspection of equipment will not be carried out unless copies of the relevant sub-orders, drawings and test procedures have been approved by the Employer.

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No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, or inspection has been waived by the Employer.

Functional electrical and mechanical tests shall be carried out on the completed plant after assembly in the Works. The extent and method of recording the results shall be agreed by the Employer in sufficient time to enable the tests to be satisfactorily witnessed or to make any change to the proposed program of tests.

All instruments and apparatus used in the performance of the tests shall be to the approval of the Employer and, if required by the Employer, shall be calibrated to an agreed standard at a laboratory of National standing to be nominated by the Contractor and approved by the Employer.

The cost of carrying out such calibration shall be borne by the Contractor in all cases.

7.4.2 Material Tests

Requirements for the testing of castings and forging are detailed elsewhere in the Specification. Representative samples of all plates, bars and pipes etc. which form components of the equipment / accessories shall be tested as required by the relevant standard or code at the request of the Employer.

7.4.3 Test Certificates

Sets of all principal test records, test certificates and performance curves shall be supplied to the Employer in number of copies within the time frame mentioned in section-2 of this specification.

These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer or his Representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the contract reference title. Specified requirements shall be shown on each certificate for comparison with actual test results.

When all equipment has been tested, test certificates from all Works and Site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index. Two copies of each volume shall be supplied to the consultant and four copies to the Employer.

7.5 Type Test

Type tests are required to prove the general design of the equipment. Type test reports of test performed on similar equipment shall be acceptable. But in case some type tests are required by the Employer, these tests prescribed shall be carried out at the Contractor's cost.

7.5.1 Tests on Tower

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Reports: The Contractor shall furnish two certified copies of full reports of all tower and material tests, the calibration of the dynamometers or gauges,

7.5.2 Insulators

- **Impulse voltage withstand and flashover tests**

The insulators for Impulse Voltage withstand tests shall be tested applying five standard 1.2/50 waves as specified in BS 137 and BS 923. If there is no flashover or puncture the insulator shall be deemed satisfactory. If there is more than one flashover the insulator shall be deemed not to comply with BS 137. In the event of one flashover occurring, a new series of ten impulses shall be applied. The insulator shall be considered to comply with BS 137 if during the second series of tests there is no flashover or puncture.

7.5.3 50% Flashover tests shall be carried out per BS 137

Additional tests will be required to show that the specified impulse level is obtained when the insulator strings are mounted on the structure. Bidders should note that the impulse test rig will therefore require earthen metalwork to simulate the proposed power configuration.

Flashover tests to determine the optimum lift shall be carried out in order to avoid cascade over as many line end insulators as possible.

7.5.4 Dry power frequency withstand

The Dry power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

7.5.5 Wet power frequency voltage withstand tests

The wet power frequency withstand test shall be carried out as specified in BS 137. The test voltage shall be maintained for one minute and the insulator shall be considered satisfactory if no flashover or puncture occurs.

7.5.6 Radio interference tests

Radio interference tests shall be carried out in accordance with IEC 437.

7.6 Insulator Fittings

Tensile tests, resistance tests and galvanizing tests shall be carried out in accordance with the requirements of BS 3288 Part 1 and BS 729.

7.7 Conductors

The conductors shall be tested in accordance with the requirements of BS: 215 or IS: 398.

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7.8 Routine Test

All equipment shall be subjected to routine tests at the manufacturer's work and shall include but not be limited to the following:

7.8.1 Operational tests

All equipment shall be tested after complete assembly to ensure the correct operation.

7.8.2 Clamps, joints and insulator fittings

Sample parts selected at random by the Employer shall be subjected to such tests as the Employer may direct in order to demonstrate compliance with Specifications and BS 3288 as applicable.

7.8.3 Insulators, fittings and conductor overall tests

A complete mechanical test of insulator string, fittings and section of conductor for suspension and tension sets at each voltage level will be required. The complete units shall withstand load tests including the safety factors specified. Tests other than mechanical tests on the complete unit may be required at the discretion of the Employer.

7.9 Cost of tests at manufacturer's works

The costs of making any test to be conducted at the manufacturer's works shall be borne by the Contractor. This shall apply to tests performed at the site or elsewhere.

After receiving the prior information about the completion of manufacturing at the factory, the Employer will depute his personnel to the Contractor's factory to witness the fabrication, assembly and testing of any or all parts of major equipment. The number of the Employer's personnel and equipment to be witnessed will be as listed below. The duration of such visits shall be as per inspection/testing requirements.

- Conductor 2 persons, 1 visit

The daily allowances and travelling expenses of the inspectors nominated by the Employer will be borne by Employer. However, the Contractor shall bear all the expenses occurred due to the repetition of the tests required due to:

- Failure of the test;
- Test facilities not ready at the time of inspection or mismatch of test schedule/program provided by the Contractor.

7.10 Site Tests

7.10.1 Measurement of footing resistance

Before stringing the conductor, the footing resistance of each support shall be measured with an earth resistance measuring instrument to the approval of the Employer.

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7.10.2 Measurement of earth electrode resistance

Where the footing resistance is found to exceed 10 ohms additional earth electrodes are to be installed and the combined earth electrode and footing resistance measured together and recorded using the same test instrument. Additional electrodes are to be installed to obtain a maximum resistance value of 10 ohms.

7.10.3 Measurement of line impedance

Positive and zero sequence impedance measurement tests shall be carried out after final line inspection has been completed. The measurement tests shall be carried out on all new lines covered by this Contract, by the Contractor and at his cost.

7.10.4 Conductor joint tests

In the case of tension clamps, joints and bi-metal terminals the resistance of each part shall be measured by instruments supplied by the Contractor and approved by the Employer. The resistance of such fittings shall not exceed 75% of the electrical resistance of the equivalent length of conductor. The tests shall be carried out in the presence of the Employer. Stringing shall not commence until suitable instruments are on Site, approved by the Employer and ready for use.

7.10.5 Measurement of galvanizing thickness

The Contractor shall have available on Site for the Employer's use an instrument suitable for the accurate checking of galvanizing thickness. The gauge shall be available from the time of arrival of the first consignment of steel work until the issue of the Operational Acceptance Certificate. The cost of the gauge and other operating expenses are deemed to be included in the Contract Price and the gauge will remain the property of the Employer.

7.10.6 Tests on completion

Acceptance tests shall be carried out on Site by the Contractor on each section of the Works. These tests shall immediately follow the commissioning of each section of the Works.

The lines shall be energized at full working voltage before handing over and the arrangement for this, and such other tests as the Employer shall desire to make on the complete line, shall be assisted by the Contractor who shall provide such labor, transport and other assistance as is required without any extra charge. Apparatus for special tests shall be provided by the Contractor.

The Contractor shall submit to the Employer at least two months before the anticipated commencement of acceptance tests his detailed proposal for carrying out acceptance tests.

7.10.7 Test instrumentation

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate BS, ISO or ANSI.

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The terminal conditions required for establishing whether the guarantees are met shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment where supplied under the contract.

The overall design of the Works shall provide for the installation and use of test equipment so as not to interfere with the plant loading or delay the guarantee completion dates.

All the precision test equipment to be used for carrying out tests shall be calibrated against standard instruments before the tests, and if required by the Employer, also after the tests. Calibration records shall be available for inspection by the Employer or his Representative.

During the design stage of the plant, the contractor shall give details of measurements to be made to substantiate that the performance of the plant meets the requirements of the specification and in particular shall submit for approval a schedule of performance test instrumentation necessary to demonstrate the guarantees.

7.10.8 Test reports

For each of the specified tests the contractor shall agree the test figures with the Employer and shall submit for approval triplicate copies of the test report containing a complete analysis of the test results within one month of the completion of the relevant test. Eight copies of the final approved report shall be submitted to the Employer.

7.11 Commissioning Test

The contractor shall be responsible for checking that total and relative sags of conductors are within the specified tolerances. Such checks shall be carried out at positions along the route selected by the Employer and the contractor shall provide the necessary surveying instruments to enable the checks to be carried out with the line in service without any extra charge.

The commissioning tests are as follows:

7.11.1 Measurement of line parameters

The line insulation resistance shall be measured on each individual section of the lines before the jumper loops are closed and again on the whole lines when they are completed.

The electrical parameters of the lines such as resistance, reactance, susceptance etc. shall be measured in a manner to be approved by the Employer, sufficiently accurately to enable the positive, negative and zero sequence impedance to be determined for the lines.

The lines shall then be energized at the proposed operating voltage from the Employer's system or generating station and the charging current measured and other such tests performed as the Employer may require making on the completed line.

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The contractor shall carry out all these tests in the presence of the Employer, and shall provide all the necessary labor, transportation, apparatus, instruments and other assistance as required, without any extra charge.

7.11.2 High voltage tests

The overhead lines shall be tested with DC voltage applied between each phase and earth by means of a DC high voltage testing unit and without cleaning of the insulators. Bidders shall state leakage current expected for such tests, for the different section of lines and taking into consideration and atmospheric conditions.

The test voltage shall be applied for five minutes for 33kV overhead lines and shall be as follows:

Line Voltage	D.C Test Voltage to Earth
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The electric power necessary for the tests at Site shall be supplied by the Employer. The contractor shall satisfy himself that all connections are good before switching power and shall be responsible for, and make good any damage that may arise because of faulty connections.

All D.C. measuring apparatus, instruments including D.C. high voltage testing unit will be subject to checking and calibration by the Employer before starting the high voltage D.C. current test, catalogues and details to be submitted with offer. Full details and catalogue of the proposed high voltage D.C. testing equipment shall be submitted for approval before shipping the test equipment.

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APPENDIX - 10.2: PRE – COMMISSIONING PROCEDURES FOR TRANSMISSION LINES

1.1 Introduction

The detailed inspection and handing over documents are required to be checked for the entire length of transmission line before energization.

1.2 Inspection

Before the line is scheduled to be handed over for the pre-commissioning/energization the same shall be inspected by representatives of EMPLOYER and Construction Agency as follows:

Such an inspection shall include:

- i. Right of way/way leave/electrical clearance
- ii. Foundation and Revetments/Protection Work
- iii. Tower and Tower accessories
- iv. Hardware Fittings
- v. Insulators
- vi. Conductors and Earth wire
- vii. Accessories for conductor and Earth wire
- viii. Aviation Warning Signals (Lights/globules/painting)

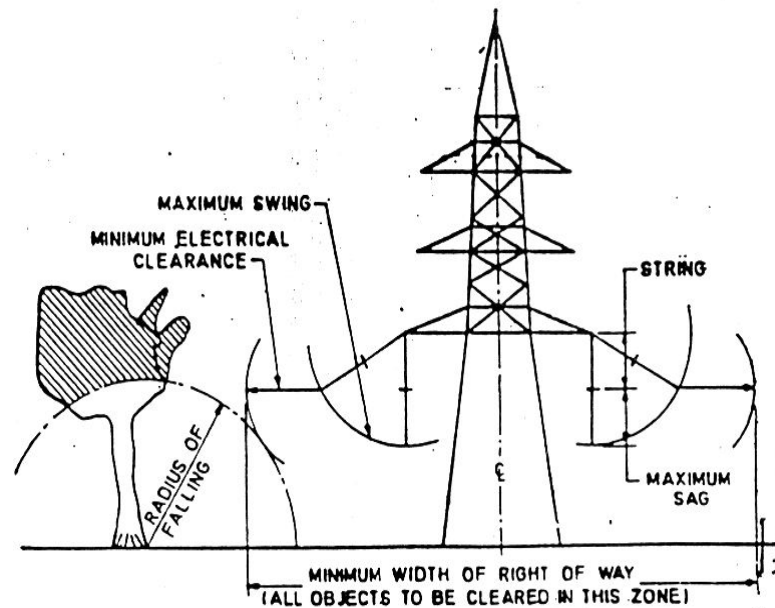
1.2.1 Right of Way / Way Leave / Clearance

Right of way/Way leave clearance

Ensure that no tree/tree branches are falling within the zone of minimum clearance specified as per Fig. 1.

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NOTE — Portion of tree falling within clearance zone to be lopped or trimmed.

FIG. 1 LINE CLEARANCE (RIGHT-OF-WAY) REQUIREMENTS

Guidelines of forest/environmental rules shall be followed to avoid excessive tree cutting i.e. all the trees should be cut from ROUTE level in the 3 meter corridor below each line Conductor/Earth wires. In the balance corridor, Trees branches are only to be lopped to attain the specified clearance as per Table no 1.

1.3 Foundation and Revetments / Protection Work

1.3.1 Foundation

There shall not be any damage/uneven settlement of foundations. For this, tolerances in levels of all four stubs should not exceed the criteria provided in the Annexure-C of IS -5613 (Part -3/Section 2):1989.***

It is to be ensured that back filling of foundation is properly done. Soil shall be filled over all legs up to ground level.

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Extra surface earth after foundation back filling shall be removed from legs of the tower beyond a lead distance of 30 mtrs. Any crack or break in chimney, if found, shall be repaired.

1.3.2 Revetments / Protection

Cracks/damages to revetments shall be repaired.

Wherever revetments are provided, weep holes shall have slope such as to flush out the deposited water away from tower platform.

In case of hilly terrain, the benching area should be levelled properly. The area around tower shall have proper slope for drainage of rain water.

1.4 Insulators

All the damaged/broken insulator discs shall be replaced. Unusual deflection in suspension strings if observed shall be rectified using appropriate counter weights.

The insulators shall be cleaned before charging.

IR value of insulators of at least 5 insulators at random shall be checked by 5/10 kV Megger.

1.5 Conductors and Earth Wires

Surface of the conductors shall be free from scratches/rubs. Ensure that conductor strands are not cut and opened up. Wherever strands are found cut/damaged/scratched, they must be repaired with repair sleeves/repair protective rods in case the nos. of damaged strands are within specified limits (normally upto 1/6th nos. of strands in the outer layer).

1.6 Accessories for Conductor and Earth Wires

1.6.1 Joints

All joints on conductor/earth wires shall be away from the tower at a distance of at least 30 metres or as provided in the Technical specification (TS).

Ensure that no more than one joint in a conductor is provided in one span.

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Ensure that no mid span joint is provided in major crossings for main roads, railway crossing and major rivers etc. or as provided in Technical Specification.

Ensure that all mid span joints on conductors/earthwire and repair sleeves of compression type are free from sharp edges, rust and dust. Wherever grease are specified the same shall be applied in the joints.

1.6.2 Clipping

Ensure that conductor is not over tightened in the suspension clamps

Spacers, vibration dampers and copper bonds.

Vibration Dampers (VD, shall be verified as per the damper placement chart. All loose/ displaced VD shall be properly tightened/relocated and missing VDs shall be provided.

1.6.3 Jumpers

Verify Electrical clearance of jumpers to tower body as per design.

All the jumpers shall be checked properly. In case, jumpers (conductor/earth wire) are found loose, it shall be tightened adequately.

1.6.4 Foreign material

Ensure that all foreign materials viz dead bird. Fallen tree branches, bird nests etc. on conductors, earthwires, Jumper, insulator string, cross arms are re-moved.

1.6.5 Others

It shall be ensured that all temporary/local earthing, guys, T & P (Tools and Plants), foreign material and other loose material which were used during stringing/tower erection have been removed.

In case there is any change in the ground profile before commissioning of line from the approved profile, the extra earth/obstruction/temporary sheds/any other construction shall be removed.

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1.7 Statutory Requirement

The concerned authorities shall be informed before commissioning the lines and their approval obtained in accordance with Statutory Provisions.

1.8 Handing Over

The transmission line shall be inspected prior to energization and a formal handing over document to be jointly signed by the Employer and Employer's representative. However all contractual taking over has to be resolved separately as per the terms and conditions of the contract. The Handing over shall be limited to the completion of Erection and ready for Energization.

Any outstanding points or remaining activities are to be listed jointly. The remaining activities/outstanding points are classified in the following category:

Details of the Sections:

- A. List of outstanding activities remaining in any part of the line
- B. A list of temporary arrangements introduced.
- C. Check list records properly documented, completed and signed.
- D. Soft copies of Profile, Route Alignment, Tower Design, Structural Drawings, Bill of Materials, Shop Drawings, Stringing charts (initial and final as applicable) etc. of all towers/line submitted to the Employer.

With the outstanding activities mentioned above are solved or with only minor points without influence on the charging remain, handing over of the transmission line shall be accepted by the pre-commissioning team. This handing over for energization with or without remaining activities shall be made by the group head to the commissioning in charge in writing.

1.9 Protective System

Before energization it must be ascertained that all protective systems for the unit to be energized are operative.

This includes confirmation that the protections have been properly tested and that the tests have been documented.

It also includes verification by inspection or otherwise, if necessary by repetition of trip test, that the protections are actually functionally enabled. This verification serves to prevent that energization takes place of a unit where a protection has been disabled for test or other reason.

Handed



1.10 Switching Procedure

For each activity the instructions to the operators and the communications to the dispatchers will be made in writing or by confirmed telephone messages. The switching procedures first to be properly documented step by step and understood by everybody involved in the switching operation prior to the energization. Any clarification required in the procedures must be resolved. The format established by the Employer for switching orders and operational data logging shall be followed.

The implication of this is that each and every activity must be listed and described, so that complete information is available for detail investigation, if required in future.

1.11 Testing and Measurement Procedures

1.11.1 Earth Resistance Measurement

Normally Earth tester is used for measuring:

a. Soil resistivity.

Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred and procedures to be adopted for measurement of soil resistivity and earth resistance.

A typical Earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1, P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the instrument scale. If R is the resistance measured then the

Specific resistivity = $2 \pi aR$

Where "a" is the distance between the electrode and R is the resistance in ohms measured on the instrument.

b. Earth resistance

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In order to measure earth resistance of electrode of the substation it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the instrument. This will give the earth resistance. The value as far as possible shall be below 10 Ohm. To improve the value, water shall be sprinkle at the earthing pit.

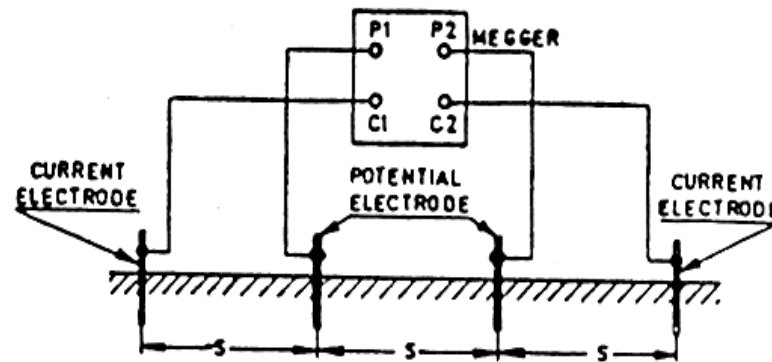


fig : 2 Test connection for a four terminal Megger

1.11.2 Other Tests

Before commissioning of the lines following tests may be carried out.

Insulation Resistance Test

This test may be carried out with the help of a 10 or 12 kV instrument preferably power driven to ascertain the insulation condition of the line. In case 5 kV instrument is used for insulation resistance measurement it shall be ensured that the induced voltage (CVT reading) is LESS than the instrument withstanding capacity otherwise it is likely that the instrument may be damaged.

This Test is to be carried out First prior to the continuity test.

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Measurement of Insulation Resistance

One of the most common devices used for testing electrical insulation is Instrument Insulation Tester.

The DC test voltage is generated by a permanent magnet generator. This generator is turned either by hand or by an electric motor. In either case a slip clutch maintains the generator speed at a constant value so long as the slipping speed is exceeded. A constant voltage is important when the insulation under test has a high capacitance. Common generator output voltage are 500, 1000, 2500 and 5000 volts.

Many insulation tester have a “guard” terminal as well as “line” and “earth”. The guard terminal is useful shall one wish to exclude part of the insulation under test from the measurement. This is possible since current flowing to the generator via the guard circuit does not pass through the deflecting coil.

Another use of the guard circuit is to shield the “line” lead between the insulation tester and the apparatus under test. This prevents leakage to ground from the “line” lead which would invalidate the insulation tester reading.

Insulation resistance is the ratio VDC/IDC . VDC is applied across two conductors separately by the insulation under test.

IDC is the current flowing through/over the insulation. For a healthy and clean insulation the insulation tester reading is in mega-Ohms to infinity. For dirty in, insulation and defective, moist insulation the insulation tester shows a very low insulation resistance value.

Insulation tester test gives clear indication about the health, cleanliness and dryness of the line/equipment insulation.

5 KV insulation tester or 10 KV insulation tester or 12 KV insulation tester may be used for the Transmission line keeping all safety requirements, Permit to work, clearance from statutory bodies and other conditions prevailing at the Sub-station where charging of the line is being co-ordinated.

Conductor Continuity Test

The objective of this test is to verify that each conductor of the overhead line properly connected electrically (the value of electrical resistance of line does not vary abnormally from that of a continuous conductor of the same size and length). The electrical resistance of the conductor shall

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be measured with a Whetstone bridge or other suitable instrument, if available taking the safety aspects of Equipment as well as testing Engineer.

1.12 Documentation

Switching and operational activities will be recorded in regular manner in the operator's log. Likewise all readings of permanent instruments, Copies of this log, notes on special observations from inspections and other measurements will constitute the test records.

Handsy



Chapter 8 : TECHNICAL SCHEDULE

Any difference in data between specification and technical data specification shall referred

8.1

System and Line Data

ITEM	DESCRIPTION	UNIT	DATA
1.	System Data		
1.1	System Nominal Voltage	kV	33
1.2	System Maximum Voltage	kV	36
1.3	System Nominal frequency	Hz	50
1.4	Line Data		
1.4.1	Rapti river crossing 33kV Double Circuit Tower	Km	0.45
1.4.2	Line Conductor		ACSR -Wolf
1.4.3	Ground Wire		Steel

Altitude and Basic Insulation Level

8.2

DESIGN DATA

ITEM	DESCRIPTION	UNIT	DATA
1.	Temperature		
1.1	Maximum ambient temperature	^o C	32
1.2	Minimum ambient temperature	^o C	0
1.3	Maximum temperature of conductor	^o C	85
1.4	Everyday temperature of conductor	^o C	32

Wind Load

ITEM	DESCRIPTION	UNIT	DATA
1.	Temperature		
1.1	Design Wind Speed (Vd)	m/s	47 (Wind Zone:4 as per IS:802)
1.2	Reliability Level		1 (50 yrs return period)
1.3	Risk Co-efficient (k1)		1

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1.4	Terrain Roughness Co-efficient (K2)	1.08
But Gust factors corresponding to terrain category –II shall be considered for conductors/earthwire, Tower and Insulator for arriving the wind load.		
The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $P_d=0.6V^2$.		

8.3

MINIMUM CLEARANCES

The followings are the minimum clearances between live conductors and other objects, which correspond to the maximum conductor sag conditions at different altitude zones.

ITEM	DESCRIPTION	MINIMUM CLEARANCES (IN METER) IN NORMAL CONDITION
		Altitude ≤ 1,000m
1.	Normal ground for pedestrians only	6.1
8.	River and other areas	6.1

For other objects not listed in the Schedule the requirements for minimum clearances shall comply also with NESC (NATIONAL ELECTRIC SAFETY CODE).

Approximately 0.5m shall be added to the clearance values above to allow for survey and drawings errors.

Crossing of houses, huts and other objects with soft roofing is not allowed.

8.4

TOWER TYPES

Type of Tower	Deviation limit	Typical use
DDE	a) 30 deg.-60 deg.	a.3) Also to be designed for anti-cascading condition.
		a.1) Tension towers with tension insulators string.
		a.2) Tension towers for uplift forces corresponding to normal and broken wire weight spans.
		a.3) Dead end with 0 deg. To 15 deg. deviation both on line and substation side (slack span).

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8.6

FACTOR OF SAFETY

ITEM	DESCRIPTION	MINIMUM FACTOR OF SAFETY
1.	Tower Foundations	
1.2	All types of other tension towers (DC, DD, DE)	1.2
2.	Conductors and Insulators	
2.1	Conductors based on ultimate tensile strength	2.5
2.2	Conductors based on ultimate tensile strength at still air every –day temperatures	4.5
2.3	Complete insulator strings and fittings on minimum breaking load of insulator	3.3
2.4	Dead end compression clamps and compression splices based on conductor ultimate tensile strength	0.95
3.	Ground Wires	
3.1	Ground wire based on earth wire ultimate tensile strength	4
3.2	Ground wire at still air everyday temperature based on earth wire ultimate tensile strength	6.0
3.3	Complete tension assembly at ground wire maximum working tension	4.0
3.4	Complete suspension assembly at maximum vertical load	4.0

8.7

TOWER PARTICULARS

ITEM	DESCRIPTION	UNIT	MINIMUM VALUES
1.1.2	Connection bolts		
	i. Shear on gross area (Class 5.6)	kg/cm ²	3160
	ii. Bearing (on Mild Steel) (Class 5.6)	kg/cm ²	4440
	iii. Tension on net area of threaded portion (Class 5.6)	kg/cm ²	2590
2	Slenderness Ratios (L/R) The slenderness ratio of unsupported length of steel compression members to their least radius of gyration.		
2.1	Main members	NA	120

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ITEM	DESCRIPTION	UNIT	MINIMUM VALUES
2.2	Braces	NA	200
2.3	Redundant members	NA	250
2.4	Members loaded in tension only	NA	400

8.8

TOWER MEMBERS PARTICULARS

The minimum thickness and diameter of material used in members and bolts shall be as follows:

ITEM	DESCRIPTION	UNIT	MAXIMUM VALUES
1.	Calculated members	mm	45x45x4
2.	Redundant members	mm	45x45x4
3.	Thickness of legs, members in crossarms and in ground wire peaks	mm	6
4.	Diameter of bolts for member carrying stress	mm	16
5.	Diameter of bolts for redundant members without calculated stress	mm	16
6.	Gusset plates	mm	6
7.	Stub angles	mm	8

8.9

LONG ROD POLYMERIC INSULATORS

Type of insulator :long rod insulator

Nominal system voltage : 33 kV (rms)

Highest system voltage : 36 kV (rms)

Visible discharge test voltage : 27 kV (rms)

Wet power frequency withstand voltage : 75 kv (rms)

Impulse withstand voltage: 170 kV(rms)

Minimum creepagedistance :900 (mm)

Center to center distance between tongue and clevis :550(mm)

Min failing load : 70(kN)

Shed diameter min : 100(mm)

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8.10

LINE CONDUCTOR

ITEM	DESCRIPTION	UNIT	DATA
1.	ACSR "wolf"		
1.1	Conductor size	mm ²	150
1.2	Conductor type		ACSR wolf
1.3	Number and size of wires		
1.3.1	Aluminum	No. Dia mm	30 2.59
1.3.2	Steel	No. Dia mm	7 2.59
1.4	Cross section	kV	
1.4.1	Aluminum	mm ²	158.1
1.4.2	Steel	mm ²	36.88
1.4.3	Total	mm ²	194.9
1.5	Conductor diameter	mm	18.13
1.6	Ultimate strength	Kg	15,381
1.7	Standard mass of conductor	Kg/km	726
1.8	Electrical D.C. resistance at 20 °C	Ohm/km	.1828
1.9	Standard unjointed length on reel	m	2,000
1.10	Modulus of Elasticity	kg/Sq mm	
1.11	Mass of zinc coating	gm/sq. m	
1.12	Co-efficient of Linear Expansion	per °C	
1.13	Direction of Lay of outer	-	Right Hand
1.14	Standards	BS 215 PART 2 IEC 1089 / IS 398 PART 2	

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8.10

GROUND WIRE

Item	Description	Unit	Data
1.	E.H.S.Galvanized Steel Wire		7/3.35
1.1	Nominal sectional area	mm ²	61.7
1.2	Number and diameter of component Wire	No/mm	7/3.35
1.3	Weight of wire	kg/km	483
1.4	Overall diameter	mm	10.05
1.5	Ultimate breaking strength	kg	7,400
1.6	Modulus of elasticity final	kg/mm ²	19,000
1.7	Coefficient of linear expansion	per ° C	1.5x10 ⁻⁵
1.8	Electrical D.C resistance at 20 C	ohm/km	
1.9	Standard unjointed length on reel	m	2,000
1.10	Every day stress	N/mm ²	180
1.11	Standards	IEC 209	

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8.12

MATERIAL FOR TOWER GROUNDING

Item Description

1. Ground rods
 - 1.1 Galvanized steel angles 50 x 50 x 5mm steel angles
2m long
 - 1.2 Copper weld ground rods
16mm dia. 2m long
2. Ground wire
 - 2.1 Galvanized steel wire 38 mm² (7/2.6 mm)
 - 2.2 Copper conductor 38 mm² (7/2.6 mm)
3. Connection of ground electrode
with stub angle
 - 3.1 For connection of steel rods: Steel wire as above
 - 3.2 For connection of copper weld rods: Copper conductor as above

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TECHNICAL DATA SHEETS

(To be filled by Bidder/Manufacturer)

The Bidders/manufacturers are required to furnish the following information in the Data Sheet. Separate sheets can be used if additional space is required. The information furnished shall be supported by the catalogue and/or test reports. The information not supported by the catalogues, test reports etc. shall be deemed to have been "Not provided". Any deviation from NEA's requirements shall be clearly mentioned giving the reasons thereof.

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(Bidder's Name)

1. TOWER

S. No.	Description	Unit	DD/DDE
	Manufacturer's Name		
	Country of origin		
	Applicable Standard		
	Years of Manufacturing Experience	Years	
	ISO Certificate submitted	yes/no	
	Manufacturer sales record submitted	yes/no	
1	Overall length of suspension insulator string from point of suspension to bottom of phase conductor clamp.	mm	
2	Vertical distance between underside of supporting cross arm and point about which live metal is connected	mm	
3	Overall length of tension insulator measured from point of attachment on cross arm to point where jumper, loop parabola leaves conductor	mm	
4	Minimum clearance from live metal to structure steelwork and earthed fitting when tension insulator is used		
4.1	Jumper loop in still air	mm	
4.2	Down comer in slack spans in still air	mm	
5	Max working stress in tension members :		
5.1	Mild steel	Kg/mm ²	
5.2	High tensile steel	Kg/mm ²	
6	Maximum ratio of unsupported length of steel compression members to their least radius of gyration		
6.1	Main members		
6.2	Redundant		
6.3	Bracing loaded in tension only		
7	Steel to ASTM A 36/IS 2062 or other proposed standard		
7.1	Elastic limit stress in tension members	kg/mm ²	
7.2	Ultimate stress in compression members (expressed as a function of L/R)	kg/mm ²	
8	Steel to ASTM A 572/IS 8500 or other proposed standard		
8.1	Elastic limit stress in tension members	kg/mm ²	

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8.2	Ultimate stress in compression members (expressed as a function of L/R)	kg/mm ²	
9	Bolts		
9.1	Property Class		
9.2	Ultimate shear stress on bolts (H.T. steel)	kg/mm ²	
9.3	Ultimate tensile quality of bolts (H.T. steel)	kg/mm ²	
9.4	Ultimate bearing stress on bolts (H.T. steel)	kg/mm ²	
10	Basic span length	m	
11	Minimum ground clearance of phase conductor assuming temperature of 85° C	m	
12	Final sag of phase conductor in still air at 85° C and standard span	m	
13	Distance of phase conductor below underside of cross arm, allowing for maximum length of insulating string	m	
14	Height above ground of underside of bottom cross arms	m	
15	Vertical distance between top and bottom phase conductor cross arm	m	
16	Height of structure above ground	m	
17	Horizontal spacing between center line of structure and conductors :		
17.1	Top	m	
17.2	Middle	m	
17.3	Bottom	m	
18	Minimum vertical spacing between adjacent phase conductors	m	
19	Final conductor sag at everyday temp. in still air for basic span :		
19.1	Phase conductor	m	
19.2	Earth Wire	m	
20	Width of structure attachment of center cross arm where applicable	m	
21	Overall dimensions of support base at ground level :		
21.1	Transverse	m	
21.2	Longitudinal	m	
22	Weight of tower above ground level	kg	
22.1	Standard height	kg	
22.1	With -4.5 m extension	kg	
22.2	With -3 m extension	kg	
22.3	With -1.5 m extension	kg	
22.4	With 0.0 m extension	kg	

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22.5	With 1.5 m extension	kg	
22.6	With 3 m extension	kg	
22.7	With 4.5 m extension	kg	
22.8	With 6 m extension	kg	
22.8	With 7.5 m extension	kg	
22.9	With 9 m extension	kg	
23	Weight of steel work below ground in concrete foundation	kg	
24	Approximate (Ultimate uplift load per tower)	kg	
24.1	Approximate (Ultimate uplift load per tower Broken wire condition)	kg	
25	Approximate (ultimate compression load per tower normal condition).	kg	
26	Approximate (ultimate transverse load per leg).	kg	
27	Approximate (ultimate Longitudinal load per leg).	kg	

Signed:

As Representative for:

Address:

Date:

Note: Maximum working stress and max. Stress when structure is subjected to normal loading at any temperature or wind loads within the range specified.

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(Bidder's Name)

1.0 ACSR Conductor

S. No.	DESCRIPTION	UNIT	OFFERED DATA
	Manufacturer's Name		
	Country of origin		
	Applicable Standard		
	Years of Manufacturing Experience	Years	
	ISO Certificate submitted	yes/no	
	Manufacturer sales record submitted	yes/no	
1	Code word		
2	Aluminum Wires :	no/mm	
2.1	No. of & diameter		
2.2	Lay inner layer	mm	
2.3	Lay middle layer	mm	
2.4	Lay outer layer	mm	
3	Steel Wires :		
3.1	No. & diameter	no/mm	
3.2	Lay outer layer	mm	
3.3	Steel quality (Grade)		
4	Overall diameter of conductor	mm	
5	Maximum DC resistance of conductor at 20°C	ohms/km	
6	Maximum AC resistance of conductor at 20°C	ohms/km	
7	Ultimate tensile strength of conductor	kg	
8	Tension of conductor in still air at everyday temperature	kg	
9	Maximum working tension of conductor	kg	
10	Equivalent modules of elasticity of complete conductor	kg/m ²	
11	Conductor weight with grease	kg/km	
12	Equivalent coefficient of linear expansion of complete conductor 10 ⁻⁶	per °C	
13	Standard length of conductor on drum	m	
14	Maximum weight of conductor and drum	kg	
15	Vibration dampers		
15.1	Type		
15.2	Weight	kg	
15.3	Distance from clamp mouth to attachment point :		
	a. 1st damper	mm	
	b. 2nd damper (if required)	mm	

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16	Conductor grease :		
16.1	Type		
16.2	Density	kg/m ³	
16.3	Weight of grease	per kg kilometer	
17	Aluminum wires before stranding :		
17.1	Minimum breaking load	kg	
17.2	Tensile breaking stress	kg/m ²	
17.3	Cross sectional area	mm ²	
18	Steel wires before stranding :		
18.1	Minimum tensile strength	kg/m ²	
18.2	Minimum stress of 1 % elongation	kg/m ²	
18.3	Elongation in 200 mm length of breaking %		
18.4	Yield stress/breaking strength %		
19	Conductor manufacturing process		
20	Joint compressors :		
20.1	Type of compressor		
20.2	Dies to be supplied		
20.3	List of recommended spares		
21	Type Test Report Submitted	Yes/No	
21.1	List of Type Test Reports submitted		
22	Drawing of Conductor submitted	Yes/No	
23	Drawing of Drum submitted	Yes/No	

Signed:

As Representative for:

Address:

Date:

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(Bidder's Name)

3.0 Insulators and Fittings

S. No.	DESCRIPTION	UNIT	COMPOSITE LONG ROD INSULATOR TENSION
	Manufacturer's Name		
	Country of origin		
	Applicable Standard		
	Years of Manufacturing Experience	Years	
	ISO Certificate submitted	yes/no	
	Manufacturer sales record submitted	yes/no	
1	Insulator type		
2	Composite Material		
2.1	Core Material		
2.2	Housing Material		
2.3	Weather Sheds Material		
2.4	End Fitting		
2.5	Grading Ring		
3	Long Rod Material and Diameter	mm	
3.1	Diameter of Core	m	
3.2	Diameter of Weather Sheds	m	
4	Overall length of Insulator	mm	
5	Highest system voltage	kV	
6	System frequency	Hz	
7	Rated lightning impulse withstand voltage (dry)	kVmax	
8	Rated power frequency withstand voltage		
	a) Dry	kVrms	
	b) Wet	kVrms	
9	a) Creepage distance	mm	
	b) Creepage distance as multiplied arcing distance		
10	Minimum mechanical failing load		
	a) Suspension	kNkN	
	b) Tension Rod		
11	Factor of safety under maximum loading condition		
	a) Insulator		
	b) Iron fitting (if any)		

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12	Accelerated Aging test report submitted	Yes/No	
13	Type Test Report Submitted	Yes/No	
13.1	List of Type Test Reports Submitted		
14	Dimensioned GA Drawing Submitted	Yes/No	
15	Manufacture's Catalogue submitted	Yes/No	

Deviations from technical requirements and reasons for such deviations:

Signed:

As Representative for:

Address:

Date:

H. andy



(Bidder's Name)

4.0 Technical Particulars of Ground Wire

S.No.	DESCRIPTION	UNIT	OPGW	ADSS
	Manufacturer's name			
	Country of Origin			
	Applicable Standard			
	Years of Manufacturing Experience	Years		
	ISO Certificate Submitted	Yes/No		
	Manufacturer's sales record submitted	Yes/No		
1	Galvanized steel wires / Aluminum Clad Steel wire			
1.1	No. of and Diameter	Nos/mm		
1.2	Lay Outer layer	Mm		
1.3	Steel Quality (Grade)			
1.4	Normal Cross Sectional area	mm ²		
1.5	Weight	Kg/m		
2	Overall diameter	mm		
3	Ultimate tensile strength	Kg		
4	Tension in steel air at everyday temperature	kg		
5	Equivalent modulus of elasticity	kg/m ²		
6	Maximum Working tension	kg		
7	Coefficient of linear expansion	/°C		
8	Standard length on each drum	km		

Deviations from technical requirements and reasons for such deviations:

Signed:

As Representative for:

Address:

Date:

H. Pandey



(Bidder's Name)

5.0 Method Statement for Erection of Towers and Stringing of Conductors

S. No.	DESCRIPTION	UNIT	REQD.	OFFERED DATA
1	Erection Method to be adopted at site			
1.1	Method of Statement for Erection of Tower Submitted	Yes/No	Yes	
2	Stringing Method to be adopted at site			
2.1	Method Statement for Stringing submitted	Yes/No	Yes	

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33kV Lamahi Jaluke Transmission Project
Shuba Shree Agni Cement
Bill of Quantity of material

Project :	Lamahi Jaluke 33kV TRANSMISSION LINE PROJECT	Estimated			unit rate NRs (excluding VAT)	unit rate in word	Amount	Remarks
		Quantity	kg	Unit				
Item No.	Description							
1	Supply of Towers including bolt and nuts, hangers, U-bolts complete							
1.1	Tower Type							
a	Stub	8	106	No.				
b	tower with body and leg extension (for 450 m river crossing) set	2	7418	No.				
2.2	Supply of Tower Earthing Material							
a	Pipe Type	8		No.				
3	Supply of Line Materials							
3.1	Conductor and Groundwire							
a	ACSR wolf Conductor including armour-rod, mid-span joints, repair sleeves, etc. (single	3.10		km				
b	Vibration Dampers for wolf	24.00		set	include			
b	galvanised steel wire 7/3.25	1		km				
3.2	33 kV Insulator sets							
a	Double tension Insulator Strings complete with all accessories. With jumper	36		Set				
b	jumper insulator string 33kv	12		set				
	Total (to Schedule Grand Summary)						-	

Signed:

As Representative for:

Address:

Date:



Lamahi- Jaluke 33kV Transmission Line
Shuba Shree Agni Cement
Bill of Quantity of material

Project : Lamahi Jaluke 33kV TRANSMISSION LINE PROJECT				Construction & Installation (Excluding Taxes)			Remarks
Item No.	Description	Quantity	Unit	Unit Rate	Unit Rate in word	Amount	
1	Soil Investigation						
d	River Crossing	2	Loc.				
2	Erection of towers & its body extensions (Complete) including bolts & nuts, tack welding and supply and application of enamel & zinc rich paint						
2.1	Tower Type DD/DE						
a	Stub	8	No.				
b	tower with body and leg extension (for 450 m river crossing) set	2	No.				
3	Work associated with installation of tower foundations						
3.1	Tower Type (for all type of body and leg extensions)						
a	all type of soil	2	No.				
4	Installation of Tower Accessories & Earthing						
4.1	Tower Accessories						
a	Anti Climbing Device	2	Sets				
4.2	Installation of Tower Earthing Material						
a	Pipe Type	8	No.				

Bill of Quantity of material

Project : Lamahi Jaluke 33kV TRANSMISSION LINE PROJECT				Construction & Installation (Excluding Taxes)			Remarks
Item No.	Description	Quantity	Unit	Unit Rate	Unit Rate in word	Amount	
5	Installation of Line Materials						
5.1	Stringing of Conductor and Groundwire						
a	ACSR wolf Conductor including armour-rod, mid-span joints, repair sleeves, etc. (single wire).	3.10	km				
b	galvanised steel wire 7/3.25	1.00	km				
5.2	33 kV Insulator sets						
a	tension Insulator Strings complete with all accessories.and jumper	48	Set				
b	Vibration Dampers for wolf conductor.	24	set	include			
6	Protection of tower footing						
a	Random rubble stone masonry including excavation (1:4 cement : sand)	20	CUM				
b	Stone bound in galvanizing wire netting including excavation	15	CUM				
c	Back filling and leveling of volumes enclosed by revetment	15	CUM				
d	M15 Conc. Nominal Mix 1:2:4 for foundation lean concrete top seal cover	15	CUM				
e	Reinforcement Bars	1	tons				
f	Dismantling of river pole and dog conductor and transportation to store	1	lot				
Total (to Schedule Grand Summary)							

Signed:
 As Representative for:
 Address:
 Date:



Handwritten signature

33kV Lamahi Jaluke Transmission Project

Shuba Shree Agni Cement

Bill of Quantity of material

Lamahi Jaluke 33kV Transmission Line Project

Summary of Cost Estimate

NRs

SN	DESCRIPTION	Amount (NRs.)
1	schedule 1: Material supplied	
1 .a	transmission line Plant and Equipments Supplied	
2	schedule 3: construction and installation	
2.a	Transmission line Construction & Installation Services	
	Grand Total	

Signed:

As Representative for:

Address:

Date:



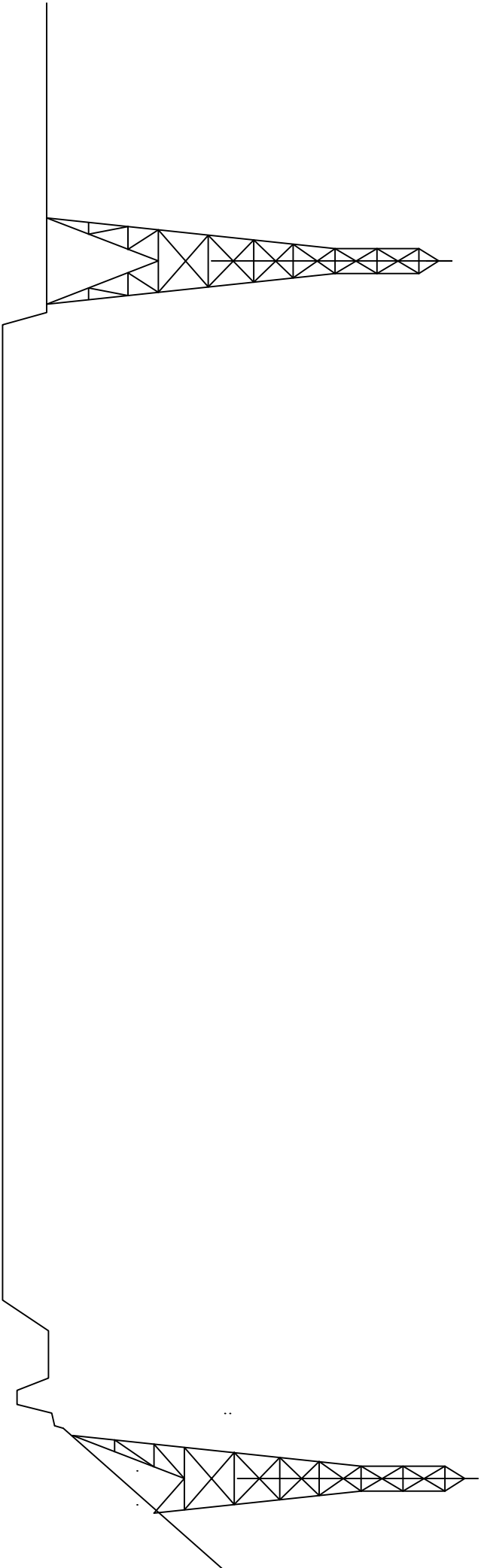
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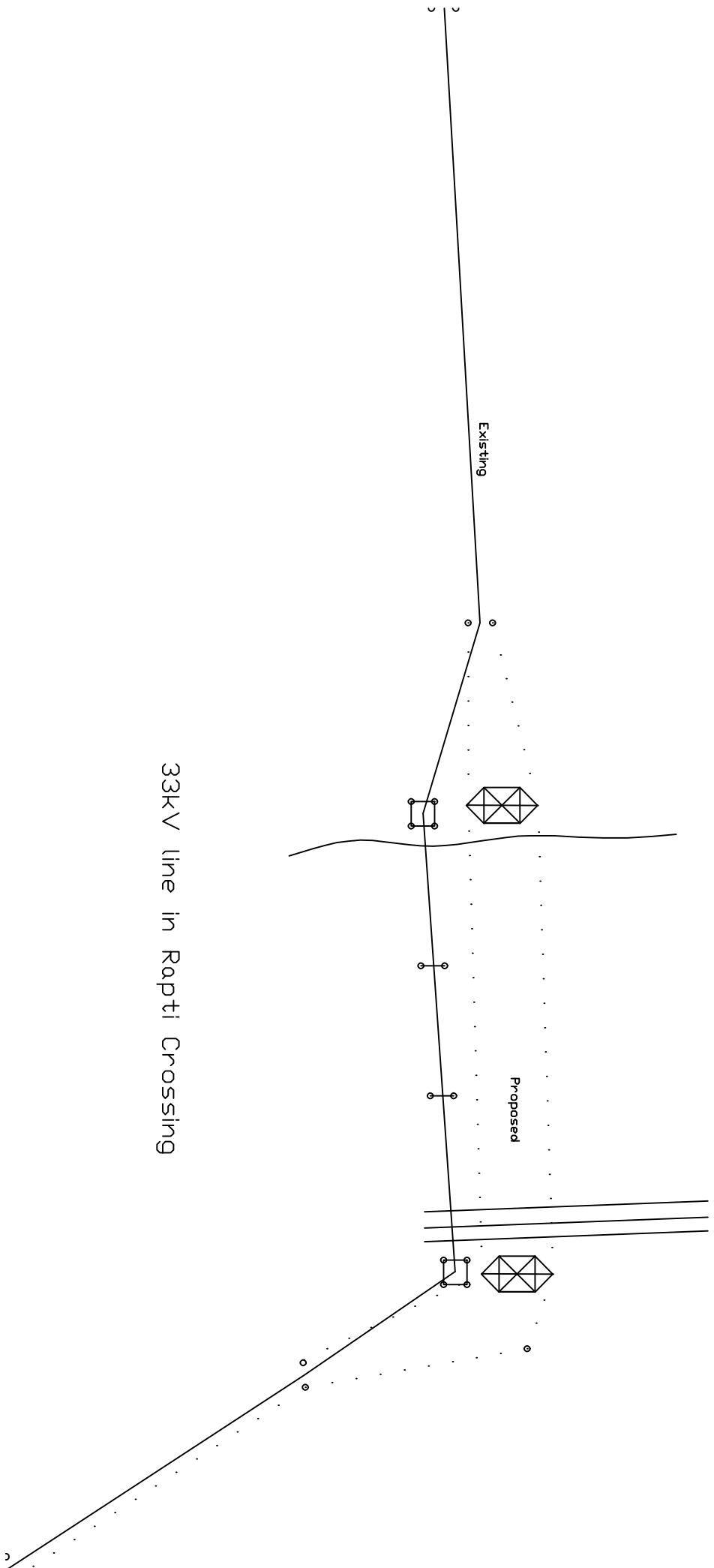
Drawings
(All Drawing are sample Drawing)

Handsy



Rapti crossing

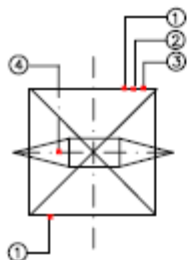




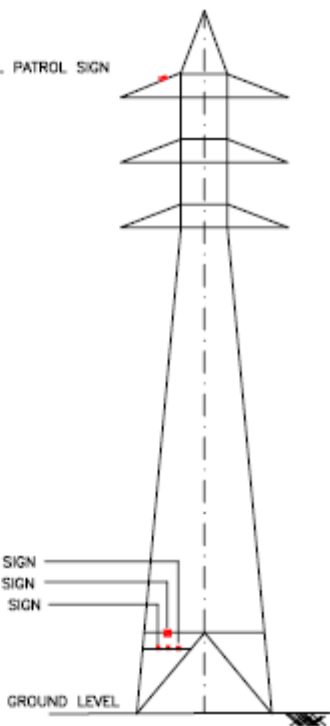
33kV line in Rapti Crossing

④ ARIAL PATROL SIGN

PHASING SIGN



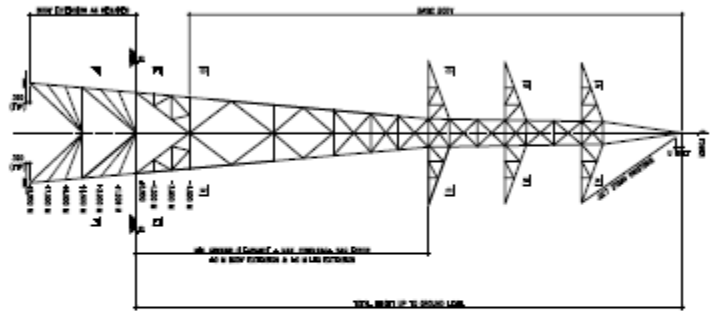
- ① NUMBER SIGN
- ② DANGER SIGN
- ③ PHASING SIGN



**FOR TENDER
PURPOSE ONLY**



TOWER OUTLINE CONFIGURATION



MEW-E



MEW-E



MEW-D



MEW-C



MEW-B



MEW-A



TOWER OUTLINE CONFIGURATION

