Nepal Electricity Authority

(A Government of Nepal Undertaking)

Transmission Directorate

Grid Development Department

DORDI CORRIDOR 132 kV TRANSMISSION LINE PROJECT

Bidding Document

for

Design, Supply, Construction, Installation, Testing and Commissioning of Kirtipur-Udipur 132 kV Transmission Line

(Single Stage, Two Envelope Bidding Procedure)

ICB No: DCTL-073/74-01

Volume – II of III

May2017

Table of Contents – Summary Description

PART I BIDDING PROCEDURES

Section 1 – Instruction to Bidders (ITB)…….. 1-1
This Section specifies the procedures by Bidders in the preparation and submission of their Bids following a Single-Stage, Two-Envelope bidding procedure. Information is also provided on the submission, opening, and evaluation of bids and on the award of contract.

Section 2 - Bid Data Sheet (BDS) …… 2-1
This Section consists of provisions that are specific to each procurement and supplement the information or requirements included in Section 1 - Instructions to Bidders.

Section 3 - Evaluation and Qualification Criteria (EQC) 3-1
This Section contains the bid evaluation criteria to determine the lowest evaluated bid and specifies the necessary qualifications of Bidders**.**

Section 4 - Bidding Forms (BDF)…….. 4-1
This Section contains the forms which are to be completed by the Bidder and submitted as part of its Bid.

Section 5 - Eligible Countries (ELC)…… 5-1
This Section contains the list of eligible countries

PART II REQUIREMENTS

Section 6 - Employer's Requirements (ERQ)…… 6-1
This Section contains the Scope of Supply of Plant and Services, Specifications, the Drawings, and Supplementary Information that describe the plant and services to be procured, Personnel Requirements, Equipment Requirements, Certificates, and Change Orders.

PART III CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section 7 - General Conditions of Contract (GCC)…… 7-1
This Section contains the general clauses to be applied in all contracts. These Conditions are subject to the variations and additions set out in Section 8 (Special Conditions of Contract).

Section 8 - Special Conditions of Contract (SCC) …….. 8-1
This Section contains provisions that are specific to each contract and that modify or supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC. The clause number of the SCC is the corresponding clause number of the GCC.

Section 9 - Contract Forms (COF)……...…… 9-1
This Section contains forms, which, once completed, will form part of the Contract. The forms for Performance Security and Advance Payment Security, when required, shall only be completed by the successful Bidder after contract award.

Employer’s Requirements (ERQ)

(Scope of Supply of Plant and Services, Specifications, Drawings and Supplementary Information)

TABLE OF CHAPTERS

	Total No. of Pages
Chapter 1 General Information and Scope	6
Chapter 2 General Technical Conditions	23
Chapter 3 Preliminary Works	14
Chapter 4 Transmission Line Tower	26
Chapter 5 Tower Foundation and Civil Works	25
Chapter 6 Line Conductor	8
Chapter 7 Insulator and Accessories	13
Chapter 8 Optical Ground Wire (OPGW) and Optical Terminal Equipment	7
Chapter 9 Erection, Testing and Miscellaneous Works	4
Chapter 10 Inspection, Testing and Commissioning	29
Chapter 11 Technical Schedule	11
Technical Data Sheets	
1 Tower	3
2 ACSR Conductor	2
3 Insulator and Fittings	2
4 Technical Particulars of Optical Fiber Ground Wire (OPGW)	2
5 Method Statement for Erection of Tower and Stringing of Conductors	1
Drawings	

Chapter 1: GENERAL INFORMATION AND SCOPE

1.1 Salient Features of the Project

Dordi corridor 132kV Transmission Line project consist of Design, manufacturing, supply, construction, installation, testing and commissioning of works shall satisfy the general technical requirements specified in the Specification or implied as per IEC/IEEE/IS/British Standard codes (B S Codes)/equivalent International Standards.

The following 132 kV transmission line associated with Transmission Directorate for Execution of 132 kV double circuit Kirtipur-Udipur transmission line are included in the scope of the contractor for this package:

	Line Length (Approx)
Kirtipur-Udipur 132 kV Double Circuit Transmission Line	11.5 km

1.1.1 Kirtipur to Udipur 132kV double circuit transmission line

Volume I of the turn key bidding documents covers the technical requirement for construction of approximately 11.5 km long, 132 kV Double Circuit Transmission Line. The proposed 132 kV Transmission line traverses through undulating landscapes of Lamjung district of Nepal. The variations of altitudes of the proposed 132 kV transmission line ranges from 604 m above MSL to approximately 1000 m above MSL.

1. 2 Intent of the Specification

This part of the specification is intended to cover the design, manufacture, engineering, inspection and testing at Bidder's work(s), packaging, forwarding to site, unloading, erection, testing, commissioning, performance testing and handing over of 132kV Double Circuit Transmission Line from Kirtipur Substation in Lamjung district to Udipur with all associated ancillaries and auxiliaries.

This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points. The quantities shown on drawings and annexure are indicative. Any variation arising during detailed engineering stage will be taken into account by the Bidder without any extra cost and time to the Employer.

Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to complete the scope and fulfill the intent of ensuring efficiency, operability, maintainability and the reliability of the complete work covered under this specification. It is not the intent to specify completely herein, all aspects of design and construction of equipment. Nevertheless, the equipment shall conform in all respects to high standards of engineering, design and workmanship

and shall be capable of performing continuous commercial operation, in a manner acceptable to Employer, who will interpret the meaning of the specification, drawings, requirements of operation, maintenance redundancy etc. and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable International standards mentioned elsewhere in the specification.

Bidder is requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. The bidder's offer should clearly bring out the technical deviation and commercial deviation (If any) that the Bidder is taking. No other clarification, interpretation and assumption shall be considered for evaluation. In the event of conflict between the requirements of any two clauses of this specification or requirements of different codes/standards, the more stringent requirement shall govern, unless confirmed otherwise by the Employer in writing before the award of this contract, based on a written request from the bidder for such a clarification. However, if the bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

Bidder may also make alternate offers provided such offers are superior in his opinion, in which case, adequate technical information, operating feedback data, etc. shall be enclosed with the offer, to enable the Employer to assess the superiority and reliability of the alternatives offered. In case of each alternate offer, its implications on the performance, guaranteed efficiency etc., shall be clearly brought out for the Employer to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications.

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or trade mark, the specific items shall be understood as established type/make, meets functional requirement and of required quality. Other manufacturer's products may also be considered provided sufficient information is furnished so as to enable the Employer to determine that the products are proven and equivalent or superior to those named.

1.3 Scope of Work

The scope of works covering design, engineering, procurement, inspection & testing at manufacturer's works, supply, insurance, receipt at site, storage and preservation at site, site transportation, construction, erection, commissioning, trial operation, handing over to Employer, guarantee all equipment, spares and material, catalogues, drawings, documents and services including lubricants, transformer oil, consumables for the proposed 132 kV Double Circuit Transmission Line from Kirtipur to Udipur inclusive of all mechanical, electrical and civil, structural & architectural works on basis of single point responsibility.

The scope of work shall include but not limited to the following:

- Detailed survey and check survey including route alignment and profiling, right of way identification and clearance, tower spotting, optimization of tower locations, soil resistivity measurement, geotechnical investigation and check survey.

- Complete engineering services for the project including basic & detailed engineering, design philosophy, operation philosophy, submission of technical parameters, characteristic curves, capability curves, etc of equipment and material for Employer's approval.
- Prototype testing of towers at manufacturing plant of the Contractor.
- Any study through which the capacity and rating of equipment offered shall be proved for the main & on analysis of site location and attitude.
- Submission of manuals, engineering & construction drawings, design basis reports, optimization study reports, design calculations, quality assurance plans, testing procedures, operation and maintenance manuals, commissioning procedures, etc.
- Obtaining of any consents, licenses and approvals from relevant statutory authorities, other than those obtained by the Employer and required as per law. The scope of Bidder also covers extending necessary assistance wherever logically required to enable Employer to obtain the requisite approval.
- Quality assurance of all work related to scope of work of the Bidder.
- Submission of schedule of work from zero date to handing over to Employer complete plant and equipment in the form of chart, 'S'-curve; write up etc for Employer's approval. Submission of monthly progress reports, photographs, graphs etc for engineering, supply, construction and commissioning for all major works with suggestions and plans for making up back log if any for review of Employer. To attend meetings, review, discussion etc for resolving all issues.
- Submission of shipping schedule of equipment and material from country of origin up to receipt at site for off shore supply and ex-works to site for on-shore supply matching with schedule of work for approval of Employer.
- Manufacture, fabrication, quality control, shop testing of equipments and material after approval of required technical data and drawings by Employer. To furnish notice to Employer for inspection.
- Packing, forwarding, shipment and transportation (including port handling and custom clearance) from the manufacturer's works to site. Comprehensive marine/transit-cum-storage-cum-erection insurance coverage of all equipment from Nepal Border / ex-works to project site till the equipment supplied is taken over by Employer. Preservation of all equipment during transportation till testing and commissioning stage.
- Hiring of a suitable storing area which shall be approved by the Employer,
- Receipt at site, unloading, movement to proper storage, carriage to storage area / interim / final foundation location, security, preservation and conservation of equipment at the site.
- Erection and construction including supply of construction material and labour complete for structural and including all temporary enabling works, cabling, testing, start-up, successful trial operation and performance guarantee testing of the plant as indicated under the specifications and tender documents.
- Performance Guarantee of the plant.
- Supply of spares parts.
- Supply any other equipment including special tools & tackles, for operation, capital maintenance
- Supply of all manuals covering erection and commissioning, performance testing, operation, preservation, and capital maintenance including supply of as-built drawings and services required for satisfactory completion of the project.
- Supply of all construction consumables, e.g., welding electrodes, cleaning agents, diesel oil as well as materials required for temporary supports, scaffolding, storage tanks, illumination as necessary.

- Deployment of all skilled and unskilled manpower required for erection, commissioning, testing, etc, supervision of erection, commissioning, testing etc for services to be rendered.
- Deployment of all erection tools & tackles, adequate number and capacity of cranes, construction machinery, transportation vehicles, and all other implements in adequate number, capacity and size. Any other tools, tackles and resources required to complete the contract with required quality and with the schedule.
- Training of Employer's personnel as specified.
- Arrangement of construction power and construction water at site.
- Any other activity not listed above but required for safe and trouble free operation of the substation shall be deemed to have been included in the Bidder's scope.

1.3.1 Major Equipment and Works

The following list of the major plant items and systems shall be included in the Bidder's scope of work. This list is not exhaustive and is without prejudice to the more fundamental responsibility of the Bidder for completeness of 132 kV Double Circuit Transmission Line from Kirtipur to Udipur.

a) Conductors and Accessories
   - Line Conductor (ACSR – CARDINAL) and accessories
   - Optical fibre ground wire (OPGW) and accessories
   - Insulator, Hardware Fittings and other accessories

b) Tower and Tower Accessories
   - All types of transmission line towers (total 4 types - DA, DB, DC, DD) including bolts, nuts and washers, hangers, D-shackles and
   - All types of tower accessories like phase plate, circuit plate, number plate, danger plate, anti-climbing device, bird guard, aviation signals, painting of towers etc.

c) Foundations
   - classification of foundations for different soil conditions for different type of towers and casting of foundation for tower footings including stub setting

d) Grounding of each towers

e) Other items not specified above but required to complete the transmission line as per technical specifications, Bid Forms & Price Schedules.

1.4 Exclusions

The following items shall be excluded from the scope of supply by the Bidder:

- Construction of 132kV Line Bays at Udipur substation required for connection 132 kV transmission line covered under this specification.

1.5 Terminal points

The Bidder's scope of work shall terminate at the points as shown on the table below. These interconnection points represent the physical boundary points of the Bidder's scope of works. They do not necessarily define the operational responsibilities between the Bidder and the third parties.

System	Terminal Points
Termination of Line	132 kV Gantry of the line bay within Kirtipur Substation. Connection with the

conductor at Kirtipur Substation	Gantry including supply of string insulators hard ware and other accessories are included in the scope of work of this specification.
Termination of Line conductor at Udipur Substation	132 kV Gantry of the line bay within Udipur Substation. Connection with the Gantry including supply of string insulators hard ware and other accessories are included in the scope of work of this specification.

The Contractor shall have to construct these 132 kV transmission line from dead end tower at one end (Kirtipur Substation) to the dead end tower of the Udipur Substation. Stringing shall also be carried out from dead end tower to terminal arrangements/terminal points.

1.6 Additional responsibilities of the contractor

The Contractor shall take care of the following during execution of the works under the contract.

1.6.1 Existing Fences

Where it is necessary to operate equipment through existing fences, the Contractor shall install suitable temporary gates. The temporary gates shall be constructed of materials and to standards equal to those of the existing fence. Before cutting the fences for the installation of temporary gates, the Contractor shall install adequate braces and additional posts, if necessary, on each side of the opening and shall fully anchor the fence so that all wires will maintain their original tension after opening is cut. Except when equipment is passing, such gates shall be kept closed. After completion of the work, the fence shall be restored as nearly as practicable to its original condition. Deviation from the above requirement will be permitted only where the Contractor furnishes advanced written approval from the landowner or landowners for a different method of operation.

Where it is necessary for the Contractor to remove or to alter portions of existing fences to permit construction, temporary fence protection shall be provided at all times during construction and upon completion of the construction, the fence shall be rebuilt in its original or relocated position.

The cost of all work herein described shall be borne by the Contractor. Should the contractor refuse or neglect to perform any work required by the above provisions within twenty-four hours after notification by the Employer to do so, the Employer reserves the right to perform the work and the cost thereof will be deducted from payment due to the Contractor.

1.6.2 Transmission, Telegraph and Telephone Lines:

The Contractor shall make all necessary or required provisions concerning any interference with the operation or maintenance of traffic or service of any transmission, telegraph or telephone lines existing on the date of receiving bids, caused by the work of the Contractor under this Contract, all in a manner satisfactory to the Employers or operators and to the Employer.

The Contractor shall notify the Employers of such facilities of any damage, which is his responsibility and shall promptly settle proper claims. Pending settlement of such claims by the Contractor, an appropriate

sum as determined by the Employer may be withheld from payments due to the Contractor until the matter is settled.

The cost of providing and maintaining all necessary or required watchmen, signals, guards and temporary structures, of making any necessary repairs, replacements, or similar operations and all or any other costs required by this Sub-Clause shall be borne by the Contractor.

1.6.3 Operation and maintenance

The Contractor shall provide at least one operating and maintenance expert at the site for a continuous period of Six (6) months or any extension required thereof because of serious breakdown or any extensions of warranty period, from the commencement of the Defect Liability Period to train the local staff on the operation of various equipment.

1.6.4 Commissioning and pre-commissioning

The Contractor shall provide sufficient, properly qualified personnel; shall supply and make available all raw materials, utilities, lubricants, chemicals, catalysts, other materials and facilities; and shall perform all work and services of whatsoever nature required to properly carry out Pre-commissioning, Commissioning and Guarantee Test all in accordance with the provisions of the Contract Agreement.

1.6.5 Other Responsibilities

a) The Contractor shall be responsible for selecting and constructing appropriate communication means necessary for the executing of the project at his own expense. If required, the Employer will assist the Contractor in obtaining licences/permits from the concerned government agencies.
b) Gasoline, oil and lubricants for construction equipment and vehicles are available in Nepal and the Contractor will not be permitted to import such products for use on the work.
c) The Contractor shall be responsible for the arrangement of water supply for drinking and construction purposes at his own cost.
d) The Contractor shall be responsible for the arrangement of electricity supply for construction and any other purposes at his own cost.

1.7 Required Completion Schedule

The scope under Volume – I of the bidding document includes following component of Dordi Corridor 132 kV transmission line project:

a. Design, manufacturing, supply, construction, installation, testing and commissioning of 132 kV Transmission Line from Kirtipur to Udipur.

All works under the scope shall be completed within eighteen (18) months from the effective date of the contract.

Chapter 2: GENERAL TECHNICAL CONDITIONS

2.1 General

The following provisions shall supplement all the detailed technical specifications and requirements brought out herein. The contractor's proposal shall be based on the use of materials complying fully with the requirements specified herein.

All works described herein and other works necessary to complete the job for proper coordination and operation, even if not specified, shall be within the scope of the Contractor's work and the cost of such works shall be considered to be included in the bid price.

The Contractor shall provide spare parts and tools for the 132kV Transmission line as specified in this specification; furnish qualified supervision and construction personnel for the installation, testing, commissioning and remedying defects within warranty period and checking out of the equipment necessary to complete the scope of works as mentioned above and detailed in the Price Schedule. The work shall be performed in close cooperation with the Employer.

Coordination of the 132kV Transmission line works with the installation of others shall be the responsibility of the Contractor. The Employer will furnish the information needed to coordinate the 132kV Transmission line works with other works.

Locally available goods, construction materials including stones, fuel, lubricating oil, cement, timber, iron and steel goods, etc. shall be procured locally. Cost of such local materials will be limited to the cap specified elsewhere in the bidding document.

2.2 Engineering Data

The furnishing of engineering data by the Contractor shall be in accordance with the Schedule as specified in the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

All engineering data submitted by the Contractor after review by the Employer shall form part of the contract document.

2.3 Site Location and Access

The 132 kV double circuit transmission line will connect 132 kV substation at Udipur located in Lamjung district with 132/11 kV substation at Kirtipur located in Lamjung district. Six (6) VDCs of Lamjung district falls in this 132 kV transmission line route. The entire transmission line route is accessible from earthen

road and partially black top road (Udipur – Chiti - Kirtipur road), which is connected with Dumre–Besishahar–Chame Highway of Nepal near Udipur.

Location of Dordi Corridor 132 kV Transmission Line Project is shown in Map of Nepal in Location Map of Dordi Corridor 132 kV Transmission Line Project.

The entire site and location of tower may not be easily accessible round the year. However, the Employer shall not be responsible for the condition of the roads and the transport. Transportation of the material to the work sites shall be the Contractor's responsibility. Manual transportation of material may be required at hilly terrain.

2.4 Climate and Meteorological Data

132 kV Transmission line traverses through undulating landscapes. The variations of altitudes of the proposed 132 kV transmission line ranges from 603 m above to approximately 1000 m above MSL in Lamjung district.

The project area has extremely cold to humid, subtropical climate, warm in winter and hot and normal cold in summer.

The monsoon period of torrential rain lasts from mid of June to mid of September. The annual average rainfall of Lamjung district is 1442 mm. Almost 80% rainfall occurs during monsoon period.

All plant and equipment of 132 kV transmission line shall be entirely suitable for the climatic conditions prevailing at site. All structures shall be designed with the seismic factor of 0.15g.

Atmospheric pollution is low and special insulator design or washing shall not be required. Following climatic conditions shall be considered for design of 132 kV transmission line.

- Maximum ambient shade temperature : 32 °C
- Minimum ambient shade temperature : 0 °C
- Annual average temperature : 24^0C
- Maximum wind speed : 47 m/sec
- Rainfall : 650 mm/annum
- Monsoon season : June-August
- Relative humidity, maximum : 100 %
  Minimum : 20 %
- Altitude : 604 m to 1000 m above Mean Sea Level
- Atmospheric pollution : Light
- Isoceraunic level (thunderstorm days) :50

2.5 Salient Features of 132 kV Transmission Line

The connectivity of the Dordi Corridor 132 kV Transmission Line with the grid of Nepal Integrated Power System (INPS) is shown in following drawings:

a) Single Line Diagram of Dordi Corridor 132 kV Transmission Line Project-

b) Power Map of Nepal showing Dordi Corridor 132 kV Transmission Line Project

The Employer has studied several alternatives for the route alignment of the said 132 kV transmission line and selected a route alignment. The Employer has also conducted Initial Environmental Examination (IEE) study. The route of the transmission line is shown in the survey drawings prepared by the Employer.

For some practical reason such as change in topography due to construction of some new object in the line route, to avoid heavy afforestation or to avoid abolishment of houses under the line in some section of the line route minor modifications may be required. Therefore, the Contractor shall be responsible for undertaking detailed and check survey of selected route alignment. The Contractor along with the Employer shall examine the angle points and fix them within 45 days from Contract signing date. Immediately after that the Contractor shall carryout detailed check survey and prepare Strip plans and longitudinal profile sections of that section at scales horizontal 1:2,000 and a vertical scale of 1:200 or 1:400 as appropriate.

2.6 Main System Parameters

2.6.1 Altitude of Site

Analysis of above preliminary survey drawings prepared by the Employer, reveals that proposed Dordi Corridor 132 kV Transmission line traverses through undulating landscapes of Lamjung districts. The variations of altitudes of the proposed 132 kV transmission line ranges from 604 m above MSL to approximately 1000 m above MSL.

The stretches, and approximate length of the 132 kV transmission line falling in the different Alignment Points is given in the following table.

Altitude Zone	Section	Alignment Points	Approximate Length of the Transmission Line (m)
			Total
Up to 1,000 m	Udipur-BajarKhutta	AP0 – AP0A	382.04
	BajarKhutta – BajarKhutta	AP0A – AP1	582.29

	BajarKhutta – Panditthok	AP1 – AP2	1011.07
	Panditthok – Thapadanda	AP2 – AP3	598.21
	Thapadanda – Gariswara	AP3 – AP4	647.09
	Gariswara – Gariswara	AP4 – AP5	472.84
	Gariswara – Odare	AP5 – AP6	685.73
	Odare – Basnetgaun	AP6 – AP7	802.54
	Basnetgaun – Basnetgaun	AP7 – AP8	529.83
	Basnetgaun – Dhodeni	AP8 – AP9	783.98
	Dhodeni – Dhodeni	AP9 – AP10	241.98
	Dhoden – Bansar	AP10 – AP11	643.35
	Bansar – Khinchokbesi	AP11 – AP12	640.76
	Khinchokbesi – Khinchokbesi	AP12 – AP13	689.79
	Khinchokbesi – Miduswara	AP13 – AP14	1084.55
	Miduswara – Kirtipur	AP14 – AP15	697.08
	Kirtipur – Kirtipur	AP15 – AP16	673.83
	Kirtipur – Kirtipur	AP16 – AP17	333.62

2.6.2 Basic Insulation Levels

The following Basic Insulation Levels (BIL) shall be considered for design and construction of 132 kV Transmission Line. The corresponding clearances in air shall be as per relevant codes and standards.

Altitude Zone	Rated System Voltage - kV	Highest System Voltage - kV	Short-duration power frequency withstand voltage – kV (rms)	Lightning Impulse withstand voltage – kV (peak)
Up to 1,000 m	132	145	275	650

2.6.3 Ground Clearances

In view of the above, ground clearances for 132 kV transmissions line shall be as mentioned below.

Altitude Zone	Short-duration power frequency withstand voltage – kV (rms)	Lightning Impulse withstand voltage – kV (peak)	Rated Voltage - kV	Minimum Ground Clearances - m
Up to 1,000 m	275	650	132	7.1

2.6.4 Transmission Line Towers

The towers will of self-supporting lattice steel type, designed to carry ACSR "Cardinal" line conductors with necessary insulators, optical fibre ground wire (OPGW) and all fittings under all loading conditions.

Normally the following types of double circuit towers shall be used for the proposed 132 kV transmission line.

Tower Type	Deviation Angle	Typical Use
Altitude up to 1,000 m		
DA	0 deg.-2 deg.	To be used as tangent Tower up to 2 deg deviation
DB	0 deg.-15 deg	a) Tension Tower with Angle deviation from 0 to 15 deg. b) Section tower c) To be designed for anti- cascading condition.
DC	15 deg.-30 deg	a) Tension Tower with Angle deviation from 15 to 30 deg b) Tension tower for uplift forces resulting from a uplift span as per weight span specified in Schedule-A4, Section-11. c) To be designed for anti-cascading condition.
DD/DDE	30 deg.-60 deg	a) Tension tower Angle deviation from 30 to 60 deg. b) Tension towers for uplift forces resulting from an uplift spam as per weight span specified in Schedule-A4, Section-11. c) Complete Dead end with 0 to 15 day deviation on both sides. d) For river crossing anchoring with longer wind span with 0 deg deviation on crossing span side and 0 to 30 deg

Tower Type	Deviation Angle	Typical Use
Altitude up to 1,000 m		
deviations on other side.		

Towers for altitude up to 1,000 m shall be designed based on the requirement BIL and Ground Clearances applicable up to altitude of 1,000 m.

2.6.5 Insulators

Composite long rod insulator made of HT-Silicon Rubber shall be used for 132 kV transmission line.

The bidder shall offer composite long rod insulators of suitable core diameter to meet specified Electro Mechanical strength requirements of 90 kN for suspension string and 160 kN for tension string. Bidder shall submit the overall string length and other details with the Bid.

2.7 Site Survey

The information in this section is given solely for the general assistance to Bidders. No responsibility for it will be accepted, nor 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. The Contractor shall be responsible for surveying; detailed check survey, geo technical investigation including measurement of soil resistivity at the precise locations as required for foundation and other design of the substation.

The Contractor shall locate, and record on the construction drawings, all interfacing utility lines or other obstructions. Damage to existing installations shall be repaired by the Contractor at his expense.

Contractor shall make the arrangement of water and power supply for construction work.

2.8 Codes and Standards

2.8.1 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 by the Employer. Any details not specifically covered by these standards and specifications shall be subject to approval of the Employer.

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
EEI	Edison Electric Institute
IEC	International Electro technical Commission
NEMA	National Electric Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers
ITU-T	International Telecommunication Union
IS	Indian Standards

All plants and equipment supplied under this Contract shall conform to or be of higher quality than the latest applicable standard.

If the Specifications contained in this Contract conflict in any way with any of the reference standards, the Specifications shall take precedence. If there are conflicts between different specified reference standards covering the same material or equipment, the standard, which will provide the highest quality and most suitable application, as determined by the Employer shall prevail.

References to standards or to equipment of a particular manufacturer shall be regarded as followed by the words "or equivalent", except as otherwise noted.

The Contractor may propose alternative standards, or equipment, which shall be equal to those, specified unless the system requires specific equipment, as mentioned in the specification, to ensure compatibility. If the Contractor for any reason proposes alternatives to or deviations from the above standards, or desires to use equipment not covered by the above standards, the Contractor shall state the exact nature of the change, the reason for making the change, and shall submit, for their approval. The submittal shall include relevant specifications of the equipment in the original language, and in case that these specifications are written in language other than English, the English version shall be attached and shall govern. The decision of the Employer in the matter of equality will be final.

Notwithstanding the above, if the specification calls for equipment of specific manufacturers, only those manufacturers, which are specified, shall be acceptable to the Employer. Also, manufacturers having collaboration with the specified manufacturers will not be accepted.

2.9 Assistance by the Employer

The Employer will give assistance to the Contractor as much as possible in the following manner; this however will be without any obligations, legal or otherwise.

a) Facilitating access to all locations involved in carrying out the works.

b) General guidance to the Contractor for all negotiations with the Authorities in Nepal

2.10 Variation in Quantities of Work

The Quantities listed in the Schedule of Prices represent the estimated quantities for Tender purpose only. The Contractor shall carryout detail design and shall submit final bill of quantity for approval within 120 days from the effective date of contract. The actually required quantity may vary from the quantity as listed in price schedule.

Final quantities shall be determined after completion and approval of the detailed route survey and check survey. The final quantities of towers, line materials and foundations shall be confirmed by the Employer based on the requirement of quantities of various items furnished by the Contractor after completion of detailed and check survey. Hence it will the responsibility of the Contractor to intimate the exact requirements of all towers, line materials and foundations required for the line at the earliest after the survey. Employer will order the final quantities at the unit rates quoted in the bid.

The quantities of individual items may very up to any extent after the final route plans and route profiles of the lines covered in the package are finalized.

The Contractor shall agree to make no claim for anticipated profits or for alleged losses because of any difference between the quantities actually furnished and installed and the estimated quantities after the detailed and check survey and approve by the Employer.

In the course of detail survey, tower staking; installation of special tower (other than the tower type specified in the schedule) or modification on the cross-arm may be found necessary. In such case the Contractor shall conduct design related works without any additional cost to the Employer. Payment for the special tower and the modified cross-arm will be made at the unit rate of the tower material (weight) used.

2.11 Expected life cycle

Life expectancy of the following items shall be as given below:

a) Optical terminal equipment: min. 10 years

The contractor shall submit certificate from independent laboratory for the life expectancy above material equipment or the manufacturer shall provide any other reliable document to prove the life expectancy.

2.12 Drawings and Documents

In addition to those stipulated in clause regarding drawings in GCC/PC, the following also shall apply in respect of Contractor Drawings.

All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials,

weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

2.12.1 Tender Drawings

Drawings are to be submitted with the Bid, showing all essential details of supply and construction of various supplies. The drawings furnished by the Employer with the Bidding Document are preliminary and indicative only and the Contractor shall investigate the sites and design as per actual site requirement without any additional cost to the Employer.

2.12.2 Contract Drawings and Documents for Approval

Prior to commencement of the work, the Contractor shall submit detailed design drawings and data to the Employer for approval. Should the Employer 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 prepare and furnish to the Employer such drawings, calculations, and data on materials and equipment (hereinafter in this provision called data) as are required for the proper control and completion of the work. This shall including but not be limited to those drawings, data and calculations specifically required elsewhere in the Technical Specifications.

The Contractor shall submit detailed drawings, instructions and maintenance books, and parts lists with recommended stock quantities for the equipment and accessories furnished, prepare and submit detailed engineering, design and construction drawings pertaining to all civil, structural, architectural and electrical equipment and installations of 132kV transmission line. The drawings to be furnished by the Contractor shall include, but not be limited, to the following:

a) Work Schedule (Master Network) Plan.

b) Drawing deliverable Schedule.

c) Detailed and check survey report including profile drawings showing ground clearance and tower locations (as applicable).

d) Soil Investigation report including ground resistivity measurement.

e) Tower schedule and foundation classification for individual tower locations (as applicable).

f) Bill of Quantity of Towers and Foundations

g) Design Basis Report

h) Tower design and structural drawing including bill of materials.

i) Foundation design and working drawings/excavation Plan.

j) Tower footing grounding drawing.

k) Stub and stub-setting (template) drawings.

l) Stringing procedure and stringing chart.

m) Tower accessories drawings like danger plate, name plate etc.

n) Quality plans for fabrication and site activities including Quality System.

o) Sub-vendors approval.

p) Drawings and datasheets of Line Conductors.

q) Drawings and datasheets of OPGW

r) Technical Catalogues

s) Instruction Manuals for Erection, Testing and Commissioning

t) Operation and Maintenance Manuals.

u) General Documentations

- Monthly Progress Report
- QA/QC Documentation including MQP and FQP for all Equipment & systems
- Testing and commissioning procedure of each equipment
- Design (Type) Test Reports as specified
- Routine Test Reports of all Equipment
- Field Test Reports

All rights of the design/drawing for all types of towers and foundations shall be strictly reserved with the Employer only and any designs/drawings/data sheets submitted by the contractor from time to time shall become the property of the Employer. Under no circumstances, the Contractor shall be allowed to use/offer above designs/drawings/data sheets to any other authority without prior written permission of the Employer. Any deviation to above is not acceptable and may be a cause for rejection of the bid.

2.12.3 Drawings and Documents Submission Schedule

The Contractor shall submit the drawings and data to the Employer for approval in the following manner and designated deadlines.

Table 2.1: **For Supply of Equipment and/or Installation Works**

Item	No. of Copies	Deadline & Remarks
Proposed work program	3	Within 30 days from the Effective date of the Contract.
Principal equipment drawings for approval	3	Within 90 days from the Effective date of the Contract.
Principal installation drawings for approval	3	Within 120 days from the Effective date of the Contract.
Revised drawings for approval	3	Within 14 days after receiving drawing for revision.
Final drawings with reproducible copies	5	Within 14 days after receiving approval
AutoCad files of Final Drawings in USB flash Drive	2	Within 15 days after receiving approval
Schedule of manufacturing and transportation	2	Within 45 days from the Effective date of the Contract.
Plan for shop tests	2	Not less than 30 days before testing
Results of shop tests for approval	4	Upon completion of tests
Records of shop tests	4	Upon approval of results of shop tests
Plan for field-tests	2	Not less than 14 days before testing
Report for field tests	4	Within 14 days after completion of each test
As-built drawings	5	Within 30 days after completion of installation work
AutoCad file of as-built drawings in USB flash Drive	3	Within 30 days after completion of installation work
Instruction manuals and drawings with reproducible copies for installation	5	30 days after shipment of Equipment

Table 2.2: For Civil Works

Item	No. of Copies	Deadline & Remarks
Detail construction schedule & method	3	Within 45 days from the Effective date of the Contract.
Detailed Check Survey Report	3	Within 60 days from the Effective date of the Contract.
Route Profile and Tower Spotting with Quantity of Tower and foundations	3	Within 90 days after receiving drawings for revision
Drawing for approval (principal drawings for construction)	3	Within 120 days from the Effective date of the Contract.
Revised drawings for approval	3	Within 14 days after receiving drawings for revision
AutoCad file of approved drawings in USB flash Drive	2	Within 14 days after receiving drawings for revision
Reports of Field Tests	4	Within 14 days after completion of each test
As-built drawings	5	Within 30 days after completion of construction works
AutoCad files of as-built drawings in USB flash Drive	3	Within 30 days after completion of construction works

Table 2.3: Others

Item	No. of Copies	Deadline & Remarks
Drawing and Deliverable Schedule	3	Within 30 days from the Effective date of the Contract.
QA/QC Documentation	3	Within 30 days from the Effective date of the Contract.
Monthly Progress Reports with photographs	3	By 7th of following month
Packing list (copy)	5	At each shipment

Item	No. of Copies	Deadline & Remarks
Invoice (copy)	5	At each shipment
Bill of lading (copy)	5	At each shipment
Certificate of origin (copy)	1	At each shipment

2.12.4 Drawing Submission Schedule

Within 30 days from the effective date of the Contract, the Contractor shall prepare and furnish to the Employer a schedule for submission of all drawings and data. Each drawing to be submitted for the work of the Contract shall be listed in the Schedule, and the Schedule shall contain separate columns for scheduled submittal dates and actual submitted dates. The schedule will be reviewed by the Employer/Consultant and the Contractor shall correct any defects noted therein. The schedule shall at all times present a complete plan for orderly submission of such drawings and data and shall be updated and resubmitted monthly showing actual submittal dates and revised scheduling. The Contractor shall promptly notify the Employer of any occurrence requiring substantial revision of the schedule giving a detailed explanation of the cause of the revision. Revised schedules will be revised and corrected in the same manner as the original schedule.

2.12.5 Drawings: Titles, scales and Sizes

All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be acceptable. After final approval all the drawings shall be submitted to the Employer in USB flash drive.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

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 in the following format:

Nepal Electricity Authority
(Government of Nepal Undertaking)
Grid Development Department

Dordi Corridor 132kV Transmission Line Project
Contract No…….
Name of the Transmission Line: Kirtipur-Udipur 132 kV Transmission Line
Item No…….

Brief Description ……

In general the scales of the drawings shall be 1:200. The Contractor, however, can prepare and submit drawing in any other appropriate scales with the prior approval of the Employer. The Contractor shall use any one of the following sizes for the preparation of drawings as appropriate:

A0	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)

2.12.6 Employer's approval

A copy of each drawing reviewed will be returned to the Contractor as stipulated herein.

Copies of drawings returned to the Contractor will be in the form of a print with the Employer's marking, or a print made from a microfilm of the marked up drawing.

The Employer will send comment/ approve each drawing within twenty-one (21) days after receipt at his office. One print of each of the drawings submitted for approval will be returned by the Employer or Employer's Representative, marked either "APPROVED", "APPROVED EXCEPT AS NOTED", or "RETURNED FOR CORRECTION".

a) 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 the drawings and submit for approval within twenty-one (21) days in the same manner as before drawing and documents for which detailed review / approval is not required shall be marked as for INFORMATION.
   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.
b) Reproducible: Reproducible of all final approved drawings shall be made on USB flash Drive.

The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:

a) The Contractor has completed the part of the Works covered by the subject document (i.e. confirmation of progress of work).
b) The Works appear to comply with requirements of Specifications.

In no case the approval by the Employer of any document does imply compliance with technical requirements or the absence of errors in such documents.

If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible for consequences.

Neither the review nor lack of review of any drawing, calculation or data shall waive any of the Specifications or Contract drawings, or responsibility for correctness of the drawings, calculations or data. Defective work, materials, and equipment may be rejected notwithstanding conformance with drawings, calculation and data reviewed by the Employer/Consultant. The Employer shall have the right to require the Contractor to make any changes in the design which may be necessary, to make the apparatus/works conform to the requirements and intent of the Specifications, with no additional cost to the Employer.

Approval of the Contractor's drawings (including cases of un-noticed/un-known deviations) 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. The ultimate responsibility of meeting all the requirements of the technical specifications and fulfill contractual obligations shall rest on the Contractor.

Any drawings changed by the Contractor during the development of his design after review by the Employer shall be submitted for approval.

The work shall be performed by the Contractor strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

All manufacturing, fabrication and erection work under the scope of Contractor, prior to the approval of the drawings shall be at the Contractor's risk. The contractor may incorporate any changes in the design, which are necessary to conform to the provisions and intent of the contract and such changes will again be subject to approval by the Employer.

2.13 Design Improvements

The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

2.14 Design Co-ordination

Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best co-coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

2.15 Design Review Meeting

The contractor will be called upon to attend design review meetings with the Employer during the period of Contract. The contractor shall attend such meetings at his own cost at the Corporate Office of the Employer or at mutually agreed venue as and when required. Such review meeting will be held generally four times in a year or as and when required.

2.16 Quality Control

The Contractor shall provide and maintain a quality control program to ensure compliance with quality standards of the Technical Specifications. Within 30 days from the effective date of the Contract, the Contractor shall furnish to the Employer his complete quality control procedures, manual, and a description of the quality control organization in required number of copies.

The Employer/Consultant will monitor the Contractor's methods, procedures and processes for compliance with the quality control program and the quality standards of these Specifications. Failure of the Contractor to effectively maintain the quality control program throughout all phases of the work will be considered a failure to execute the work with the diligence required by the Contract documents.

2.17 Quality Assurance, Inspection & Testing

2.17.1 Quality Assurance Manual

To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at site or at any other place of work are in accordance with the specifications. The Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the Contractor and shall be finalized after discussions before the award of Contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by the Employer after discussion. A quality assurance programme of the Contractor shall generally cover but not limited to the following:

a) His organization structure for the management and implementation of the proposed quality assurance programme.
b) Documentation control System.
c) Qualification data for Contractor's Project Manager.
d) The procedure for purchase of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
e) System for shop manufacturing including process controls and fabrication and assembly controls.
f) Control of non-conforming items and system for corrective action.
g) Control of calibration and testing of measuring and testing equipments.
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 product to the Employer.
l) System for maintenance of records.
m) System for handling storage and delivery and
n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item and equipment and materials furnished and/or services rendered.

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

2.17.2 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 equipment/material.

The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractor's/his vendor's Quality Management and Control Activities.

2.17.3 Employer's Supervision

To eliminate delays and avoid disputes and litigation to the Contract, all matters and questions shall be resolved in accordance with the provisions of this document.

The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Employer, pursuant to the contract, will include but not be limited to the following.

a) Interpretation of all the terms and conditions of these Documents and Specifications.
b) Review and interpretation of all the Contractor's drawings, engineering data etc.
c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.
d) Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.
e) Issue certificate of acceptance and/or progressive payment and final payment certificate.
f) Review and suggest modification and improvement in completion schedules from time to time, and
g) Supervise the Quality Assurance Program implementation at all stages of the works.

2.17.4 Inspection & Inspection Certificate

The employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and /or works of the contractor and/or their sub-contractor(s)/sub-vendors and shall have the right, at all reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

The Contractor shall give the Employer's Inspector fifteen (15) days (in case of domestic testing) and thirty (30) days (in case of foreign testing), as the case may be, written notice of any material being

ready for testing. All such inspections shall be to the Contractor's account except for the expenses of the Employer's inspector. The Employer's inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days (in case of domestic testing) and thirty (30) days in (in case of foreign testing) of the date of which the equipment is notified as being ready for test/inspection or on a mutually agreed date, failing which the Contractor may proceed with the test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports / certificates in triplicate.

The Employer's Inspector shall, within fifteen (15) days from the date of inspection, give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall make the modifications that may be necessary to meet the said objections.

When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer's inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Employer's inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test Certificate by the Employer's Inspector. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

In all cases where the Contract provides for test whether at the premises or works of, the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such item as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer's inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer's Inspector or to his authorized representative to accomplish testing.

The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

The Contractor shall keep the Employer informed in advance about the time of starting and of the progress of manufacture and fabrication of various parts at various stages, so that arrangements could be made for inspection.

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 Specifications.

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 Specifications.

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.

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 Employer or his authorized representative considers that the defects can be rectified.

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.

All gauges and templates necessary to satisfy the Employer shall be supplied by the contractor.

The specified grade and quality of steel shall be used by the Contractor. If the Contractor uses other grades of steel other than specified, the Contractor shall prove by design calculation that the required stress is met and that towers meet all the design requirements mentioned in the specifications. However, the Contractor shall not use the lower grade steel than the minimum grade mentioned. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.

2.17.5 Tests

The type, acceptance and routine tests and tests during manufacture shall be carried-out on the material and shall mean as follows:

a) Type Tests shall mean those tests which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.
b) Acceptance Tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.
c) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements which are likely to vary during production.
d) Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.
e) The norms and procedure of sampling for these tests will be as per the Quality Assurance Program to be mutually agreed to by the Contractor and the Employer.
f) The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified in Annexure-A or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Program.
g) For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

2.17.6 Type Tests

The bidders must offer type tested equipment only.

Bidders shall submit reports of type tests of the following equipment performed on equipment of each type in accordance with latest revision of IEC Publications / Indian Standards.

a) ACSR Cardinal Conductor
b) Optical Fiber Ground Wire (OPGW)
c) Composite Long Rod Insulator
d) Clamps, Connectors and Hardware's

For all type test reports following criteria shall apply.

a) Type Test must have been carried out within five (5) years prior to the date of opening of the bid.
b) Type Test must have been carried out in Central Power Research Institute (CPRI) or any laboratory owned by the Government or An Government Undertaking or the test was witnessed by any Government Utilities.

2.18 Tools and Appliances

All The Bidder shall propose complete, new and unused sets of all special tools or gauges and testing kits, which will be required for normal operation and maintenance. The Bidder shall furnish the list of tools and appliances and their prices under Price Schedule of this Tender Document. To the greatest extent possible, the tools for each specific operation shall be stored in a single, locked, portable, steel box suitably and clearly marked for convenient identification. In the event that such a box must be too large for convenient carrying by one man, it shall be provided with rubber-tyred wheels of substantial construction.

2.19 Spare Parts

The Bidder shall propose spare required for three years' maintenance for trouble free operation and shall include a price list of these parts. Sufficient information shall be provided to permit the Employer to estimate spare parts requirements. This information shall be furnished under Price Schedule of this Tender Document.

Final quantity of spare parts shall be decided by the Employer and will inform the Contractor within 35 days from the submission of the final BOQ (with the name of the manufacturer and their type designation) by the Contractor pursuant to clause 2.10.

All spare parts supplied under the Contract shall be strictly interchangeable with the parts for which they are intended to replace. They shall be treated and packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description and purpose. When more than one spare part is packed in a single case or other container, a general description of its contents is to be shown on the outside of such cases or container and a detailed list enclosed inside. All case containers and other packages must be suitably marked and numbered for purposes of identification.

All cases, containers or other packages are liable to be opened at the site for such examinations as the Employer may consider necessary and all such opening and subsequent repackaging shall be at the expense of the Contractor.

All spare parts must be delivered to Site in advance of the trial operation. Contractor shall ultimately prepare and deliver five (5) copies of the final consolidated spare parts list, arranged specification-wise, with unit prices and quantities supplied.

It shall be in the interest of the Contractor to organize the delivery and systematic storage of spare parts before the trial operation to obviate post erection difficulties and delays. Any spare part consumed by the Contractor before final acceptance shall be replaced without any cost to the Employer.

2.20 Technical Requirements

2.20.1 Transmission Line Towers

Contractor shall develop structural drawings, shop drawings & Bill of Materials of all 132 kV self-supporting steel towers after completing proto type tower testing. Similarly the design and drawings for all type of foundations for the towers shall also be developed by the contractor, in sequence, suiting the project requirement.

The provisional quantities of fabricated & galvanized steel towers as per specifications requirement, foundation type and their numbers, quantity of various line materials and other items are given in appropriate Price Schedule of the bid documents. However, the work shall be executed as per approved construction drawings and project requirement.

The various item of work is described very briefly in the appropriate Price Schedule. The various items of the Price Schedule shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder's rates shall be based on the description of activities in the Price Schedule as well as necessary operations detailed in these Technical Specifications.

The Unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labor etc. essential for satisfactory completion of various works.

All measurements for payment shall be in S.I. units (International System of units). Lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters rounded off to two decimals.

All the raw materials such as steel, zinc for galvanizing, reinforcement steel and cement for tower foundation, coke and salt for tower earthing etc. bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plates, number plates. Circuit Plates, anti-climbing device, bird guards, etc., required for tower manufacturing and erection shall be included in the Contractor's scope of supply. Bidder shall clearly indicate in the offer, the sources from where they propose to procure the raw materials and the components.

The entire stringing work of conductor and OPGW shall be carried out by tension stringing technique. The contractor shall indicate in their offer, the sets of tension stringing equipment he is having in his

possession and the sets of stringing equipment he would deploy exclusively for this project which under no circumstance shall be less than the number and capacity requirement indicated in Qualifying Requirements for Bidder. However, the Bidder having requisite experience has freedom to use helicopter for stringing. The Bidder intending to use helicopter shall furnish detailed description of the procedure, type & number of helicopter & accessories etc., to be deployed for stringing operation.

In the hilly/mountainous terrain or in thick forest areas, the Contractor may carry out stringing work by manual method with approval of the Employer. The Contractor shall deploy appropriate tools /equipment /machinery to ensure that the stringing operation is carried out without causing damage to conductor/OPGW and the conductor/OPGW is installed at the prescribed sag-tension as per the approved stringing charts.

2.20.2 Guaranteed Technical Particulars

The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in one original and two (2) copies in the prescribed schedules of the Specifications. The Bidder shall also furnish any other information as in their opinion is needed to give full description and details to judge the item(s) offered by them

The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (whichever is ruling condition as per the requirement of the specification) required. A Bidder may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum / maximum value required, whichever is ruling condition, as per the Technical Specification. No preference what so ever shall be given to the bidder offering better/more stringent values than those required as per specification except where stated otherwise.

2.20.3 Packing

All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

The Contractor shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.

All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e. fragile, handle with care, use no hook etc. wherever applicable.

Each package shall be legibly marked by the Contractor at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the Contractor etc.

2.21 Environment Mitigation Measures

2.21.1 Physical Environment

The following mitigation measures shall be undertaken to reduce the adverse impacts on the physical environment during construction of the substation.

a) Discharge of cement slurry, garbage and other solid wastes generated by the construction activities and workforce should be avoided where possible.
b) Chemical and other hazardous materials should be dumped safely far away from the water bodies.
c) Disposal material of substation should be carried out within the acquired land for substation. The waste materials of the substation shall be minimized to avoid for separate land for disposal.

2.21.2 Biological Environment

None

2.21.3 Socio-economic and cultural Environment

In the construction phase following mitigation measures shall be adopted in accordance with the EIA final report to minimize the impacts:

a) Control of adverse socio interactions between local communities and construction work force.
b) Awareness program regarding health and safety of substation.
c) Awareness program for workforce.
d) Insurance against health and safety.

2.21.4 Employment

Priority shall be given to the local project affected people while hiring workers and labors during construction of the project. Nepal being a signatory to the International Convention against Child Labor, the Contractor shall not employ child Labor in construction.

Chapter 3: PRELIMINARY WORKS

3.1 Check Survey and Staking

The Employer has studied several alternatives for the route alignment of the said transmission line and selected a route alignment. The Contractor shall be responsible for undertaking detailed check survey of that selected route alignment.

The Employer has completed Initial Environmental Examination (IEE) study. The Contractor shall be responsible for compliance with the finding / recommendation of IEE study reports in totality.

The proposed 132kV Transmission double circuit line with ACSR Cardinal Conductor is passing through undulating hilly landscapes of six (6) VDCs of Lamjung districts. The variation of attitude of the terrain ranges from 604m above MSL to 1000m above MSL. Hence it is envisaged to adopt 132kV (650 kV peak BIL) level tower located up to 1,000m attitude for the proposed 132kV Transmission line.

Strip plans and longitudinal profile sections of ground prepared by the employer as listed below are attached in drawings with this specification.

For some practical reason such as change in topography due to construction of some new object in the line route, to avoid heavy afforestation or to avoid abolishment of houses under the line in some section of the line route minor modifications may require. Therefore, the Contractor along with the Employer shall examine the angle points and fix them within 60 days from Contract signing date at least for the first section of the line. Immediately after that the Contractor shall carryout detailed check survey and prepare Strip plans and longitudinal profile sections of that section at scales horizontal 1:2,000 and a vertical scale of 1:200 or 1:400 as appropriate.

The Contractor shall study the plan and profile and locate the intermediate tower location. The contractor shall fix the type of towers for each location and submit for Employer's approval both 132kV level towers located upto 1000m attitude for the proposed 132kV Transmission line (i) three copies of profile drawings (ii) two sets of sag templates showing the sag in still air at maximum temperature of the conductor along with sag calculations, the ground clearance line and the line showing the sag in still air at minimum temperature of the conductor (iii) tower schedule indicating tower number, tower type, insulator type, tower type, line angle, span length, elevation of tower spot, leg extensions, dampers, etc.

For construction purpose the transmission line shall be divided in three sections. Considering the importance of the line sections, works related to each of the sections shall be completed within the set mile stone date.

The quantities given in the Price Schedule are provisional only and the Contractor shall finalise the quantities after the tower and foundation selection. Any delay in tower selection works will not be held as a valid reason for lack of progress in manufacture and construction and the Contractor will be

expected to commence manufacture and construct the line even though the final quantities are not known until a later stage.

The Contractor shall perform all necessary survey work which consists of determination, checking and lay out the accurate centre of line and elevation of all the reference points, based on the key map and plan and profile drawings. Furthermore, the Contractor shall check the minimum clearance of conductor crossing the existing highways, major waterways, power and telecommunication lines, etc.

The tower to be erected shall comprise of Basic body, body extension and leg extensions as provided in the Price Schedule, if for some reason the leg extension are not sufficient or require some modification in the body extension part, the Contractor shall make necessary changes with the prior approval of the Employer. The Contractor shall not be entitled to claim for any materials furnished or work performed in this respect.
During check survey, the Contractor shall assess and design works required to be undertaken for the protection of the foundations.

The check survey work shall be performed by qualified and experienced personnel and supervised by qualified surveyor. Not less than 15 days prior to commencement of work, the Contractor shall submit qualification of surveyors, work program and list of surveying equipment for the three sections of the proposed transmission Line and obtain approval of the Employer.

Following points shall also be considered during tower staking and preparation of tower schedule.

a. Road Crossing

At all important road crossings, the tower shall be fitted with double suspension or tension insulator strings depending on the type of tower but the ground clearance at the roads under maximum conductor design temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than the values specified at Schedule A-3, Section-11 for 132 KV lines. At all national highways crossing span will not be more than as basic span specified in schedule A.4 (Support Types and Design Spans) item no. 2.

b. River Crossings

In case of Major River crossings which are more than 500 meter towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be DD 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). In case of river crossing with a span up to 500 meter normal tower spotting procedure as detailed in schedule A-3, Section-11 (Minimum Clearance).

c. Power Line Crossings

Where this line is to cross over another line of the same voltage or lower voltage, DA type tower with suitable extensions (if necessary) shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the directions of the Employer. All

the works related to the above proposal shall be deemed to be included in the scope of the Contractor except if modifications are required to line below, in which case, the conditions to be agreed upon. The minimum clearance while crossing the lines up to 132 kV shall be3500 mm as given in schedule A-3, Section-11 (Minimum Clearance).

d. Telecommunication Line Crossings

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

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

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

Payment: Payment for the contract item, Detailed Check Survey and Staking, will be made at the unit price bid based on horizontal distance measurement. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and other operations related to the scope of work of survey as specified before.

e. Access and Erection

Land Schedule

The land schedule of the given line route will be prepared by the Contractor. The Employer shall assist the Contractor to the extent possible. The Contractor will identify the exact plot number and area of the land required for the tower foundations.

f. Routes, Right-of-Way and Access

The necessary right of way for the lines to enable the Contractor to carry out stringing and erection will be obtained by the Employer.

The Contractor will not be reimbursed for waiting time caused by delay in obtaining right of way unless he has established on site in advance of obtaining right of way. Where partial right of way only is granted, the Contractor shall program his work accordingly.

The Contractor shall make all necessary arrangements for the access roads with the land owners before going onto private land, but if any difficulty should arise, the Contractor shall promptly inform the Employer. Such arrangements shall be at least one month in advance of the desired access date to allow time to clear any difficulties. The Employer shall be kept informed of all negotiations and successful arrangements.

At any early stage of the Contract the Contractor shall arrange all proposed points of access and after the approval of the Employer shall prepare maps for submission to the Employer for the settlement of way leave arrangements. No other access shall be used without the prior consent of the Employer.

It shall be clearly understood by the Contractor that the cost of construction of access roads and delivery of construction material to erection points shall be deemed to be included in the bid price and the Contractor shall have no claim whatsoever to extra payment for construction and maintenance of access as may be required.

g. Clearing

- General

The Contractor shall be responsible for clearance of the foundation site. Clearing shall include removal and disposal of all tress, bushes, down timber, tree roots, debris, indicated structures and other obstructions from the areas to be occupied by permanent works of the contract, and as indicated on the drawings, specified herein and as directed by the Employer at tower foundation site and the access. The Contractor shall also be responsible for removal of creeping vines and all vegetation on all existing towers from the base to the top. The cost of this work shall be included in the Bid price. The Employer shall however be responsible for the clearance of the right of way for the transmission line as regards trees and houses.

- Protection

The Contractor shall be responsible for prevention of damage to structures and other objects which are not included in the clearing work. No objects of any kind outside the indicated limits of the work shall be removed or damaged. Existing utilities which are not specifically included in the work shall be protected by the Contractor. The Contractor shall be responsible for employment of safe methods of demolition and clearing.

<u>Notices</u>

Before construction commences, the Contractor shall give to the Employer not less than seven days' notice that support positions have been pegged and are available for inspection.

Before the Contractor commences work he shall obtain from the Employer a way leave schedule giving details of any special requirements of the occupiers or Employer concerned.

When the Contractor is about to carry out erection of the conductors along or across power, telegraph or telephone lines, or public roads he shall give the requisite notice to the appropriate authorities of the date and time which he proposes to perform the work and shall send a duplicate copy of each notice to the Employer. The Contractor shall construct trestles for such line or road crossings. No separate payment shall be made for such works.

The Contractor shall at all times during the execution of the Works ensure compliance with all such reasonable requirements of the occupier or Employer as are brought to the Contractor's notice by the Employer.

Damage

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, fences, walls, gates, etc., and shall ensure that the work is adequately supervised so that unavoidable damage is reduced to the minimum. The Contractor will be liable for all damage arising by or in consequence of the works except unavoidable damage to crops and shall pay compensation or make good at the option of the Employer. The Contractor shall remove all soil and surplus material after erection.

The Contractor will be responsible for payment necessary for agreed passage over private roads, where arrangements have been made by the Contractor.

The Contractor will be responsible for notifying the Employer of all instances of damage to crops which in the opinion of the Contractor are unavoidable. In the event of such notification not being received by the Employer, Employer may at his discretion refuse to consider any claim by the Contractor for compensation resulting there from.

Crossing of obstacles

The Contractor shall make all necessary arrangement and take all necessary precautions where the route crosses buildings, power lines, orchards, gardens or other obstacles or ground over which erection cannot be carried out in the normal manner.

Where the local authorities or other public undertaking affected deem it necessary to make provision for the protection of their employees or property or of the public, or for the assistance of traffic, the cost of such provision shall be borne by the Contractor.

The provision of special scaffolding for purposes of effecting crossings of the route over roads, railways, rivers, telegraph and telephone lines or other similar obstructions as the Employer and/ or the Contractor may consider necessary shall be the Contractor's responsibility and all cost of such special crossings shall be borne by the Contractor.

Adequate provision shall be made by the Contractor to prevent the straying or damage to livestock during the execution of the Contract Works and until permanent reinstatement of fences, walls, hedges, gates and the like is completed, the Contractor shall be held responsible for any loss or damage due to failure to comply with the above requirements.

Payment

No separate payment shall be made for clearing, cutting and special scaffolding arrangements and access road. Therefore, the Contractor shall include all the cost in the unit bid for construction of foundation, stringing or tower erection.

3.2 Soil Test

Scope

This specification covers all the work required for geotechnical investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervisors and technical personnel skilled and unskilled labor and other as required, to carry out field investigations and test, laboratory tests and analysis and interpretation of data and results, preparation of a detailed soil report including recommendations and providing technical services as and when called for by the Employer. The investigation method shall be as described herein or any other methods approved by Employer giving the same information as needed to ensure that soil parameters are sufficient for reliable foundation design. The location for the geo-technical investigation shall be approved by the employer.

Codes and standards

All work shall be carried out strictly in accordance with the Technical Specifications unless otherwise approved by the Employer in writing. Where not specified, the latest-edition of one or more of the following codes of practice or any other applicable code shall be followed.

SP 32(Part-2) : Compendium of Indian Standards on soil engineering Laboratory (Field Testing of soils for Civil Engineering Purpose.

BS 1377 : Methods of Test for Soils for Civil Engineering Purposes

BS 1924 : Methods of Test for Stabilized Soils

BS 5930 : Code of Practice for Site Investigations

BS 6031 : Code of Practice for Earthworks

CP 2004 : Code of Practice for Foundations

CBIP Manual on Transmission Line

Codes equivalent to these in American/ DIN Standards can also be used.

Purpose

The purpose, in brief, of the proposed geotechnical investigation, is to ascertain the type of sub-strata such as soil, rock etc., their characteristics and their suitability for the structures proposed to be built and to

decide on the choice of the type of foundation to be adopted for the type and magnitude of envisaged loading. All the tests that are considered necessary in the opinion of the Employer for this purpose shall be conducted. Any additional tests/ works change in the number and type of specified tests revision in the diameter, depth of bore holes, samples to be collected etc. shall be carried out as directed by the Employer.

Calibration of equipment

The Contractor shall ensure that all the equipment/instruments are properly calibrated, at the start of the work, to reflect actual values. If so demanded by the Employer, the Contractor shall have the instruments tested at an approved laboratory at his cost and the test reports shall be submitted to the Employer. If the Employer desires to witness such tests, the Contractor shall arrange for the same at his own cost.

Field work

a. General

It is essential that personnel on this work of geotechnical investigation and laboratory testing should have the appropriate experience. The entire investigation shall be supervised by a suitably qualified and experienced engineer or engineering geologist. All field and laboratory work shall be executed by experienced technicians.

The Contractor shall have on site all required survey instruments as determined by the Employer to carry out the work accurately according to Specification and Drawings. All the specified locations for boreholes and field tests shall be set out at site by the Contractor. At each location of bore-hole, and other field tests the Contractor shall establish the ground level prior to commencing of the boring operation. The ground level shall be related to an established bench mark.

b. Method of boring

- Boring in soil

In soil strata, boring may be carried out by auger or percussion tools or by method approved by the Employer or Employer's representative. Bentonite slurry or mud circulation process can also be used if permitted. However, for those boreholes, where water samples are to be collected for chemical analysis, bentonite slurry or mud circulation method shall not be used or shall be restricted as directed by the Employer or Employer's representative. The diameter of the boreholes, unless stated otherwise shall be such as to permit collection of undisturbed samples of 90mm diameter.

Where necessary boreholes shall be cased and whenever a borehole is cased, the bottom of the casing shall always be maintained within 150mm of the bottom of the borehole. The casing shall never be in advance of the bottom of borehole during undisturbed sampling or standard penetration tests.

- Borehole depth

All the boreholes shall be sunk to a depth of 6m at field.

c. Sampling

- Sequence of sampling

The general sequence of sampling adopted shall be such as to obtain alternatively undisturbed samples at every 1.5 meter intervals and at every significant change of stratum. Undisturbed sample wherever possible, shall be collected at every 3.0 meters interval and at every identifiable change of soil formation. Likewise disturbed samples, as obtained in the standard split spoon, shall be collected by conducting the standard penetration test at every 3.0 meters interval and at the significant change of soil stratum.

- Undisturbed sampling in boreholes

Samplers used for collecting undisturbed samples in soils shall meet IS/BS and American Standards requirements and shall be appropriate to the type of soil to be sampled. Undisturbed soil samples collected shall be 90mm in diameter and 450mm in length so as to enable laboratory testing.

The area ratio of samplers shall be within the permissible limit and shall not exceed 25 percent for samples of 90mm diameter. The cutting edge of the cutting shoe of the sample shall be tapered at an angle not exceeding 20 degrees and inside clearance ratio shall generally be limited to 0.5 to 1.5 percent. Samples with lower clearance ratio shall be used in soft strata and these with higher clearance ratio shall be used in stiff strata. The cutting edge or shoe of sampler shall be free from rust, pitting, burring or any other defect. The sampler shall be fitted with ball check valve at the upper end.

For clays other than very soft clays open drive samplers are permissible whereas in very soft clays and in sandy soils piston samplers with core catcher device or other approved samplers shall only be used. The use of oil inside the samplers in operation shall be limited to minimum practicable.

Before sampling operation, the Contractor shall clean the bottom of borehole very carefully and every care shall be taken to avoid disturbance of material to be sampled. For sampling the sampler shall be lowered to the bottom of borehole without impact and pressed into the soil in a single continuous movement at a sufficiently slow rate to permit the check valve to pass the water in the tube with creating excess back pressure. In firm material, and whenever approved by the Employer the sampler may be driven into the soil; but the sampler shall never be pushed or driven to its full length. After penetration to the required depth, the sampler shall be free from the soil by being rotated by one full turn and then shall be withdrawn.

The sample shall not be removed from the tube but shall be trimmed back from the ends of the tube and the space filled with molten microcrystalline wax, the tube capped with metal or plastic cap and sealed with adhesive tape.

- Undisturbed soil samples from trial pits and other sources

The Contractor may be required to collect undisturbed soil samples from trial pits excavations or other sources. these samples may be core samples or block samples and may be obtained with a special orientation as indicated by the Employer core samples shall generally be obtained by jacking a thin walled

open drive sampler of around 100mm diameter into the stratum. The sample tubes shall be driven if approved by the Employer or Employer's representative. The sample tubes shall be held steady during jacking/driving and a suitable frame shall be used for guiding inclined samplers.

- Disturbed soil samples

The material from the cutting shoe of the thin walled sampler and from the split spoon sampler of the standard penetration test can be treated as disturbed sample, but will not be paid for separately. All disturbed samples collected shall be placed without delay in an air-tight jar of not less than 0.4kg nominal size and each sample shall fill the jar as far as possible.

Larger disturbed samples may be required to be collected from trial pits or excavations. Each of such samples should be at least 10 kg. Such samples shall be sealed into heavy duty polythene bags immediately on collection.

- Water samples

Contractor shall take water samples from boreholes, whenever directed by the Employer, before addition of water to the hole. If this is not possible prior to collection the water level in the borehole shall be lowered by about 0.5m, water allowed to rise by seepage through walls of bore hole and then water sample collected.

No water sample shall be taken when bentonite slurry or mud has been circulated in the borehole. The method of sampling shall be such as to ensure that the sample is not contaminated by rain water, surface water etc. The quantity of sample to be collected is about 1 liter and shall be stored only in approved airtight, clean container. Water samples should be tested as soon as possible after collection.

- Numbering of samples

The Contractor shall assign a reference number to each soil and water sample taken from the borehole. this number shall be unique for that borehole and shall be in order of depth below ground level.

- Labeling of samples

All samples shall be clearly labeled indicating job number, borehole number sample number, date of sampling, brief description of samples, type of sample, elevation of sample etc. and in case of undisturbed samples, the top and bottom of samples shall also be clearly labeled. Each such label shall be pasted on the container and shall also be included in the container.

- Transporting and storing of samples

The Contractor shall store properly all the samples at the site till they are transported to his laboratory for testing. All rock cores and samplers with undisturbed soil samples shall be placed in order of their occurrence in strong wooden boxes, suitably partitioned and provided with hinged wooden covers, so that the samples are not damaged during transit by impact or improper handling. To minimize disturbance

during shipment samplers containing undisturbed soil samples shall be packed with wood dust or similar other resilient material and as directed by the Employer or Employer's representative

The Contractor shall transport all samples to his testing laboratory as quickly as possible and test the samples. Samples shall be transported by air, if the stipulated completion period so warrants. All unused and excess samples after testing should be retained and safely stored by Contractor till three months after the end of submission of the report.

d. Specific observations during boring

The observation to be made by the Contractor during boring shall include but not be limited to the following:

- Sequence and thickness of different strata

Visual description of each stratum shall be provided.

- Ground water table

The depth at which ground water is struck during boring shall be carefully noted and the depth of water table shall be ascertained subsequently in the complete borehole by daily observing the depth for the next six to seven days. Depth of ground water shall also be observed in wells, if wells exist in the vicinity.

- "Loss" or "Make" of drilling fluid

The "Loss" or "Make" of drilling fluid if observed during the boring shall be noted and brought to the attention of the Employer or Employer's representative. Attempts shall be made to detect joints, fissures, artisan conditions etc.

- Presence of lime, mica. etc.

The soil and rock samples shall be examined for presence of lime, mica etc. and shall be recorded, if any. The Contractors rate for boring shall be deemed to include these and all other relevant observations.

e. Submission of field logs

The Contractor shall submit or mail to the Employer as directed, two copies of the preliminary log of each borehole as soon as the borehole is completed.

f. Field tests

- Standard penetration test (SPT)

Unless directed otherwise by the Employer or Employer's representative, the Contractor shall carry out standard penetration test at 1.0 meter intervals and at every noticeable change of soil formation and as per the procedure in IS/BS or ANSI. The finest test shall generally begin at 1.0m depth unless an undisturbed

sample is collected at that depth, and further test at 2.0m, 3.0m, 4.0 m, 5.0m and 6.0m depths shall be done.

For conducting the test, the bottom of borehole shall be cleaned properly and the spoon shall be properly and centrally seated in position in the borehole. The derive weight assembly shall consist of a driving head of 65kg weight with 75cm free fall. It shall be ensured that the energy of falling weight is not reduced by friction between the drive weight and guides or between rope and winch drum. Standard connecting rods shall be used.

The test shall be stopped (When the test is not conducted in weathered/Soft rock) when the total blow count including seating drive reaches 120. The corresponding penetration shall be noted. If the total penetration is more than the seating penetration of 15cm, a breakup of blow count for 15cm seating penetration and for the remaining portion of penetration shall also be given

g. Excavation of trial pits

The Contractor shall excavate trial pits to the depth of 3.0 meters. Relevant tests specified in these pits shall also be carried out. Whether specified or not, in every trial pit, including those excavated for loading tests, tests by "Pocket Penetrometer" and by "Picket " shall be generously carried out at different depths in different strata. Picket test shall be conducted in non-cohesive strata. In this test a wooden picket of dimensions 5cm x 5cm in cross section, with a sharp point and about 70cm long shall be pushed perpendicular to the surface of soil by a force of about 70kg and the penetration of the picket shall be recorded. The test by pocket penetrometer shall be done in soils with cohesive touch and in weathered rock.

h. Backfilling of boreholes and pits

The Contractor shall backfill the boreholes and pits. The borehole shall be back filled by bentonite/mud-cement grout. The cement and bentonite/mud for the grout shall be in the ratio 1 to cement and bentonite for the grout shall be in the ratio 1 to 1 by weight, and shall be made into a slurry with no more water than is necessary for placing the slurry in the borehole. If there is standing water in the borehole, grout shall be placed by tremie. The pit shall be backfilled with proper ramming using the excavated material.

Laboratory tests

a. General

All the laboratory testing shall be performed by qualified and experienced personnel, familiar with and having access to equipment and facilities for the accurate determination of data necessary for requirements under this specification.

b. Independent laboratory

The Employer reserves the right to have the samples tested in an independent laboratory. If the Contractor is directed to get the samples tested in an independent laboratory, he shall be paid only the actual cost of such tests.

c. Program for testing

The Employer or Employer's representative will direct Contractor on samples to be tested and on type of test to be conducted. The Employer or Employer's representative is not bound to furnish this information at the beginning of the investigation itself but shall instruct the Contractor at appropriate time during the course of the investigation. In case of clayed soil triaxial compression test on undisturbed soil samples shall be carried out.

d. Standards for testing

The Contractor shall test the samples as per the relevant BS, ANSI or directed by the Employer.

e. Access to the laboratory

The Employer shall have the right of access to Contractor's Laboratory or other Laboratory where tests have been arranged to be carried out during the progress of this investigation.

f. Submission test data and results

The Contractor shall submit when demanded by the Employer preliminary copy of the data and the computed results tests he has conducted. However, the final report shall contain all the experimental data and the results as stated below in Article 4.2.7.

Formal report

a. General

The Contractor shall submit his report in two separate volumes. Volume I shall be the main body of the report containing geological history of the Site summarized test data, observations, conclusions and recommendations. Volume II shall be in the form of appendix and shall contain actual field and laboratory observations, calculations of test results, supporting calculations for the recommendations made etc. Initially, the Contractor shall submit these volumes to the Employer in a draft form.

b. Route plan

A route plan showing location of all boreholes, trail pits, etc. shall be presented in the report.

c. Borelogs

A true cross-section of all boreholes, trial pits showing thickness, position and classification of each soil stratum found between top surface and bottom of the hole shall be submitted. The various tests conducted and recovered from every soil and rock stratum shall be clearly against that stratum.

A record in full of every trial pit or incomplete boring with appropriate explanations, shall be reported in the same manner as the completed pits or boreholes.

d. Ground water

All available data on ground water conditions shall be presented separately and shall be identified by borehole number and sampling dates and timing of observations, showing clearly the number of observation made in a particular safe.

e. Test results

The recommendations shall be based on observations and test results and shall encompass theoretical as well practical considerations for foundations for the types of structures envisaged. The Contractor shall acquaint himself with the type of structures proposed.

Recommendations shall include but not be limited to the following:

- A brief geological description including that of faults, folds, etc. if any on the basis of published literature.
- Seismic history including a brief description of previous earthquakes, giving time, period, magnitude, ground acceleration, epicenter, damage done etc.
- Recommended type of foundations and safe/allowable bearing capacities.
- Possibility and extent of scour in river beds.
- Recommendation for class of concrete to be used for foundations vis-a-vis deleterious effect of ground water/soil chemicals concrete and steel.
- Earth pressure coefficients that may be adopted.
- Any other relevant information and data.
- Technical services as and when called by the employer.

Payment

Payment for the contract item, Soil Test, will be made at the unit price bid. Therefore, in the schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials, equipment, technical services, labor and other operations related to the scope of work of soil test as specified before.

3.3 Measurement of Ground Resistance

The Contractor is required to perform ground resistance test at every support location. Method of measurement, tools and instruments shall be submitted to the Employer for approval.

The measurement of ground resistance shall be performed at every meter depth from ground surface to the specified depth or to maximum depth of sub-soil tests except where ground resistance value of 10 ohms or less is obtained at any adjacent levels, no further measurement is required.

The Contractor may use drilling rod(s) of sub-soil test equipment during performing the sub-soil test as earth electrodes for measuring the ground resistance.

The Contractor shall recommend the type of earth electrodes in accordance with the results of ground resistance obtained. Selection of earth electrode type shall be suitable for each structure and its particular site conditions. The data obtained shall be prepared in an approved form and submitted to the Employer.

Payment

Payment for the contract item measurement of ground resistance 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 equipment and labor related to "Measurement of Ground Resistance".

Chapter 4: TRANSMISSION LINE TOWER

4.1 General

The scope of work comprises of Design, prototype testing, Supply and erection of self-supporting steel lattice double circuit towers for 11.5 km long 132 kV transmission line from Kirtipur to Udipur. The towers shall be self-supporting, hot dip galvanized, latticed steel type & designed to carry the line conductors with necessary insulators, shield wires and all fittings under all loading conditions. Outline diagram of double circuit towers are enclosed with the Specification. Please refer to drawing attached.

4.2 Design Spans

The design shall provide for basic, wind and weight spans given in Schedule A.4. of Chapter 11.

The term basic span shall mean the horizontal distance between centers of the adjacent towers on ground level.

The term wind span shall mean half the sum of adjacent horizontal spans lengths supported on any one support.

The term weight span shall mean the equivalent length of the weight of conductor supported at any one support at maximum temperature in still air.

4.3 Conductor and OPGW Clearances

For all supports the clearances from conductors, arc horns, jumper loops and all live metal to the structure or grounded steel work shall not be less than those specified in Schedule A.3. of Chapter 11. Where uplift condition occurs at tension tower positions, details 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 plain normal conductors.

For 132 kV towers carrying deviation angles up to 30° cross arms shall generally be so proportioned that live metal clearances of 1600 mm are maintained under all conditions without the use of jumper suspension insulators. Jumper suspension insulator strings must be used on tension structures with deviation angle of 30° or more. However, for tension structures with deviation angle below 30°, suspension insulator strings should be used on locations where sufficient clearance of the jumpers is not available with the structure without any additional cost to the Employer.

Sr. No	Type of insulator string	Swing in deg.	Min. live metal clearance in mm
			Altitude upto (+)1000m
1	Single suspension	Nil	1530
		15	1530

Sr. No	Type of insulator string	Swing in deg.	Min. live metal clearance in mm
			Altitude upto (+)1000m
	insulator string	30	1370
		45	1220
		60	1070
2	Jumper(without Pilot String)	Nil	1530
		10	1530
		20	1220
		30	1070

The minimum ground clearances from the bottom conductor shall not be less than for the following Altitudes at the maximum Sag conditions i.e. at max. temperature and still air:

- 7100mm upto Altitude (+)1000m,

However, to achieve the above clearance the height of tower has been increased in the following manner:

a) An allowance of 500 mm shall be provided to account for errors in stringing.

b) Conductor creep shall be compensated by over tensioning the conductor at temperature of 21°C lower than the stringing temperature for ACSR Cardinal.

Further, the tensions of the earth wires and power conductors shall be so co-ordinated that the sag of earthwire shall be at least 20% less than that of power conductors under all temperature loading conditions.

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.

Where obstructions of other types are met requiring special clearance, the clearance shall be approved by the Employer. If any factors likely to cause infringement of clearance become apparent the Contractor shall inform the Employer immediately.

Clearance between phases: 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 less than 3.0 m.

4.4 Extensions

The towers for ACSR Cardinal Conductor lines shall be designed for adding -4.5m -3.0m,-1.5m, 1.5m, 3.0m,4.5m, 6.0m, 7.5m and 9.0m body extensions for maintaining adequate ground clearance without reducing the specified factor of safety in any manner. All above extension provision to normal towers shall be treated as part of normal tower only.

In order to expedite the project and to reduce leveling, grading and protection works in hilly region leg extension of some towers may be required subjected to the approval of Employer. Payment for these leg extensions will be done on weight basis based on unit rate quoted by the bidder.

4.5 Tower Design

4.5.1 Design Requirement

Towers shall be self-supporting type of vertical configuration and are designated as suspension towers, tension towers, transposition towers and special towers. The requirement of transposition and special towers shall be assessed after finalization of the detailed survey, profiles etc. The proposed Double circuit suspension towers shall be provided with single suspension string single conductor and jumper pilot string and double suspension string of EMS rating as given in relevant clause.

The details of ACSR CARDIAL Conductor, OPGW Earthwire and Insulators are as shown in the Section 11 Schedule A.10 & Schedule A.11 respectively. The minimum ground clearance and height of bottom conductor, wind spans & weight span are as indicated in the Section 11 Schedule A.3 & Schedule A.4.

In case of certain locations where actual spotting spans exceed the design spans, cross arms and certain members of towers are required to be modified / reinforced, the bidder shall submit the proposal to Employer for approval for reinforcement.

4.5.2 Base Width of the Towers

Inview of the difficult hilly/ridges terrain conditions, forest reaches, restricted ROW of 18m narrow based towers are conceived for this Transmission Line so as to minimize the total cost of towers, foundations, benching, rock cutting/ revetment works, The base width of narrow basic towers shall be fixed on techno-economic considerations as well to expedite the execution of project. The recommended base widths for different Towers (i.e. Centre to centre distance between tower legs at the point of connection between legs & chimney for normal ±0m body extension shall be as follows:

Type of towers	Upto Altitude (+)1000m	
	Minimum Values (meter)	Maximum Values (meter)
DA	5.4	6.0

DB	6.2	7.0
DC	7.2	8.0
DD/DE	8.2	9.0

As substantial portion of Transmission Line traverses through hilly area, the maximum and minimum weight span under Normal Condition and Broken Wire Condition for Angle Towers shall be based as per CBIP Publication No 323 Tower Manual.

4.5.3 Sag Tension

The sag tension calculation for conductor and earth wire shall be made in accordance with the relevant provision of IS 5613 (Part-2/Sec-I) -1985 of the following load conditions. Appropriate drag co-efficient and gust response factors (Corresponding to Terrain Cat-II) shall be considered for accounting the wind pressure.

<table>
<tr><th>Ref. Cl.No. 10.3 of IS802</th><th colspan="4">Towers upto + 1000m attitude (DA1, DB1, DC1, DD1/DE1)</th></tr>
<tr><td rowspan="2">Condition I
(Every day Temperature + 100% Wind load)</td><td>Condition</td><td>Temperature</td><td>Wind Load</td><td>Ice Load</td></tr>
<tr><td>0</td><td>32°</td><td>100% (full)</td><td>Nil</td></tr>
<tr><td rowspan="2">Condition II
(Minimum Temperature + 36% Wind load)</td><td>Condition</td><td>Temperature</td><td>Wind Load</td><td>Ice Load</td></tr>
<tr><td>0</td><td>5°</td><td>36% (full)</td><td>Nil</td></tr>
<tr><td>Condition III
(Temperature + Wind load +Ice Load)
Refer Cl No-6.1 ice loads CBIP Publication No-323 Tower Manual</td><td colspan="4"></td></tr>
</table>

In addition all the standard conditions for Sag Tension calculation as per IS 802 and CBIP Manual shall be considered as per good Industries practice.

4.5.4 Preliminary design

The preliminary design of the towers including suspension and tension tower design shall be prepared at the start of the project which shall be sound in engineering and economical in design. The preliminary design shall consist of all the necessary item/ components required to complete the tower to be erected. This preliminary design shall be presented to the Employer with the line diagram for approval. Necessary changes, as per Employer shall be incorporated to the design by the Contractor if necessary, without additional financial implication, and should not affect the period of completion of the project.

The line diagram which is approved by the Employer shall be released for detailed design and for preparation of shop drawing. This approval in any way does not make the Contractor free from its obligation to the safety of the structure Tower Loadings.

4.5.5 Wind Load

The Transmission line is traversing in wind Zone: 4 as per IS 802 and the corresponding wind velocity is 47 m/s. This wind speed is applicable upto height of 10m at every day temperature of 32®C corresponding to 3 second peak gust wind. As this transmission line is traversing & encountering hilly / ridges terrain, higher value of terrain roughness factor, K2 =1.08, corresponding to terrain Cat-I shall be adopted. However the Gust Response factors corresponding to Terrain –II for conductors, earthwire, Tower and Insulator shall be adopted for accounting the wind pressure.

The above base wind speeds shall be applicable for Double circuit towers. The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation Pd=0.6V2 as follows:

- Reliability Level 1 (50 yrs return period)
- Risk Co-efficient (k1) 1.00
- 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)
- Design Wind Speed (V_d) 47 m /sec

4.5.6 Seismic Consideration

The design of towers and foundations shall be checked for seismic forces under no wind conditions and coefficient of seismic load as per IS: 1893 and check their criticality considering minimum seismic Load magnitude of 0.15g vis-à-vis wind load designs.

4.5.7 Lightning Consideration

To protect the line and towers against lightning, the angle of shield for 132kV double circuit towers shall be 30^0.

4.5.8 Selection of Type of Towers

Type of Tower	Deviation Limit	Typical Use	
DA	0 deg – 2 deg	a)	To be used on straight runs and upto 2^0 line
DB	0 deg - 15 deg	a)	Small Angle tower with tension insulator string. To be used for line deviation from 0 to 15 degree
		b)	To be used as transposition of transmission line.
DC	15deg - 30 deg	a)	Medium angle tower with tension insulator string. To be used for line deviation from 15 to 30 degree
DD	30 deg - 60 deg and DE1/DE2	a)	Large Angle and Dead End Tower with Tension Insulator string. To be used for line deviation from 30 to 60 degree
		b)	Complete dead end.
		c)	Dead end with 0 deg to 15 deg deviation both on line and substation side (slack span)

4.6 Loads on Towers

Loads shall be computed for the following considerations as per IS: 802 (Part I/ Sec1): latest & CBIP publication No: 323, Manual on Transmission Lines and technical specification

i) Classification of Loads

- Climatic Loads under Normal Condition (Reliability)
- Failure Containment Loads (Security Requirements)
- Construction and Maintenance Loads (Safety Requirements)

ii) Computation of Loads

- Transverse Loads comprising Reliability requirements, security requirements and safety requirement
- Vertical Loads comprising Reliability requirements, security requirements and safety requirement
- Longitudinal Loads comprising Reliability requirements, security requirements and safety requirement

iii) Wind Load on Tower

The wind load on towers shall be worked out by dividing the tower into different panels duly considering appropriate drag coefficient and gust response factors.

iv) Wind Load on Conductor/Ground Wire

The wind load on conductors and ground wire corresponding to wind loads at 100% design wind pressure at every day temperature or 36% wind pressure at minimum temperature shall be worked out on each Line conductor and ground wire considering the average height of conductor/ground wire up to clamping point on tower less 2/3 of conductor/ground wire sag at minimum temp and Nil wind pressure.

v) Wind Load on Insulator Strings

Wind load on insulator Strings corresponding to wind loads at 100% design wind pressure at every day temperature or 36% wind pressure at minimum temperature shall be determined from the attachment point to the centre line of the conductor in case of suspension towers and up to the end of clamp in case of tension towers in the direction of the wind for design wind pressure. 100% of the area in case of polymer insulator shall be adopted for working out the projected area of insulator string.

4.6.1 Loading Conditions

- Reliability Conditions
  - Transverse Loads
  - Vertical Loads
  - Longitudinal Loads

- Security Conditions

  - Transverse Loads
  - Vertical Loads
  - Longitudinal Loads
  - Narrow front wind load (for Suspension Towers only DA1, DA2)

- Safety Conditions

- Transverse Loads
- Vertical Loads
- Longitudinal Loads

4.6.2 Specific Details of Loading under Safety Conditions

- **Transverse Loads**

i) Wind loads to be considered as Nil

ii) Mechanical tension at 32°C and Nil wind on account of line deviation shall be considered under Normal and Broken Wire Conditions

- **Vertical Loads**

i) Load of 150kg to be considered acting at each cross-arm as a provision for weight of lineman with tools

ii) Load of 350kg to be considered acting at the tip of Cross-arms

iii) Erection load of 1000kg at each lifting point located a distance of 600mm from tip of cross-arm

iv) All bracing and redundant members of the towers which are horizontal or inclined up to 15˚ from horizontal shall be designed to with stand an ultimate vertical loads of 150kg considered acting at centre independent of all other loads

v) Loads due to weight of conductors / ground wire based on design weight span, weight of insulator strings and accessories. For broken wire condition where the load due to due to weight of conductor/ ground wire shall be considered as 60% of weight span.

vi) Self weight of tower structure upto point / level under consideration

- **Longitudinal Loads**

These loads shall be taken as under

i) **For normal conditions** – These loads for dead end towers shall be considered as corresponding to mechanical tension of conductor / ground wire at everyday temperature and no wind.

ii) **For broken wire conditions**

a) **Suspension Towers** – Longitudinal load per conductor and ground wire shall be considered as 1000kg and 500kg respectively.

b) **Tension Towers** - Longitudinal load equal to twice the sagging tension (sagging tension shall be taken as 50 percent of tension at everyday temperature and no wind) for wires under stringing and 1.5 times the sagging tension for all intact wires (stringing completed).

c)

4.6.3 Broken wire criteria

Broken wire conditions as applicable to double circuit towers during the design of towers:

- **Suspension Tower (0^0 - 2^0) (DA)**

Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

- **Small (0^0 -15^0) and Medium angle tension towers (15^0 -- 30^0) (DB, DC)**

Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

- **Large angle tension towers (30^0-60^0) and dead end towers (DD, DE)**

Any three phase broken on the same side and same span or any two phases and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.

4.6.4 Anti-cascading checks

All Tension towers shall be checked for anti-cascading/sectional considerations with all conductors and ground wire intact only on one side of the tower

- **Transverse Loads**
  These loads shall be taken under NIL wind condition.

- **Vertical** Loads

These loads shall be the sum of weight of conductor/ground wire as per weight span of intact conductor/ground wire, weight of insulator strings and accessories.

- **Longitudinal** Load

These loads shall be pull of conductor/ground wire at everyday temperature and NIL wind applied simultaneously at all points on one side with zero degree line deviation

4.6.5 Tension Limits

Line Conductor/ground wire tension at everyday temperature and without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:

- Initial unloaded tension 35%
- The final unloaded tension of conductors at every day temperature for Transmission line shall not exceed 22% of UTS of conductor and 20% of UTS of ground wire

Provided that the ultimate tension under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure does not exceed 50% of the ultimate tensile strength of the conductor/ground wire.

4.6.6 Strength Factors Related to Quality

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

i. 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.

ii. 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 (i) above.

4.7 Details of Structural Steel

Details of structural steel		
a)	Steel quality	IS:2062, BS:4360
	1. Minimum guaranteed yield stress (kg/cm^2)	
	MS	2600
	HT	3600
	2. Maximum allowable stress (kg/cm2) for tension members (on net area)	
	MS	2600
	HT	3600
	3. For compression member (on gross area)	
	MS	As per IS:802
	HT	As per IS:802
b)	Details of nuts & bolts	
	1. Shear stress on shank of class 5.6 bolts (kg/cm^2)	3160
	2. Bearing stress on shank of class 5.6bolts (kg/cm2)	
	MS	4440
	HT	,6322
	3. Tension on net area of the thread (kg/mm^2) Class 5.6	2590

4.8 Slenderness Ratio L/R

The Slenderness ratio (L/R) {Ratio of maximum un-braced or unsupported length (L) to the least radius of gyration (R)} of a member shall not exceed:

a. For Compression Members

Leg members, ground wire peak and cross arm chord members: 120

Bracing and other member having calculated stress : 200

Redundant or Secondary members without calculated stress: 250

In determining the slenderness ratios for various members' suitable provisions shall be taken into consideration for various types of end connections, eccentricity of load transfer in the members effective length of members as per the CBIP Manual guideline Annexure-12 and 13.

b. For Tension Members

All tension Members : 400

4.9 Miscellaneous Design Criteria

a) Redundant Members

Redundant members, if placed at an angle less than 15^0, are required to be checked to withstand bending also due to mid-point concentrated load of 150kg independent of other loads

b) Bolted Joint

In case where the bolt and structural member are of different materials, the lowest of the ultimate strength of bolt and structural member governs the breaking strength of the joint.

c) Framing

The angle between any two members common to a joint of a trussed frame shall preferably be greater than 20^0 and never less than 15^0 due to un-certainty of stress distribution between two closely spaced members.

d) Gusset Plates

Minimum thickness of gusset shall be 2mm more than the lattice it connects only in case when the lattice is directly connected on the gusset outside the leg member. In no case gusset shall be less than 5mm in thickness

e) Minimum Thickness of Members

Leg Members : 5mm

Other Members : 4mm

f) Minimum size of Members : ISA 45x45x4mm

g) Minimum Width of Flange

Minimum flange widths for bolts of different diameter are given as under:

Bolt Dia (mm)	16	20	24
Flange Width (mm)	45	50	60
Thickness of spring washers (mm)	3.5	4.0	4.5

The Loading trees for Reliability , Security , Safety conditions of all towers shall be prepared and ensure the proposed tower geometry satisfying all essential electrical clearances before design of the tower.

The unsupported length of stub between chimney and the last bracing connection to the leg should also be checked for combined direct and bending stresses and an additional cleat of required suitable size be provided . The supporting calculations shall also be provided. The design of stub & foundation cleats shall be designed as per the CBIP manual & ASCE 10-97, ASCE-52 .

The structural assembly drawing should be prepared according to IS 696 and IS 962. The drawing shall show the complete design dimensions, member length, slope factors or triangles, section sizes, bend lines, gauge lines, diameter, length and number of bolts, spacers, washers, sizes of gusset plates, position of holes etc., and relative location of various members.

Sufficient number of elevation, cross section and plan view should be presented to clearly indicate the details of joints and arrangement of members.

All members should be clearly shown and respective identification mark allotted to each member.

The drawing should be drawn to scale large enough to convey the information adequately.

All connection should be detailed to minimize eccentricity of connections. Due consideration should be given to the additional stresses introduced in the member on account of eccentricity of connection.

Dimension of all members and on a member the distances such as hole – to – hole, length, gauge distance etc., should be given in full integers and not in decimals.

4.10 Construction of Tower Steel work

All designs shall be such that no trouble shall arise in service from vibration or excessive deflection due to the use of too light a section. The height of standard towers (+/- 0 body & +/- 0 legs) from ground level to the bottom cross arm shall be 19m for DA and 17m for all other type towers.

Bolt holes shall not be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The distance from the center of bolt holes to the edge of any steel section shall not be less than 1.5 times the diameter of the bolt.

All tower member joints or joints between prefabricated panels to be made at Site shall be secured with bolts, nuts and washers. As far as conveniently possible, bolt heads, rather than nuts, shall be on the outer or upper faces of support joints.

Structure cross-arms shall be so arranged that they can be disconnected from the body without disturbing main structure body members.

The conductor landing points on cross-arms shall be so arranged that an additional hole for the attachment of conductor erection and maintenance tackle is provided adjacent to each hole for tension

shackles. It shall be possible to apply full conductor tension and weight safely to these additional attachment points.

Mild steel when stored in the fabricators stockyard prior to fabrication and galvanizing shall be marked continuously throughout its length with a light blue water paint line. In addition the grade number of the steel shall be painted on and ringed around with paint.

Members that are capable of being fitted in more than one position on the structure shall all be of the grade of steel suitable for the most onerous loading conditions.

4.10.1 Anti-climbing device

At a height of at least 3m from floor or normal ground level (whichever is the higher) an adjustable anti-climbing frame shall be fitted to all faces of each tower.

The device for tower shall also prevent climbing access inside the structure body.

At each climbing leg a suitable gate shall be provided to allow access by the Employers maintenance staff.

4.10.2 Step-bolts

Two diagonally opposite legs of all structures shall be equipped with galvanized step bolts (M16 x 160mm) confirming IS:10238 on the leg at intervals not exceeding 380mm commencing immediately above the anti-climb device and extending to within one meter of OPGW. Step-bolt design shall be to the approval of the Employer or the Employer's Representative. Holes for removable step-bolts below the anti-climbing device shall be provided at no more than 380mm centers on the legs to which the permanent step-bolts are fitted.

4.10.3 Workmanship

All work shall be in accordance with the best modern practice in the manufacture and fabrication of materials covered by this specification. The Contractor shall be responsible for the correct fitting of all parts, shall replace free of cost any defective material discovered during erection and pay all costs of field corrections for such replacement. All parts of the structure shall be neatly finished and free from kinks, twists or bends. All holes shall be made with sharp tools and shall be clean cut without torn or ragged edge. The fabrication shall be in strict accordance with the shop drawings prepared by the Contractor and approved by the Employer or the Employer's Representative.

Structural materials shall be straight and cleaned of all rust and dirt before laid out or worked in any manner. Shearing and cutting shall be performed carefully. Manually guided cutting torches shall not be used.

All bolt holes in steel members shall be punched, sub-punched, reamed or drilled before galvanizing. Holes shall be drilled instead of being punched if the thickness of the metal exceeds the diameter of the hole. All holes shall be clean-cut and without torn or ragged edges. All holes shall be cylindrical and perpendicular to the member.

The diameter of the finished bolt hole shall not be greater than the normal diameter of the bolt plus 1.5mm. Plugging, welding or slotting of mispunched, misreamed or misdrilled holes will not be permitted. The holes shall be located accurately so that when the members are in position the holes will be lined up before being bolted.

4.10.4 Member fabrication-galvanising

All galvanizing shall be carried out by the hot dip process and shall conform in all respects with BS 729.

All surface defects in the steel including cracks surface laminations, laps and folds shall be removed in accordance with BS 4360/IS 2629/ IS 209/IS2633. All drilling, cutting, welding, forming and final, fabrications of unit members and assemblies shall be completed before the structures are galvanised. The surface of the steelwork to be galvanised shall be free from welding slag, paint, oil, grease and similar contaminants.

The preparation for galvanising and the galvanising 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 0.086mm in thickness for steel members thickness equals to or more than 5mm.

At least 460 grams of zinc per square meter and 0.065mm for thickness of members less than 5mm.

On removal from the galvanising bath the resultant coating shall be smooth continuous free from gross surface imperfections such as bare, spits, lumps, blisters and inclusions of flux, ash or dross.

During off loading and erection of supports the use of nylon or braided slings shall be used. Galvanized steel work which is to be stored in the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanized coating damaged in any way shall be restored in accordance with the requirements of item 1.7 of General technical specifications.

Tests on samples shall be carried out to BS 729/IS 4759/IS6745/IS14394.

4.10.5 Bolts and nuts

No bolt of diameter less than 16mm shall be used. No screwed threads shall form part of shearing plane between members.

When in position all bolts or screwed rods shall project through the corresponding nuts by at least one full thread but such projection shall not exceed 10mm.

Bolts shall be galvanized after thread cutting to the same specified coating weight as specified in BS 729/IS1367/IS1368/IS12427 /IS14394

Spring washers shall confirm to IS3063 and pack & plain washers confirm IS6821.

Nuts and heads of all bolts shall be hexagonal.

All bolts, nuts and washers shall be hot dip galvanised and subsequently centrifuged (according to BS 729). Nuts shall be tapped after galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut.

All bolts supplied for this contract will be provided with one nut and one spring washer of approved design. Taper washers and packers are to be fitted where necessary.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc rich paint. Only one type of bolt for the whole project, either mild steel or high tension steel will be permitted in order to prevent inadvertent misuse. The Contractor shall state clearly which type of bolt his designs are based upon.

The Contractor will instruct his supplier to select two samples of each type of bolt and nut to be used on the Contract and send these samples to the Employer or the Employer's Representative for approval within one month of the date of issuing the order. The Employer or the Employer's Representative will then reject bolt consignments, which in his opinion fall in any respect below the standard of samples submitted and approved.

4.10.6 Aeronautical Sign on Steel Towers

The Contractor shall paint the steel towers in the vicinity of airports or aviation route in accordance with the following stipulations:

Painting of steel towers shall be applied on all surfaces of steel members after erection works have been completed. No painting shall be done in cold, damp, foggy or dusty atmospheres or started when the weather forecast indicates such conditions for the day. Prior to painting, the Contractor shall submit a painting plan including the quality of paint and the division of painting for the approval of the Employer.

The color of the paint shall be yellowish-red and white alternately in strips from the top of the tower. Painting shall be applied in four coats including prime coat. The primer paint shall be zinc dust-zinc oxide/ metal primer.

4.10.7 Bird Guards

To prevent birds perching immediately above the suspension insulator string of suspension and/ or tension towers and fouling the same with dropping, suitable bird guards shall be provided at cross arm tips of all suspension towers. The bird guard arrangement shall be such that it shall either prevent bird from perching in position where they are liable to cause the damages or ensure that if birds do perch, dropping will fall clear of the insulator string.

4.10.8 Payment for Line Tower

Payment for the contract item, "Line tower" including any required painting, will be made at the unit bid price per tower type bid. For supply, the tower is divided into Basic body, Body extension and leg extension. For Erection the unit price shall include all cost incurred in transportation and erection of a complete tower. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and all other operational related to tower design, fabrication delivery etc. as specified.

4.11 Tower Earthing

4.11.1 General

In addition to the mechanical OPGW termination requirement, all steel towers shall be fitted with separate earth bonds for OPGW continuity and the Contractor shall provide all necessary connecting facilities.

All the four legs of the tower shall be connected to the earth through electrode as shown in attached Drawing.

The footing resistance shall be measured by the Contractor and approved by the Employer or the Employer's Representative for every tower prior to the stringing of the OPGW. The maximum footing resistance to the general mass of earth shall be 10 Ohms.

Steel towers need not be fitted with a separate earth bond and earthing continuity throughout the support will therefore depend upon surface contact between members.

All towers shall be provided with means for connecting an additional earthing device as required by the Employer or the Employer's Representative. Holes are to be provided in all supports near ground level to take bolts for earth lead connections.

All legs of every tower shall be equipped with galvanized steel wire and cast into the foundation concrete to be readily available for the connection of additional earth electrodes in the event of the initial footing resistance exceeding 10 ohms. Bidder's rates for the structures shall include for such additional works.

Galvanized steel rods shall be driven where necessary in sufficient number to ensure the combined structure footing and earth electrode resistance does not exceed 10 Ohms. Where it is necessary to drive more than one earth electrode at any support, the locations shall be to the approval of the Employer or the Employer's Representative. All earth electrodes shall be electrically bonded together using galvanized steel wire.

The tops of all electrodes shall be at least 500 mm below the surface of the normal reinstated ground level.

Connection of earth wires to the structure stub-angles shall be by bolting. Bidders shall submit details of their proposals in this regard.

4.11.2 Payment for Grounding Materials

Payment for grounding materials shall be made at the unit price bid. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and other operational related to the scope of work of earthing as specified. Each set shall mean one complete set for each tower footing.

4.12 Danger, Phase and Number Plate

4.12.1 General Requirement

All structures shall be equipped with a suitable framework mounted immediately above the anti-climb device level, to accommodate a danger plate and support- number plate in a conspicuous position. One plate is to be supplied for every tower, except for phase identification plates, which shall be supplied for angle towers only.

All terminal structures shall be equipped with additional frameworks, mounted immediately above the anti-climb device level, to accommodate a set of three phase color plates.

All plates shall be affixed to the framework by means of galvanized bolts, nuts and lockouts. Washers should be of such material and so positioned that damage to the enamel will be prevented. The height for fixing these accessories shall not be more than 4.5m above the ground level. The corners of the number, danger & circuit plate shall be rounded off to remove sharp edges. All plates shall be manufactured from mild steel sheet with vitreous enameled finish. The letters figures and the conventional skull and bones of danger plates shall conform to IS:2551-1963 and shall be in a signal red on the front of the plate. A detail drawing for such plates shall be prepared by Contractor subject to the Employer's approval.

Line color-coded vitreous enamel identification plates should be fitted to the climbing legs of every structure in accordance with line color code scheme to be supplied to the successful Bidder. Each plate shall be approximately 70mm wide and shall be applied one immediately below the anti-climb device, one halfway up the towers and one immediately below the lowest crossarm.

4.12.2 Payment for Plates

Payment for danger, phase and number plates shall be made at the unit price bid. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and other operational related to the scope of work as specified.

4.13 Final Design and Design Drawing

The detailed design shall be prepared in line with the approved line diagram, which shall be submitted to the Employer required number of copies.

The tower accessories drawings like name plate, danger plate, phase plate, anti-climbing device, step bolt, D-shackle etc. shall also be prepared by the Contractor and shall be submitted to the Employer required number of copies along with the soft copies in CD. These drawings shall be prepared in A4 size sheet only.

Once the design is approved, the approved design drawing shall be submitted to Employer in four copies, along with one soft copy. The overall responsibility of fabricating tower for its correctness lies with the Bidder only, and should ensure that all the tower members can be fitted without any undue strain on them.

4.13.1 Shop drawing

The shop drawings shall be prepared based on the approved design drawing. Shop drawing should contain complete information necessary for fabrication of the component parts of the structure. These drawings should clearly show the member size, length and marks, hole positions, gauge lines, bend lines, edge distances, amount of chipping and notching etc.

For gusset fabrication, separate individual item wise template can be made to facilitate gusset fabrication as well as inspection. In case of member to be bent, shop drawing should indicate the provision for variation in length. At the design/ drawing stage itself, drawing should indicate that the degree of bend given in any member such that neither flange width nor thickness shall vary beyond permissible limits.

Items requiring steep bending may be cut and welded as per approved welding procedure.

At the time of proto stage/ tower testing itself specific bend gauge and template to locate the holes after bending must be established for the items to be bent.

4.13.2 Bill of Material

Bill of material for each type of tower and extensions required should be prepared separately. This should indicate grade of steel (like high tensile steel , mild steel etc.), mark numbers, section sizes, member's lengths, their calculated weights, type & number of bolts, nuts and washer and their sizes, total quantities and structural drawing members.

Marking

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

A-BB-CC-DDD

A	=	NEA's code assigned to the Bidder –Alphabet
BB	=	Bidder's Mark-Numerical
CC	=	Tower type-Alphabet
DD	=	Number mark to be assigned by Bidder -Numerical.
HT	=	High Tensile steel

4.13.3 Shop Erection/Proto type Tower Assembly

Steel work should be temporarily erected in horizontal or vertical so that accuracy of the member can be checked before testing the towers or commencing mass fabrication as applicable. The proto assembly is done on the basis of approved structural shop drawings of towers, all body extensions, stubs & templates for all types of towers.

4.14 Testing of Towers

4.14.1 General

Testing of tower generally serves as guide to good tower design and therefore shall not be considered as requisite proof test for all towers. The test shall be conducted on full scale prototype galvanized tower as per the approved loading schedules and rigging diagram. The members constituting the prototype shall be of same grade of steel as specified in the design and fabrication shall conform to the provision stipulated in IS 802 (Part – II). The tower shall be tested on rigid foundation.

The test tower shall successfully withstand the ultimate loads specified for various conditions.

4.14.2 Leg Anchorage

The tower shall be erected vertically on rigid foundation with as much unbraced portion of the stub protruding above ground level as provided in the drawing.

4.14.3 Calibration of Measuring Instruments

All measuring instruments shall be calibrated in a systemic manner with the help of standard weights. The calibration shall, before commencing the test on each tower, be done upto the maximum anticipated load to be applied during testing. Calibration curves for the instrument to be used during

testing shall be drawn by the testing authorities and the test loads shall be suitably corrected with the help of these curves.

Calibration of load cells shall be done with Universal Testing Machine (UTM) or by using standard weights. The UTM in turn shall be calibrated once in every six months or periodically as per advice of the supplier of UTM.

4.14.4 Types of Tests

- Bolt-Slip Test
- Load Tests
  - Reliability Condition (Normal Condition)
  - Security and Safety Conditions as well as Anti-Cascade Conditions
  - Broken Wire Condition
- Destruction Test including Material test after Destruction Test

4.14.5 Method of Load Application

Load shall be applied according to approved rigging diagram through normal wire attachments, angles, or bent [plates. U bolt/ D shackle or swinging brackets (hangers) may be used in the test tower if desired by the Employer, provided that satisfactory and safe rigging is attained.

The various type of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the tower due to jerk from the winches.
Loading cases (values, direction and points of application of loads) shall be determined by the Bidder and get approved form the Employer before applying to the test towers.

4.14.6 Loads and Deflection Measurement

All loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided the same shall be measured by means of standard weight and accounted for in the test loads.

Tower deflection under loads shall be measured by suitable procedure at the top cross arm level on the front side of the transverse and longitudinal faces or front and rear side of the transverse faces. Deflection reading shall be recorded for the 'before load', ' load on' and 'load off' conditions.

4.14.7 Testing Procedure

Bolt slip test – In bolt slip test, the test loads upto 50% of Ultimate Normal Condition (Reliability Condition) Loads are gradually applied and kept constant for 1 minute at these loads and then the loads are released gradually.

The initial and final reading on the scale before application and after the release of loads respectively shall be taken with the help of theodolite. The difference between these readings gives the value of the bolt slip.

Normal load/ broken wire load tests – All loads shall be applied gradually upto the ultimate design loads in the following steps and shall be released in the similar manner:

- 25%
- 50%
- 75%
- 90%
- 95%
- 100%

4.14.8 Observation Periods

Under normal and broken wire load tests, the tower shall be kept under observation for sign of failure for one minute (excluding the time for adjustment of loads) for all intermediate steps of loading upto and including 95 % of ultimate design loads.

For normal as well as broken wire tests, the tower shall be kept under observation for five minutes after it is loaded upto 100 percent ultimate loads.

While the loading operations are in progress, the tower shall be constantly watched, and is it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then the entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.

4.14.9 Recording

The deflection of the tower shall be recorded at each intermediate and final stage of normal loads/ broken wire load test by means of a theodolite and graduated scale.

4.14.10 Destruction Test

If the Employer desired so, destruction test for the tower shall be carried out.

Destruction test shall be carried out under normal condition or broken wire condition as agreed between the Employer and the Bidder.

All the provision of the specification and IS 802 for normal broken wire conditions shall be applicable to destruction tests of Double circuit towers during the design of towers.

4.15 Material Quality Control

Various grade of steel used in tower, details of sections, bolts and nuts and other accessories need a detailed scrutiny and quality control procedure before being processed for fabrication, assembly etc. All structural material including nuts and bolts shall be in compliance with their respective Indian Standards.

Chemical composition and mechanical properties of various grade of steel used shall be clearly mentioned and those shall be in accordance with relevant IS or international standards.

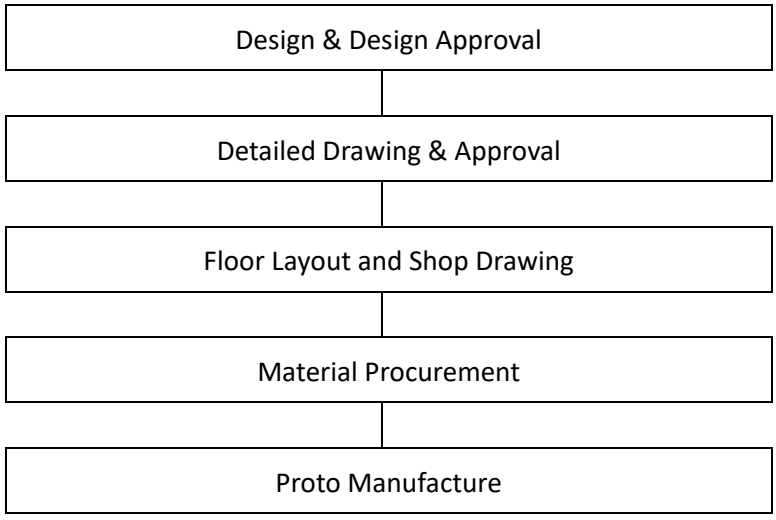
Steel Sections of tested quality in conformity with IS: 2062 (Designated Yield Strength. 250 MPa) and/ or IS: 8500 grade 490 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

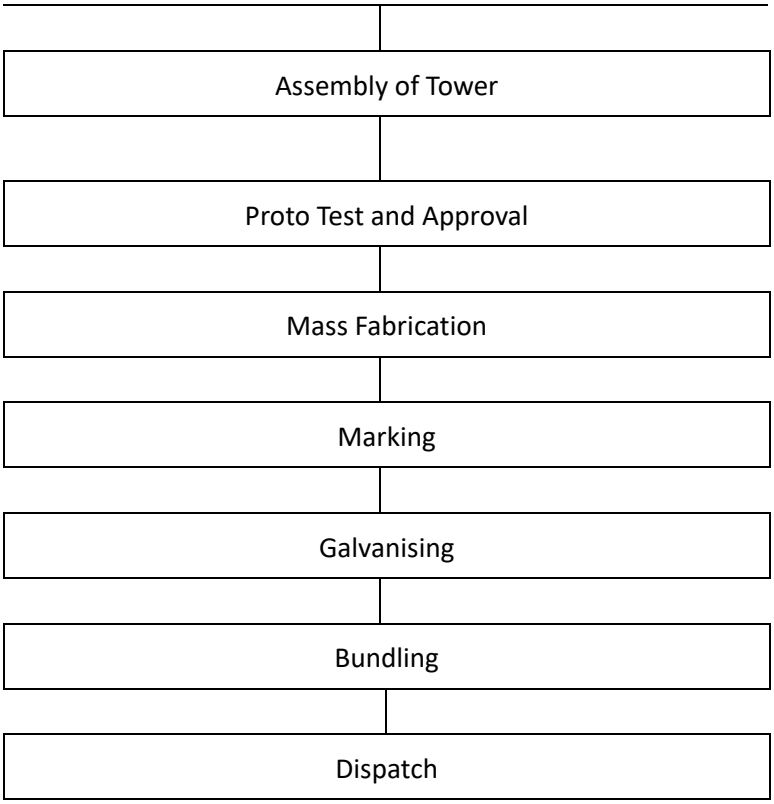
For designing of towers, preferably rationalized steel sections shall be used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Bidder. However, design approval for such substitution shall be obtained from the Employer before any substitution and records of such substitutions shall be maintained by the Bidder.

At the time of procurement of steel other than that conforming to IS 2062, green colour on the edge of HT material on both sides is applied so that there is no mix up of MS and HT steel in stockyard as well as in shop. A distinct green colour patch is maintained throughout and on shop sketch also, HT marking is added for identifying high tensile steel item.

4.16 Process Flow Chart for Fabrication of Towers

In general following flow chart shall be followed for design, assembly, testing and supply of towers:





4.17 Packing

Angle section shall be wire bundled.

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. Bolts, nuts washers and other attachments shall be packed in double gunny bags accurately tagged in accordance with the contents. The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked.

4.18 Standards

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.

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) Standards / Guides	Title	Internationally recognized
1.	IS: 209-1992	Specification for Zinc	ISO/R/752 ASTM B6
2.	IS: 278-1991	Galvanized Steel Barbed wire	ASTM A131
3.	IS: 800-2007	Code of Practice for General Building Construction in Steel	CSA 6.1
4. (a)	IS: 802(Part1) Sec 1-1995	Code of Practice for General	ASCE 52
		Building Construction in Steel Sec 2-1992 in Overhead Transmission Line Towers: Materials, loads and Permissible Stresses	IEC 826 BS 8100
		Section 1 Materials and loads	
		Section 2 Permissible stresses.	
4. (b)	IS: 802-1990 (Part 2)	Code of practice for use of structural steel in over-head Transmission Line : Fabrication, Galvanizing, Inspection and Packing	
4. (c)	IS: 802-1990 (Part 3)	Code of practice for use of Structural Steel in over-load Transmission Line Towers Testing	ASCE 52 IEC 652
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	IS: 1363-1990 Hexagon Nuts(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:	

Sl. No.	Indian Standards (IS) Standards / Guides	Title	Internationally recognized
		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 Galvanizing 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 Bolts, Nuts Screws	DIN-127
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.	ASTM A394

Sl. No.	Indian Standards (IS) Standards / Guides	Title	Internationally recognized
			CSA B334
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	
32.	IS:4091-1979	Code of practice for design and construction of foundation for transmission line between tower & poles.	
33.	IS:5358	Specification for hot dip galvanized coating and fastners	
34.	IS: 7215-1992	Specification for tolerance for fabrication of steel structures	

Chapter 5: TOWER FOUNDATION AND CIVIL WORKS

5.1 General

The Contractor shall furnish all materials, equipment and labour and perform all operations required for the design and construction of all of the concrete foundations as shown on the drawings and other relevant civil works, as specified herein and as evidently necessary to complete the work.

Before start of design of foundation, successful bidder shall carry out geotechnical investigation during detailed/check survey of Transmission Line route primarily consists of laying trial bore-holes (normally up to 6.0 meter below natural ground level) at all tower locations or as directed by the Employer to have a fair idea of soil type/nature and subsoil water position. If the soil characteristics are changing rapidly or soil up to 6.0 meter is very weak, the depth of bore-hole be increased beyond 6.0 meters so as to know the soil properties / type below the foundation. The bore log data containing information such as position of sub-soil water table, soil strata, the crop pattern in the agricultural fields where the foundation is to be laid and the suitability for founding the required foundation, shall be submitted to the Employer for according approval for "Classification of foundation" at each location.

5.2 Foundation Design

5.2.1 General

The foundation for tower structure plays an important role in the safety and satisfactory performance of the structure as it transmits the load from the structure to the soil. Therefore, the foundation shall be so designed to carry the entire load as required, with sufficient factor of safety as recommended by the Code of practices.

The foundation in various types of soils shall be designed to suit the soil conditions of particular type, from the recommendation of the geotechnical investigation report, which has to be approved by the Employer.

Several types of foundations are used for different type of transmission towers and different types of soil. The foundation should be strong and stable, and able to take care of all the loads like dead load, live load, wind loads, seismic load, erection loads etc., causing vertical thrust, uplift as well as horizontal reaction.

The quantity of foundations in every type given in the Price Schedule is provisional only and may vary as per the result of the detail soil test.

Foundations should be designed for a working life of 50 years and Bidders should comply in full with the requirements of these specifications in establishing his design. In all locations, all steelwork, whether part of the tower or part of the stub-angle foundations shall be completely encased in concrete to ensure a cover of 100mm from any part of the stub leg or tower from a point 300mm above ground

down to the base of the main foundation block. All Stubs shall have cleats designed to carry the entire stub load.

The Contractor shall design at least one foundation for each of the foundation types specified on the bid drawings for all types of towers used in the line to produce an economical family drawings and calculation for the approval of the Employer or Employer's representative before commencement of construction. Upon completion of detail soil test, the Contractor shall select the most economical foundation subject to the approval of the Employer or Employer's representative. The general foundation design parameters are given in Schedule A. 13 and Conceptual Drawing is given in Dwg. No. 5.

5.2.2 Submittal

The Contractor shall submit for each type of foundation one set of design calculations, detail drawings and reinforcing steel and concrete schedules to the Employer or Employer's representative for review and comment before construction commences. Review of the foundation designs by the Employer or Employer's representative in no way relieves the Contractor from his responsibility for an adequate foundation design, even though this specification sets forth the basic foundation design criteria. Upon receiving the Employer's or Employer's representative's comments, the Contractor shall submit to the Employer required number of sets, electronic copy and prints of drawings of all foundation details, including reinforcing steel schedules on drawing sheet sizes, form, heading, etc., as required by the Employer for record.

5.2.3 Structural Design of Foundation

It comprises the design of chimney and the design of base slab / pyramid / block. Structure design of chimney shall be suitable for maximum bending moments due to side thrust in transverse and longitudinal directions combined with uplift (tension), down thrust (compression). The combined uplift and bending shall determine the requirement of longitudinal reinforcement in the chimney. The stub angle shall be embedded in the chimney to its full depth and anchored to the bottom slab / pyramid. The chimney shall be designed considering the passive resistance of soil leaving 500mm from ground level.

Design of foundation based on stub embedded in the chimney for required development length alone and the same is not taken to bottom of the foundation, is not permitted.

a) Structural Design of Base Slab

The base slab in RCC foundation may be single stepped or uniform. The design of concrete foundation shall be done as per Limit – state method of design given in IS: 456.

b) Criteria for Structural Design of Foundation

(a) Isolated identical footings shall be provided for each leg of the tower.
(b) All foundations shall be designed so as to satisfy and meet the following requirements:

i) The chimney of the foundation shall at least be 400 mm square providing a minimum clear concrete cover of not less than 100 mm over any part of the stub angle in case of dry foundations and at least 450 mm square with minimum clear concrete cover of not less than 150 mm over any part of the stub angle in case wet, fully submerged foundations.

ii) The chimney top shall extend 500 mm (Minimum) above ground level and coping shall be up to 50 mm below the joint between the bottom bracing and the leg members.

iii) In all foundations, a lean concrete sub-base having a thickness of 100 mm and of size equal the concrete pyramid base/RCC shall be provided under structural concrete. The lean concrete shall be of grade M-10 (1:3:6) conforming to IS: 456-2000. The lean concrete sub-base provided under the footings shall not be considered in the structural calculations.

iv) The embedded end of the stub angle shall have a 150 mm thick clear concrete cover up to the top of the lean concrete sub-base in the case of dry foundations and a 200 mm thick clear concrete cover in the case of wet, partially submerged and fully submerged foundations.

v) The depth of foundation below ground level shall not be more than 3.0m.

vi) The centroidal axis of the stub shall coincide with axis of the chimney and pass through the centre of the footing base. The design of the foundation shall take into account the additional forces resulting from eccentricity introduced due to non-compliance of above requirements.

vii) Wherever reinforcement is provided in foundation, the clear concrete cover to reinforcement shall not be less than 50 mm.

viii) The slab type isolated RCC foundations shall also satisfy and meet the following requirements:

- The structural design of foundations shall be strictly in accordance with IS: 456-2000 and other relevant IS codes.
- The design of RCC foundations shall be carried out by Limit state method in accordance with IS:456-2000.
- The minimum thickness of footing slab at chimney perimeter shall not be less than 300 mm.
- The minimum thickness of footing slab at the edges shall not be less than 150 mm as specified in IS:456-2000.
- In the design of the footing slabs, actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections. The critical sections for moments and shears shall be as specified in IS: 456-2000. The reinforcement in the footings shall be accordingly calculated and provided.

5.3 Design loads

The loads used to design the foundations shall be actual loads applied to the foundations by the towers.

The foundations shall be designed in such a manner that the factors of safety shall not be less than the following requirements:

5.3.1 Types of loads on foundations

The foundation may be subjected to three types of forces (ultimate loads):

- Compression or downward thrust
- Tension or uplift, and
- Lateral force or side thrust in both transverse and longitudinal directions.

The magnitudes of each of type of load depend on the type of tower and configuration of the transmission lines.

Partial Factors of safety for foundation design

a) Towers upto an angle of 15 deg deviation 1.1

b) Towers above an angle of 15 deg deviation 1.2

Weight of concrete (kg/m^3)		Dry	Wet, PS and FS
1.	Plain (M10)	2240	1240
2.	RCC (M15)	2400	1400
3.	RCC (M20)	2400	1400

S.N	Type of Soil	Angle of Earth Frustum. (deg)	Unit weight of soil (kg/ m^3)	Limit Bearing Capacity (kg/cm^2)
1	Normal Dry Soil			
	Without Under-cut	30	1440	25,000
2.	wet soil due to presence of sub soil water / surface water	15	940	12,500
3.	Black Cotton soil (a) in dry portion	0	1440	12,500

	(b) in wet portion	0	940	12,500
4.	Sandy soil (a) with clay content 0-5%	10	1440	25,000
	(b) with clay content 5-10%	20	1440	25,000
5.	Fissured Rock / Soft Rock (b) In wet portion	10	940	62,500
6.	Hard Rock	-	-	1,25,000

Unless specified otherwise, design and details shall comply with the latest published editions of BS /IS 6403, IS456, IS 1786, CBIP Tower manual or with other standard specifications provided they are of equal or higher standard where such standard exists with accepted national or international good practice. Support foundation designs as detailed in the specification which in the opinion of the Employer or Employer's representative do not demonstrate an acceptable type of foundation for the type of soil condition so described will be rejected.

5.4 Foundation type

In some section of the proposed transmission line, water level of terrain is high. In such cases the foundation is to be designed for fully submerged condition. If required by the Employer, the Contractor shall construct embankments for tower sites where footings are located in standing water of sloughs, pot holes and marshes. No separate payments shall be made for such embankments.

Reinforced cement concrete footing shall be used for all types of normal towers / extension towers in conformity with the present day practices followed in the country and the specifications laid herein. All the four footings of the tower and their extensions, if any shall be similar irrespective of down thrust and uplift.

Foundation includes supply of materials such as cement, fine and coarse aggregates, water, reinforcement steel and binding wire etc. Rates quoted for foundations shall include all items of work relating to supply and installation of foundations such as form work, excavation and back filing with good soil, compaction, stub setting, shoring & timbering etc. where ever required, placing of reinforcement in position, concreting and all other works related for completion of foundation.

5.4.1 Classification of Foundations

General Classification of Foundations

The foundation classification shall depend upon the type of soil, subsoil water level and the presence of surface water which have been classified as follows:

a) Dry Soil Foundation

To be used for locations

- where normal dry cohesive soil is met.
- where cohesionless pure sand or negligible cohesion sand mixed with soil are met in dry condition and The water table is below foundation base

b) Wet Soil Foundation

To be used for locations:

- Where subsoil water table is met at 1.5 m. or more below the ground level.
- Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy field.
- When the top layer of soil upto 1.5 m is black cotton/loose silty sandy soil and there after it is normal dry cohesive soil.

c) Fully Submerged Foundation

To be used at locations

- where sub - soil water table is met at less than 0.75 m below the ground level and the soil is normal and cohesive.
- To be used at locations where soil is cohesive having inorganic clay exceeding 15%, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing foundations, for such locations, the soil is to be considered submerged in nature.
- Fully submerged top layer consists of partly black cotton/ loose silty sandy soil followed by ordinary fine grained soil strata.

d) Wet Fissured Rock Foundation

In places, where soft rock, the decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other hard soil strata , which can be excavated using normal tools with out blasting and the water table is met at 1.5 meter or more below ground level

In case the undercut type foundation is to be used for fissured rock locations.

The additional strength obtainable from under cut provision will not be considered in the design of foundation.

e) Hard Rock Foundation

The locations where chiseling, drilling and blasting is required for excavation, hard rock type foundations are to be used. For these locations, rock anchoring by providing anchor bars embedded into the grouted anchor holes to resist uplift forces. For design purpose, rock level shall be considered at ground level and no over burden soil weight shall be considered for resisting the uplift. In case of weathered rock / out crop rock, the first half meter rock from the surface will not be considered for design purpose.

In addition to the above, depending on the site conditions other types of foundations shall also be provided by the Bidder, suitable for intermediate conditions under the above classifications to affect more economy.

5.5 Footings

5.5.1 Concrete spread footing

The foundation shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. Uplift foundations shall be cast against undisturbed soil for a minimum height of 250mm and 50mm lean concrete.

For the purpose of bidding the Bidder shall design each type of foundation with the value of soil bearing capacity as stated in Foundation Application Schedule.

These are only reference values and are taken from similar type of soil location from near by site. After award of contract the Contractor shall carry out detail soil test of support site and shall design each type of support foundation accordingly. No extra payment will be made for change in the quantity of concrete/rebar and other associated works due to change in design parameters.

5.5.2 Pile Foundation

This type of foundation is usually adopted when soil is very weak and has very poor bearing capacity or foundation has to be located in filled up soil or tower are to be erected in the land which is prone to flash flood. Piles are long and slender members which transfer load to the deeper soil or rock of high bearing capacity avoiding the shallow soil of low bearing capacity.

The piles should be cast in place fast setting concrete which should have 28 day cubical compressive strength of 210 kg/sq.cm.

The pile should be designed for the pile diameter of 900mm.

Piles in a footing should be firmly connected by horizontal tie beam of minimum 900x900mm sizes with adequate reinforcement which should be 1.5m above the existing ground level.

All arrangement for anchor plate (or any other arrangement) with anchor bolts etc whichever is appropriate for the connection of the tower legs to the foundation shall be in the scope of the pile foundation.

5.5.3 Spread foundation in hard rock

The rock which cannot be excavated using normal tools and require chiseling, drilling and blasting are classified as hard rock. These include hard sand stone, quartzite, granite, basalt, marble etc.

The foundation in hard rock shall be designed to carry maximum shear loads below ground level, that is, the stub legs are not to be considered as reinforcement. Allowance shall be made for the loss of uplift resistance due to overlap of frusta where applicable. The footing should be safe against overturning. In case if it is unsafe against overturning, appropriate measures (e.g. counter weight) should be provided.

5.6 Stub Angle Anchor

5.6.1 Stub Angle

Tower Stub angles shall be of galvanized steel and shall have cross-sectional area of not less than the structure leg member to which it will be attached. The stub angle shall not be included in the calculation of the steel reinforcement requirements against bending and tension forces in concrete foundation design.

Only those holes in the stub which have been previously punched and galvanized at the manufactures works will be used for the attachment of cleats. Site drilling will not be permitted.

5.6.2 Stub setting template

Stub setting templates, to approval of Employer or Employer's representative, shall be provided by the Contractor. They shall be of such design and construction as to resist distortion and damage and withstand repetitive use. They shall be manufactured from mild steel angle or channel or a combination of both, of approved and adequate cross- section, and shall be equipped with central alignment notches or holes corner braces, riser braces, and stub-angles in respect of the following requirements:

- Route longitudinal center line
- Structure lateral central line
- Stub elevations (with reference to datum)
- Stub leveling
- Stub rake
- Stub hip bevels

- Stub angle spacing

No concreting shall be commenced before the stub setting is approved by the Employer or Employer's representative. After the completion of Works all the template sets shall be handed over to Employer. No extra payment for the design, manufacturing and delivery for the templates shall be claimed by the Contractor.

5.7 Excavation and Backfilling

5.7.1 Scope

This specification covers the general requirements of earthwork in excavation in different materials, filling back around foundations, conveyance and disposal of surplus spoils or stacking them properly as shown on the drawings and as directed by the Employer or Employer's representative and all operations covered within the intent and purpose of this specification.

5.7.2 General

a. The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labor, materials, any temporary works, consumable, and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with specification requirements.

b. The Contractor shall carry out the check survey of the site before excavation and set properly all lines and establish levels for foundations.

c. The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades on ground excavated areas and warning lamps at night for ensuring safety.

d. The item also includes for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Employer or Employer's representative, within the lead specified and leveling the same so as to provide natural drainage. Rock/Soil excavated shall be stacked properly as directed by the Employer or Employer's representative. As a rule, all softer material shall be laid along the center of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

e. Clearing

The area to be excavated / filled shall be cleared of trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The materials so removed shall be burnt or disposed off as directed by the Employer. Where earth fill is intended, the area shall be stripped of all loose / soft patches, topsoil containing objectionable matter / materials before filling commences.

f. Precious object, relics, objects of archeological importance

All gold, silver, oil, mineral, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorize or appoint to receive the found goods.

g. The Contractor shall excavate earth, rock, stumps and all other materials encountered as required for construction of each foundation. The Contractor shall place all suitable excavated material in backfill or in graded embankment in the immediate area at structures. Materials found to be unsuitable for foundation backfill or grading shall be wasted and disposed at Contractor's own cost.

h. The Contractor shall excavate each foundation hole to the nominal excavation depth for the applicable foundation type except in case where the material being excavated is not capable of supporting 0.5 kg/sq.cm.

i. At the nominal excavation depth, the foundation shall be carefully graded to a level plane and all loose or disturbed material shall be removed. The foundation excavation shall then be examined by the Contractor and a final determination will be made on the foundation type to be used.

j. Excavations shall be maintained in a clean, safe and sound condition until completion of the foundation construction and shall be diked to prevent flooding by surface runoff. Suitable pumping equipment shall be provided and used to dewater excavations so that all installation work and backfilling is performed in the dry state. Any previously prepared foundation bearing surface that is softened by water runoff or otherwise contaminated before placement of the structure foundation shall be excavated and replaced at the Contractor's expense.

k. Those excavations where the base is unstable, lies below groundwater level, or has been over excavated, the Contractor shall furnish and place a layer of crushed stone, or selected backfill, or borrow to stabilize the base for placement of foundation materials. No extra payment shall be done for over-excavation and backfilled crushed stone layer.

l. Topsoil and excavated material that is suitable for backfill around the foundations shall be stockpiled separately for use in backfill. Material that is unsuitable for backfill shall be disposed of. The stockpiles shall be sloped to drain and shall be protected from rainfall or other elements, which render the material unsuitable for backfill.

m. Backfill shall be placed in not greater than 20cm lifts before compaction. Each lift shall b thoroughly compacted before the following lift is placed. Pneumatic or equivalent tampers shall be used on cohesive materials; vibratory compactors shall be used on non-cohesive materials. Compaction shall achieve a density at least equal to that of the surrounding undisturbed earth. Large stones or rock fragments may be used in the backfill provided they do not interfere with proper compaction. Particles larger than 25 cm shall be placed not nearer than 0.5 m of the structure and at least 1.0m below ground surface.

n. Rock particles larger than 10 cm shall not be in contact with the concrete.

o. Following completion of 75 percent of the compacted backfill portion, the remaining backfill and topsoil shall be placed and the topsoil mounded 30 cm above the ground surface and sloped to

drain. Compaction of this material will not be required. Before final acceptance of the Works, the Contractor shall refill any locations that settle below the surface of the surrounding ground.

p. Earth is defined as material which shall include all kinds of soil containing gravel, sand, silt, moorum or shingle, gravel, clay, loam, peat, ash, etc. which can generally be excavated with the aid of shovels and pick axes. This shall also include embedded rock boulders not longer than one meter in any direction and not more than 200 mm in any of the other two directions.

q. Rock is defined as material which shall include rock, boulders, shale, chalk, slate, hard mica, schist, laterite and all other materials which in the opinion of the Employer is rock and can be removed with picks, hammer, wedges, crowbars, pneumatic breaking equipment and blasting. This category shall also include excavation in macadam and tarred roads and pavements.

r. Rock excavation may be made by drilling, barring, wedging, or compressed-air tools. No blasting will be permitted. The Contractor shall furnish all material and equipment to perform all work required for excavation of rock.

For selection of rock type foundation for any tower location, the characteristics of rock shall be thoroughly investigated by the Contractor. Disintegrated rock or other types of rock such as soluble limestone, soft shale, slate, hard pan and organic rocks may not be suitable for construction of rock foundation.

s. All loose boulders, semidetached rocks (along with earthy mounds) not directly in the excavation area but so close to the area to be excavated as to be liable, in the opinion of the Employer, to fall or endanger the workman, equipment or the Works, shall be stripped off and removed away from the area of the works. Any material not requiring removal as contemplated in the work, but which in the opinion of the Employer is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Employer.

t. Payment: No separate or direct payment will be made to the Contractor for preparation of site, excavation, and backfill and rock excavation of tower foundation. All costs of soil and rock excavation incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types.

However, payment for the excavation and backfilling for foundation protection such as stone masonry work, removing unsafe boulders and earthwork near the foundation site, construction of embankment and stripping ground to obtain ground clearance between earth and conductor will be made at unit price bid specified in the Price Schedule. Therefore in the Price Schedule the unit bid price shall include full compensation for all costs incurred in furnishing all materials and labor and other operation costs.

5.8 Dewatering

5.8.1 Scope

This specification covers the general requirements of dewatering during excavations in general.

a. All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas.

The Contractor shall remove by pumping or other means approved by the Employer or Employer's representative any water inclusive of rainwater and subsoil water accumulated in excavation and keep all excavations/trenches free of water required for further work.

Method of pumping shall be approved by the Employer or Employer's representative; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing-in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

b. When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of the Employer as large, well- point system- single stage or multistage shall be adopted. The Contractor shall submit to the Employer his scheme of well-point system including the stages, the spacing number and diameter of well points, headers, etc., and the number, capacity and location of pumps for approval.

c. Payment: No separate or direct payment will be made to the Contractor for dewatering of tower foundation and any other foundation works. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundations and other civil works.

5.9 Timber Shoring

5.9.1 Scope

This specification covers the general requirements of timber shoring for open excavations for structure foundation.

a. Close timbering shall be done by completely covering the sides of the pits generally with short, upright members called polling boards. These shall be of minimum 25 cm x 4-cm sections or as directed by the Employer or Employer's representative.

The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meters spacing, strutted with bellies or as directed by the Employer or Employer's representative. The length of the bellies struts shall depend on the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

b. Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit. The type of timbering shall be as approved by the Employer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, pits, etc., from collapsing.

c. Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instruction from the Employer.

d. Payment: No separate payment will be made to the Contractor for timber shoring. All costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.10 Select Borrow

a. Where the material excavated for the foundation is unsuitable for backfill or is required for construction of embankment, the Contractor shall provide and compact select borrow. Excavated material shall be disposed at the Contractor's own expense.

b. Material for select borrow shall be well-graded bank-run gravel, relatively free from clay, loam or vegetation matter and with no stones over 10 cm in maximum dimensions, or materials of equivalent strength and characteristics. Representative sample from proposed borrow sources shall be submitted to the Employer for approval of the borrow source. Approval of borrow source shall not mean automatic approval of all materials obtained from that source.

c. The Contractor shall, at his option, use areas approved by the Employer or Employer's representative for production of select borrow or at his own expense, make arrangements for obtaining select borrow at other sources.

d. The select borrow shall be placed and compacted as specified for the backfill in Article 3.3 Excavation and Backfilling.

e. Payment: No separate payment will be made to the Contractor for select borrow required for back filling tower foundation. Hence, all costs incurred in connection therewith shall be included in the unit bid prices for the construction of the various foundation types and other civil works.

5.11 Foundation Construction

5.11.1 General requirement

All materials and labor required for the construction of foundations shall be furnished by the Contractor.

a. The Contractor will be required to remove and replace at his expense any materials incorporated in the work that do not conform to these specifications.

b. The Contractor shall furnish without any extra cost all materials the Employer require for testing. The cost of the tests shall be borne by the Contractor.

c. The final selection of the type of foundation footing to be actually constructed for each particular structure will be done by the Contractor after the results of the sub soil tests and shall be subject to the approval of the Employer.

5.11.2 Measurement for Foundation Payment

Measurement for payment for the Contract item, Foundations, shall be on the basis of the actual number of each type leg of structure foundations constructed by the Contractor. The additional concrete and rebar required by the special foundation aside from the foundation schedule shall be paid as per the unit rates of the foundation protection works for concrete and re-bars.

5.11.3 Payment

a) Payment for Spread Footing

Payment for the contract item, "Foundation" except for pile foundation, will be made at the unit price per tower, such unit price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to Foundation design and construction, including but not limited to:

a. Performing detail foundation design and preparation of construction drawings.

b. Supply and transporting all foundation materials such as concrete, reinforcement, etc to the job site.

c. Tower pegging and foundation orientation.

d. Excavation, dewatering, timber shoring and backfilling for the foundation.

e. Gravel packing in the base of footings, where necessary.

f. Template and stub setting

g. Lean concrete

h. Construction of foundations and associated works.

b) Payment for Pile foundation

Payment for the pile foundation will be made at the the unit price per set of pile foundation for single tower, such unit price shall include full compensation for all costs incurred in furnishing all materials, equipment and labor and all other operations related to Foundation design and construction, including but not limited to:

a. Performing detail foundation design and preparation of construction drawings.

b. Supply and transporting all foundation materials such as concrete, reinforcement, etc to the job site.

c. Tower pegging and foundation orientation.

d. Excavation, boring, dewatering, timber shoring and backfilling.

e. Any chemical needed to complete the job, where necessary.

f. Stub setting and anchoring arrangement

g. Formworks

h. Tie beam with reinforcement

The price schedule includes the rates per set of pile foundation for 12m and 16 m underground length of the pile. In case the actual underground length differs from the given length of the pile, payment will be made by interpolating or extrapolating with the quoted rate.

5.11.4 Reference to standard specifications

Standards referred to in these specifications are as follows:

a. ASTM referred to the latest edition of publications of American Society for the Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

b. ACI refers to the latest edition of publications of American Concrete Institute, P.O. Box 19150, Redford Station, and Detroit, Michigan 48219.

c. BIS referrers to the latest ,Bureau of Indian Standard Manak Bhawan, 9. Bahadur Shah Zafar Marg, New Delhi India.

5.11.5 Measurement Standards

Measurement standards referred to in these specifications are as follows:

a. Gallons - Wherever used in these specifications, gallons shall be understood to be U.S.gallons.

b. Bag - Wherever used in these specifications, bag will be understood to mean 50-kg bag of Portland cement. Concrete shall be composed of cement, sand, coarse aggregate, water and admixtures, if required, all well mixed and brought to the proper consistency.

5.11.6 Concrete

The Contractor shall design and test concrete mixes, which have 28-day cubicle compressive strength of 210 kg/sq.cm.

a. At least one month prior to the placement of any concrete, the Contractor shall make a set of test concrete compressive strength test cubes for each design mix under field conditions. The test cubes shall be made and tested in accordance with the applicable standards.

b. The concrete mix shall be of such proportions as to produce a plastic and workable mix which will not separate during the placing and will finish well without using excessive quantities of mixing water. Addition of water to compensate for stiffening of concrete before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required.

c. After the test results are known for the field condition test cubes, the Contractor shall submit these result to the Employer or Employer's representative and the Employer or Employer's representative will notify the Contractor of the approval of test results and the acceptable design mixes.

d. When placing concrete in hot weather, the recommendations of the American Concrete Institute's publication "Recommended Practice for Hot Weather Concreting"(ACI 605) or equivalent shall be followed insofar as the Employer or Employer's representative may direct.

The use of set accelerators will be at the Employer's or Employer's representative's discretion. For concrete placed during extremely hot weather, the aggregate shall be cooled by frequent water spraying in such a manner as to utilize the cooling effect of evaporation. Concrete with a temperature of 35 degree centigrade or higher before placement will be rejected and shall be wasted at the Contractor's expense.

e. Submerge concrete

Concrete to be placed under water shall be deposited by tremie, and only after it has been determined by the Employer or Employer's representative that placing of concrete in an unwatered excavation cannot be practically accomplished by any other means. The tremie will not be allowed to drop below the level of water outside. Under no circumstances will concrete be allowed to drop through water within the tremie.

The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The bottom of the tremie shall be as near to the surface against which the concrete is to be placed as practicable and the tremie shall not be raised until seal has been established by the concrete sufficiently to prevent the entry of water of the tremie. The discharge of the tremie shall be kept submerged in concrete at sufficient depth so as to maintain an adequate seal during underwater placement. Placing of concrete shall proceed without interruption until underwater placing in the foundation has been accomplished. As placing of concrete under water progresses, the Contractor shall remove water displaced by the concrete when the top of the concrete being placed by tremie reaches the elevation of the water table level; no further placement by tremie shall be performed.

f. The concrete used as lean concrete or base concrete shall be as mentioned on respective drawings. The aggregate size shall be 40 mm nominal. Base concrete shall be well compacted. The top surface of base concrete shall be leveled before placing the reinforcement.

g. During excavation, if excavation exceeds the required depth or if any loose pocket of earth is met below the base of footing, then the loose earth shall be removed or excavation depth be increased till normal hard soil is met as per satisfaction of the Employer. This extra depth shall be filled with lean concrete. No extra shall be paid on account of this extra excavation and lean concrete.

h. The cement concrete used for foundation shall be of grade M-20 (1:1.5:3) nominal Mix (1:1.5:3) conforming to IS 456 using 20mm size coarse aggregate shall be adopted.

i. The Water Cement ratio shall be minimum 0.50 and maximum 0.55.

j. For volumetric use of ingredients for concrete mix, the contractor along with the Mix

Design shall intimate the size of measuring boxes along with the Mix design.

k. The nominal of Mix Design shall not absolve the contractor from the responsibility of achieving the required strength, workability etc. during actual execution. In case of failure of concrete samples, the work done is liable to be rejected. In such case the contractor shall recast the foundation at the same location by dismantling the rejected foundation or at a near by location as directed by the Employer. In case of honey combing, the contractor shall do the pressure grouting as directed and to the full satisfaction of the Employer. The construction of new foundation in place of rejected one and pressure grouting if done shall be without any extra payment.

l. The water used for mixing concrete and for curing purpose shall be fresh, clean and free from oils, acids and alkalis, organic materials or other deleterious substance. Potable water is generally preferred. Saltish or brackish water shall not be used. Water used shall conform to clause 5.4 of IS 456.

5.11.7 Cement and Aggregates

In locations where conditions do not require high sulphate resistance, cement shall conform to the requirements of ASTM C150 Type T or equivalent(IS263, IS8112,IS12269)

a. In locations where, in the opinion of the Employer or Employer's representative, the conditions require the use of high sulphate resistance cement, cement conforming to the requirements of ASTM C150 Type V or equivalent shall be used. No extra payment will be made to the Contractor for the use of high sulphate resistance cement.

b. The aggregates shall consist of clean, natural material or, subject to the approval of the Employer or Employer's representative, manufactured aggregates may be used.

c. Aggregates shall be separated into sand and coarse aggregate before being used. The Employer or Employer's representative will permit no pit or crusher run materials without prior approval.

d. Natural fine aggregate or sand shall be graded within the following limits and the fineness module be between 2.5 and 2.8 as per IS 383:

Sieve size		**Amounts Finer than Each weight Percent**
Laboratory (U.S Std. Sieve)		
3/8	(9.5mm)	100
4	-4.75	95 to 100
8	(2.36mm)	80 to 100
16	(1.18mm)	50 to 85

30	(600 micron)	25 to 60
50	(300 micron)	10 to 30
100	(150 micron)	2 to 10

Natural coarse aggregate shall be graded within the following limits, depending upon the clear spacing between reinforcing bars.

U.S. Standard Sieve		Nominal 1-1/2"	Nominal 3/4" (19mm)
2''	(50.8mm)	100	
1-1/2''	(25-38mm)	95-100	
1''	(25mm)	70-95	100
3/4''	(19mm)	35-70	90-100
3/8''	(9.5mm)	10-30	20-55
No.4	(4.75mm)	0-5	0-10
No.8	(2.36mm)		

5.11.8 Slump

All concrete used shall have a slump of maximum 120mm and minimum 75mm at the time of placing. The water cement ratio shall be determined by consideration of the specified strength, the water reducing admixtures, the slump required for proper placement, air entraining requirements the available and maximum allowable aggregate size and its specific gravity, and the amount of water carried on the aggregates.

The slumps and maximum sizes of aggregate as well as, the computation of trail mixes shall be as described in the America concrete Institute Recommended Practice for Selected Proportions for concrete (ACI 613).

5.11.9 Storage of material

Cement and aggregates shall be stored at the Site of the work in such manner as to prevent deterioration or intrusion of foreign matter in Contractor's own cost. Special care shall be taken in storing cement to keep it thoroughly dry at all times.

a. Cement that has been caked in storage is still usable only if, when pressed between the thumb and fingers, it powders readily. Otherwise, its use will not be permitted.

b. When reinforcing steel is delivered to the job in advance of the Contractor's requirements, the Contractor shall provide suitable protection in order to prevent excessive rust developing on the reinforcing steel as it will be Contractor's responsibility to remove the excessive rust.

5.11.10 Concrete mixing and placing

Before any concrete mixing is begun, all equipment for mixing, transporting and debris shall be cleaned of all dirt and debris. All dirt and debris shall also be removed from the places to be occupied by the concrete.

a. All mechanical equipment shall be checked before starting a concrete pour to ascertain whether or not it is in good operating condition and if not shall be tuned-up, or repaired, or replaced to the satisfaction of the Employer or Employer's representative. Also the stock of construction material (cement, aggregate and sand) shall be checked before starting the concreting work to ascertain whether or not it is in sufficient quantity for one foundation work.

b. When a foundation location is ready for concrete placement, the Employer shall be notified at least 24 hours prior to concreting so that he may inspect to assure that the excavation is free of water, mud and debris; that the bottom surface of the excavation is well leveled and compacted; and where required, a crushed stone sub-base has been placed; that the reinforcing steel is properly secured in place; and that the formwork is properly braced.

c. Rock surfaces shall be as flat as possible and projecting ridges shall be leveled off before the concrete is placed or spaces between the ridges shall have been previously filled with concrete to form a horizontal surface.

d. The Contractor shall see that all material that is to be embedded in the concrete has been placed before the concrete is placed. The Contractor shall be responsible for the accurate location of all embedded materials. Any work inaccurately or improperly set shall be relocated and reset at the Contractor's expense.

e. All batching components of the concrete shall be accurately measured. Measuring on a weight basis is preferred, however, measuring on a volume basis will be allowed as long as careful controls are maintained. Weight measurements shall be made using standard batching equipment for large quantities and wheelbarrow scales for small quantities. Volume measurements shall be made in batching boxes. The batching boxes shall be as large as is practical.

f. The batch mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one and one-half (1-1/2) minutes after all materials are in the mixer, unless the size of the batch is over 1.2 cu.m., when additional mixing time shall be required as advised by

the Employer. A mechanically-operated batch mixer shall be used for mixing unless otherwise approved by the Employer.

g. The tempering of concrete which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

h. Concrete shall be conveyed from the mixer to the place of final deposit within 30 minutes by methods which will prevent the segregation or loss of the materials. After 30 minutes of mixing the concrete shall be rejected and replaced by fresh concrete without any extra cost to the Employer.

i. Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of the materials. The chutes shall never be on a slope that is steeper than two vertical to three horizontal. Conveying equipment shall not have any aluminum parts that come in contact with the concrete.

j. When the concrete is to be placed on hard rock or other concrete, after the existing surface has been properly cleaned and otherwise prepared, the existing surface is to be wetted until it is saturated. The first batch of concrete placed shall be a grout obtained by omitting the coarse aggregate from the mix and reducing the water as required. The grout shall be evenly spread on the water-saturated surface and then the concrete shall be deposited continuously and as rapidly as practicable.

k. The concreting shall be carried on at such a rate that the concrete is at all time plastic and flows readily into the spaces between the bars and so that each successive layer properly bonds with its predecessor. Successive layers shall be placed within 15 minutes of the preceding layer.

l. When placing foundations with drops over 2 meters, hoppers and trunks must be provided of a size to allow for proper placing.

Not less than four hoppers of any size shall be available and used, if requested, and a sufficient number of sections of trunk shall be furnished to reach within 500 mm of the bottom of the foundation.

m. The concrete shall be compacted during and after depositing by vibration. The concrete shall be thoroughly worked around embedded materials.

n. All concrete must be consolidated by means of internal vibration except where the Employer has given written permission to use some other method of consolidation. The type and make of vibrator must have a speed of at least 6,000 vibrations per minute (VPM) when the machine is being supplied at its rated voltage, air pressure, etc. The Contractor shall at his own expense, furnish sufficient transformers, compressors, etc. of approved type to operate all vibrators at the voltage, pressure, etc., specified by the manufacturer.

o. The Contractor shall always have at least two vibrators in operating condition at the location of the concrete placement.

The Contractor shall make one set of concrete compressive strength test cubes for each structure or as directed by the Employer or Employer's representative. There shall be three cubes to a set and the cubes shall be made in accordance with ASTM C31. Only one cube shall be made from any one batch containing

less the 1/2 cubic meters of concrete. The Contractor shall also make one set of concrete compressing strength test cube for each new batch of cement purchased two week before using that cement.

After the cubes have aged at least 24 hours in the field, the Contractor shall deliver them to a location designated by the Employer where they will be tested in accordance with ASTM C39/IS 516. If two of the cubes tested at 28-day tests indicate a compressive strength of 210kg/sq.cm (3,000 psi) or more, the remaining cubes shall be discarded. If the 28-day compressive strength indicates a compressive strength of less than 210kg/sq.cm., the Employer or Employer's representative will determine what remedial measures are necessary and the Contractor shall perform the remedial measures at his own expense. The remedial measures may include, but are not limited to, the replacement of the entire foundation.

5.11.11 Concrete formwork

Forms shall be used, wherever necessary, to confine the concrete for structures and shape it to the required lines, or to insure against contamination of the concrete by materials caving or sloughing from adjacent surfaces left by excavation.

a. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Molding strips shall be placed in the corners of forms so as to produce chamfered edges on permanently exposed concrete surfaces. All exposed surfaces may be formed with any material of adequate strength and tightness to hold the wet concrete in proper position and prevent the loss of mortar.

b. If plywood or steel forms are not readily available, the Contractor with Employer's special recommendation may substitute wood planking provided exposed surfaces are rubbed to remove ridges on exposed surfaces.

c. The Contractor shall provide templates, which firmly hold the stub angles within 10 mm of the horizontal side setting dimensions and within 5 mm of the required elevation during the placing of the concrete. Details of the templates shall be submitted to the Employer or Employer's representative at least one month before the commencement of any foundation construction. The bottom portion of the structure may be used for this purpose providing that adequate cribbing and bracing are supplied for support.

d. Before concrete is placed, the surfaces of all forms shall be oiled with a form oil that effectively prevents sticking and will not stain the concrete surfaces. For wood forms, form oil shall consist of straight, refined, pale paraffin mineral oil. For steel forms, form oil shall consist of refined mineral oil compound.

e. Forms shall be removed only when the strength of the concrete is such that form removal will not result in cracking, spelling, or breaking of edges of surfaces, or other damage to the concrete. Usually formwork shall be removed after 48 hours from concreting times. Any concrete damaged by form removal or otherwise shall be repaired immediately without any extra cost to the Employer.

5.11.12 Concrete finishing and curing

a. The exposed top surfaces of all concrete foundation piers shall be slightly sloped to prevent the accumulation of water.

b. Immediately after the removal of forms, the holes left by form tie rod fasteners shall be filled with mortar and all damaged or defective concrete shall be repaired or removed and replaced to the satisfaction of the Employer or Employer's representative. Improperly consolidated concrete shall be removed by chipping, and the chipped openings or recesses shall be of such depth and shape as required by the Employer or Employer's representative to insure that the patching material placed in the openings or recesses will be thoroughly keyed and bonded to the concrete. "Dry pack" mortar shall be used for filling relatively deep required for the replacement of defective concrete where surface dimensions of the chipped openings or recesses are relatively large. The depth of chipped recesses for concrete patches shall extend at least 25 mm beyond the nearest reinforcing steel.

c. To ensure proper curing, all concrete shall be kept moist for a period of at least 10 days. Burlap or an equivalent material or a curing compound shall be applied over exposed concrete surfaces. The burlap shall be kept moist at all times. If the foundation is backfilled before the one-week curing time has elapsed, the burlap protection shall remain on the exposed projection.

5.11.13 Membrane curing compound

Membrane curing compound shall be applied uniformly by spray, leaving no pinholes or gaps, at a rate not to exceed 4.91 square meter per liter. The curing compound shall be applied after finishing operations are completed and surface moisture has disappeared. If forms are removed prior to 7 days after placing the concrete, the uncovered surfaces shall be coated with the curing compound as specified herein.

a. Foundation shall not be backfilled before they have been inspected to see that they are free from surface defects and voids, or that the defects and voids have been properly repaired.

b. The foundations shall not be subjected to any loads in addition to those existing at the time of the placing of the foundation concrete until the curing period has elapsed.

5.11.14 Payment

No separate or direct payment will be made to the Contractor for concrete, lean concrete, tests, curing, form works for foundations. All costs incurred in connection therewith shall be included in price schedule in the unit bid price for the construction of the various types of tower foundation.

5.11.15 Torsteel Reinforcing Bar

All torsteel-reinforcing bars shall conform to the requirements of Grade fe-415 (IS :1786) and shall be fabricated in accordance with the "Manual of Standard Practice" of the Concrete Reinforcing Steel Institute.

a. Mill scale, rust, oil and mud shall be removed from reinforcing steel by firm rubbing with burlap or equivalent treatment before the reinforcing steel is placed.

b. The minimum center-to-center distance between parallel bars shall be two and one-half (2-1/2) times the diameter of the bars. In no case shall the clear spacing between bars be less than 25 mm nor less than one and one-third (1-1/3) times the maximum size of coarse aggregate.

c. All torsteel-reinforcing bars shall have a protective concrete cover of not less than:

- 50 mm - on the bottoms of footings and on any surface of concrete that will be exposed to salt water.

- 50 mm - concrete exposed to weather or ground.

d. Torsteel reinforcing bar shall be accurately located and shall be secured in position by the use of annealed iron wire of no less than No.16 gauge, and shall be supported in a manner that will keep the reinforcement away from the exposed concrete surfaces. Concrete blocks shall be used to support the reinforcing steel in the foundation mat; broken stones or wooden blocks shall not be used for supporting the reinforcing steel.

5.11.16 Payment

No separate or direct payment will be made to the Contractor for reinforcement bars of tower foundation. All costs incurred in connection therewith shall be included in the unit bid price for the construction of the various foundation types.

5.12 Foundation Protection Works

The Contractor shall suggest for foundation protection works where needed. The Employer will evaluate and give instruction for the protection design. The Contractor shall design the protection work and submit design of such protection works for Employer's or Engineer's approval.

5.12.1 Random rubble stone masonry including excavation (1:5 cement concrete)

The stone shall be hand placed with uncoursed close joints to the lines and grades as designed. The rubble stone shall be placed with 1:5 cement mortar after having joints thoroughly moistened. The surface joints shall be finished with 1:3 cement mortar.

After completion of masonry wall, it shall be cured with water for more than 10 hrs.

Weep-holes with Perforated Poly Vinyl Choride (PVC) pipes of 10 cm in diameter shall be made in each 2 sq.m. of slope surface of the masonry wall or as required by site conditions. The upper surface of the masonry wall shall be finish smooth with concrete. The perforated pipe shall be extended at least 30 cm both ends from the stone masonry wall & in the backfilling end the perforated PVC shall be covered with gravel at least 30 cm in all-around.

The sides of the stone masonry wall should be backfilled, compacted and leveled as directed by Engineer.

Payment:

Measurement for payment of Random rubble stone masonry works shall be made on the basis of actual placed volume of stone masonry in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labor, tools and equipment, materials including furnishing, transporting and placing the materials, installation of PVC pipes, excavation, gravel packing and all other cost necessary for the performance and completion of the work

5.12.2 Stone bound in galvanizing wire netting including excavation

The standard type gabion shall be a flexible hot dip galvanized gabion of the type and size specified below. It is made of wire mesh of the type and size and selvedge as specified in the following:

- The mesh shall be hexagonal woven mesh with the joints formed by twisting each pair of wires through three and half turns.
- The size of mesh shall conform to the standard specification issued by the factory and shall be not greater than 1/3 of the smallest stone filled in the gabion.
- All wire used in the fabrication of the gabions and in the wiring operations during construction shall be "Mild steel wire", i.e. wire having average tensile strength of 44 kg/sq.mm.
- The diameter of the wire used in the fabrication of the netting shall be at least 3.0 mm depending on the design requirement.
- All wires used in the fabrication of the gabions and in the wiring operations during construction shall be hot dip galvanized.

All edges of the standard gabions including end panels and the diaphragms, if any, shall be mechanically selvedge in such a way as to prevent unraveling of the mesh and to develop the full strength of the mesh. The wire used for the selvedge shall have a diameter greater than that of the wire used to form the mesh. Wire having a diameter of 3.0 mm and the selvedge wire shall have diameter equal to or greater than 3.9 mm.

The stone for the gabion shall be taken from the quarry or river deposit material or as approved by the Employer or Employer's representative. The rock shall be of compact, firmly-bound and uniformly grain texture and absolutely weather-resistance, shall not have cracks, holes, laminations or detrimental materials. The stone blocks shall be of natural irregular cubical shape. The thin sliced blocks shall not be accepted. The size of stone shall be at least 10 cm.

The sides of the gabion wall should be backfilled, compacted and leveled as directed by Engineer.

The standard gabion shall have following dimension:

Length : 2.0 meter

Width : 1.0 meter

Height : 1.0 meter

Sufficient lacing and connecting wire shall be supplied with the gabions for all the wiring operations to be carried out in the construction of the gabion work. The quantity of such wire is estimated to be 8% of the gabion supplied. The 2.4 mm lacing wire shall be used for the gabion made of wire gauge 3.0 mm.

Payment:

Measurement for payment of gabion works shall be made on the basis of actual placed volume of gabions in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labour, equipment, materials, backfilling with compaction and all other cost necessary for the performance and completion of the works.

5.12.3 M15 Concrete Nominal Mix 1:2:4 for top seal cover: P.C.C.

Top of the gabion wall and stone masonry wall shall be sealed with M15 concrete cover. The thickness of the cover shall be minimum 75mm or as directed by Employer's representative.

Payment:

Measurement for payment of "M15 Concrete Nominal Mix 1:2:4 for top seal cover" works shall be made on the basis of actual placed volume of Concrete in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labour, equipment, materials and all other cost necessary for the performance and completion of the works.

5.12.4 Slope Cutting and revetment works:

This section covers the cutting of slopes where sufficient electrical ground clearance of the line is not available. After slope cutting, revetment wall shall be constructed as directed by Engineer. Back filling of the revetment wall shall be done with leveling.

Payment:

Measurement for payment of "Slope cutting and revetment Works" works shall be made on the basis of actual cut volume of slopes in cubic meters. Payment shall be made for the number of cubic meters measured as provided at the unit price specified in the schedule. The unit price shall include all labour, equipment, materials, revetment walls and all other cost necessary for the performance and completion of the works.

Chapter 6: LINE CONDUCTOR

6.1 General

The scope of work comprises of supply and stringing of ACSR "Cardinal" conductor for 132 kV transmission line from Kirtipur to Udipur.

6.2 Conductor Specification

All conductors shall be of aluminium conductor steel reinforced (ACSR) construction and shall be manufactured in strict conformity with BS 215 Part 2. Bidders must offer conductor from reputable and experienced manufacturers with not less than five years manufacturing experience and the manufacturers shall possess manufacturing and testing facilities for producing the offered conductor at the time of bidding.

The steel core and the first layer of aluminium of ACSR conductors shall be greased. The grease shall be of neutral type and at a temperature of 100-degree centigrade. 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 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 aluminium 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. Aluminium wires shall be made to BS 2627 and steel wires to BS 4565.

Precautions shall be taken during the manufacture, storage and erection of steel-cored aluminium conductors to prevent the possibility of contamination by copper or other materials, which may adversely affect the aluminium. The manufacture of steel-cored aluminium conductors shall be carried out in a portion of the factory specially set aside for such purposes. Machinery previously used in the manufacture of copper or copper bearing conductors shall not be used for the manufacture of these aluminium or steel wires.

6.2.1 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 with 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 Employer and be returned by the Contractor to the Employer's stores nominated by the Employer. The maximum length of conductor shall not exceed 2 km per drum.

6.2.2 Creep of ACSR-conductors

When stringing ACSR-conductors the creep shall be adopted into account. A suitable method is for stringing the conductor to a higher tension. This is expressed as a temperature difference corresponding to the estimated creep.

Unless more reliable data is available, the temperature difference for Cardinal-conductor as may be used.

6.2.3 Details of ACSR Conductors

The ACSR Conductor shall generally conform to BS: 215(Part-2) /IS: 398 (Part-II) except where otherwise specified herein.

The details of the ACSR CARDINAL Conductor are tabulated below:

1.0	Designation as per BS-215(Part-2)	
2.0	Stranding and wire diameter	54/3.38 mm Aluminium +7/3.38 mm steel
3.0	**Number of Strands**	
3.1	Steel core	1
3.2	1st steel layer	6
3.3	1st Aluminium layer	12
3.4	2nd Aluminium layer	18
3.5	3rd Aluminium layer	24
4.0	Sectional area of Aluminium	484.5 sq. mm
5.0	Total sectional area	547.3 sq. mm
6.0	Overall diameter	30.42 mm
7.0	Approximate mass	1833 (Kg/ KM)
8.0	Calculated D.C. resistance at 20 ® C	0.05979 Ohm/KM
9.0	Minimum UTS	15,381 kg
10.0	Modulus of Elasticity	7,036 kg/Sq mm
11.0	Co-efficient of Linear Expansion	19.3 x 10-6 per ^{0}C
12.0	Standard Un jointed length on reel	2,000 m

6.2.4 Joints in Wires:

a) Aluminum Wires

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints in the 12 wire inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of

aluminium wires. Such joints shall not be more than four (4) per conductor lengths. This joist shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.

b) Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand nor strand joint or strand splices in any length of the complete stranded steel core of the conductor.

6.2.5 Materials

The Aluminium strands shall be hard drawn from electrolytic aluminum rods having a purity of not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC:889-1987.

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or basic open hearth process, the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition:

Element	% composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorus	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

The steel wire stands shall have the same properties and characteristics as proscribed for regular strength steel wire in IEC:888-1987..

The zinc used for galvanizing shall be electrolytic high grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS:209.

6.2.6 Packing

The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Supplier shall be responsible for any loss or damage during transportation handling and storage due to improper packing. The drums shall generally conform to IS: 1778, except as otherwise specified hereinafter.

The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

The general outline of the drum for conductor shall be as in the annexed drawings. The Bidder should submit their proposed drum drawings along with the bid.

For conductor, one standard length shall be wound on each drum.

All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not vary by more than 3mm from that indicated in the figure. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75mm. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.

Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.

A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.

Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.

Outside the protective lagging, there shall be minimum of two binder consisting of hoop iron/galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote in the package.

6.2.7 Marking

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

- Contract/Award letter number.
- Name and address of consignee.
- Manufacturer's name and address.
- Drum number
- Size of conductor
- Length of conductor in meters
- Arrow marking for unwinding
- Position of the conductor ends
- Distance between outer-most Layer of conductor and the inner surface of lagging.
- Barrel diameter at three locations & an arrow marking at the location of the measurement.
- Number of turns in the outer most layer.
- Gross weight of drum after putting lagging.
- Tear weight of the drum without lagging.
- Net weight of the conductor in the drum.
- Material Inspection & Clearance certificate No.
- The above should be indicated in the packing list also.

6.2.8 Verification of Conductor Length

The Employer (NEA) reserves the right to verify the length of conductor in any conductor drum to be supplied by contractor.

6.3 Tests

The following acceptance and routine tests and tests during manufacture shall be carried out on the conductor . For the purpose of this clause, the following shall apply.

Acceptance tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-despatch inspection, for the purpose of acceptance of that lot.

Routine tests shall mean those tests, which are to be carried out on each strand/ spool/length of the conductor to check requirements which are likely to vary during production.

Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the manufacture to ensure the desired quality of the end product to be supplied by him.

For all acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the guaranteed technical particulars of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

6.3.1 Design (Type) Tests

Only type tested conductor the equipment should be offered. Type test reports as specified in section-2 of this specified shall be submitted by the Bidder to alongwith the bid. The type test report includes:

a) Surface condition test
b) Test for ultimate breaking load on stranded conductor
c) Stress-strain test
d) Measurement of diameter of individual aluminium and steel wires.
e) Measurement of lay ratio.
f) Breaking load of individual wires.
g) Ductility test
h) Wrapping test
i) Resistance test and
j) Galvanizing test

6 . 3 . 2 Acceptance Tests

a) Visual and dimensional check on drum
b) Visual check for joints scratches etc.and lengths of conductor by rewinding
c) Dimensional check on steel and Aluminium strands
d) Galvanising test on steel strands
e) Torsion and elongation test On steel strands
f) Check for lay-ratios of various layers
g) Breaking load test on steel and aluminum strands
h) Wrap test on steel and aluminum strands
i) DC resistance test on aluminium strands
j) UTS Test on welded joint of strands

Note: All the tests except (j) shall be carried out on Aluminium and steel strands after stranding only.

6.3.3 Routine tests

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc. on the strands.

c) Check that drums are as per specification.

d) All acceptance test as mentioned above to be carried out on each coil.

6.3.4 Tests during manufacture

a) Chemical analysis of zinc used for galvanizing

b) Chemical analysis of aluminum used for making aluminum strands

6.3.5 Testing Expenses

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price except for the expenses of the inspector/ NEA representative.

6.3.6 Test Reports

Record of routine test reports and acceptance tests shall be submitted to the Employer for approval.

Test certificates of tests during manufacture shall be maintained by the manufacturer. These shall be produced for verification as and when desired by the NEA.

6.3.7 Inspection

The representative of the Employer shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the manufacturer works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

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 later case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

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

6.4 Standards

The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

In the event of the supply of conductor 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 Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS: 3436-1986
2.	IS: 398-1982	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC: 1089-1991 BS: 215-1970
3.	IS: 398-1990 Part-II and IS:398-1994 Part-4	Aluminum Conductor Galvanized Steel Reinforced and All Aluminium Alloy Conductors	BS: 215-1970 IEC: 1089-1991
4.	IS: 1778-1980	Reels and Drums for Bare Conductors	BS: 1559-1949
5.	IS: 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
6.	IS: 2629-1990	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
7.	IS: 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.	IS: 4826-1992	Galvanized Coating on Round Steel Wires	IEC: 888-1987 BS: 443-1969
9.	IS: 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS: 433-1969 ISO 1460 - 1973
10.	IS: 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC: 437-1973 NEMA: 107-1964 CISPR
11.		Zinc Coated steel wires for stranded Conductors	IEC: 888-1987
12.		Hard drawn Aluminium wire for overhead line conductors	IEC: 889-1987

Chapter 7: INSULATOR AND ACCESSORIES

7.1 Composite Long Rod Insulator

The Insulator strings consist of Composite long rod insulators (HT-Silicon Rubber) for a three phase, 50 Hz, effectively earthed 132 kV transmission systems in a lightly polluted atmosphere. Coupling shall be ball and socket type.

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:

Table 7.1: 132kV Transmission Line at an altitude ≤ 1,000m

Sl. No.	Type of string	Creepage Factor (C.F.)*	No. of individual units per string (Nos)	Electro-mechnical strength of insulator disc (kN)	Mechanical strength of insulator string along with hardware fittings (kN)
1	Single "I" suspension	3.5	1	70	90
2	Single 'I' Tension		1	70	160
3	Double "I" suspension		2	70	2 x 90
4	Double "I" Tension		2	120	2 x 160

"*"C. F. = Creepage Factor for pollution level II, as described in Appendix – D of IEC 60815. Creepage distance (mm) = C.F X Arcing Distance of insulator.

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.

7.2 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 of replacement of either insulator units or fittings under the live line conditions.

7.3 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-Ill)/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).

7.4 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.

7.5 Dimensional Tolerance of Composite Insulators

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

± (0.04d+1.5) mm when d≤300 mm.

± (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.

7.6 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.

7.7 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.

7.8 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.

7.9 Materials

7.9.1 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.

7.9.2 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.

7.9.3 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 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.

7.9.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce radio and TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The bidder shall furnish calculations along with the proposed placement and design of corona ring in support of the above. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The supply of grading rings shall be in the scope of the composite insulator supplier.

7.10 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.

7.11 Equipment Marking

Each Composite Long Rod Insulator shall be legibly and indelibly marked with the trade mark of the manufacturer, name of Employer and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word 'kN' to facilitate easy identification and to ensure proper use.

For porcelain insulator, the marking shall be on porcelain. The marking shall be printed, not impressed and shall be applied before firing. For toughened glass insulators the marking shall be on the metal parts.

One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap end fitting of each composite long rod insulator of particular strength for easy identification of the type of insulator. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark:

For 90 kN Long rod : Orange

For 120 kN Long rod : Yellow

For 160 kN Long rod : Green

7.12 Bid Drawings

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

The Bidder shall furnish along with the bid the outline drawing (6 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.

7.13 Tests

7.13.1 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

(a)	Tests on interfaces and connections of metal fittings (Tests to be performed on the same samples in the sequence given below) 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	IEC: 61109
(b)	Assembled core load time test 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	IEC: 61109
(c)	Brittle fracture resistance test	Annexure-A
(d)	Test of housing, Tracking and erosion test	IEC: 61109
(e)	Tests for the core material i. Dye penetration test ii. Water diffusion test	IEC:61109
(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

7.13.2 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.

7.13.3 Routine Tests

For Composite Long Rod Insulator Units

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

7.13.4 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

7.13.5 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.

7.13.6 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.

7.13.7 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.

7.13.8 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.

7.13.9 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.

7.13.10 Guarantee

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

7.13.11 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.

7.13.12 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.

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.

7.14 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 palleted.

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.

7.15 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.

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 Publi- cation No.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
15.		Guide for the selection of insulators in respect of polluted conditions	IEC:60815

ANNEXURE 7-A tests on complete strings with hardware fittings

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC: 383.

1.2 Test (Dry)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry condition. The test procedure shall be in accordance with IS: 8263/IEC: 437.

1.3 Mechanical Strength Test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 metres. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and two sub-conductors (each tensioned at 43 kN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than 1000/f1.8 where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to Mechanical performance test followed by mechanical strength test as per relevant standards.

1.5 Salt-fog pollution withstand test

This test shall be carried out in accordance with IEC : 60507. The salinity level for composite long rod insulators shall be 160 Kg/m3 NACL.

2.0 Composite Long rod Insulator Units

2.1 Brittle Fracture Resistance Test

Assembled core load time test with container that contains1n-HNO3 concentric acid that is applied at the naked rod. The rod should be held at 80% of SML for the duration of the test.
The rod should not fail within the 96 hour test duration

2.2 Recovery of Hydrophobicity Test

(1) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.

(2) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.

(3) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

(4) Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

2.3 Silicone content test

Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Employer & Supplier in Quality Assurance Programme.

2.4 High Pressure washing test

The test is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, followed by a dry power frequency voltage test as per IEC 61109.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Employer in Quality Assurance Programme.

3.4 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.

ANNEXURE 7-B BASIC INSULATION LEVELS OF INSULATORS

SYSTEM PARTICULARS

Transmission Line at an altitude upto 1000m		
A	System Voltage	132 kV
B	Maximum Voltage	145 kV
C	Rated Lightning Impulse withstand (dry)	650 kVp(max)
D	Rated Power frequency withstand voltage (wet)	275kV rms

Chapter 8: OPTICAL GROUND WIRE (OPGW) AND OPTICAL TERMINAL EQUIPMENT

8.1 General

The scope of work comprise of supply, installation, testing and commissioning of Optical Fiber Ground Wire (OPGW), including necessary accessories for fiber termination and splicing, for 11.5 km long Kirtipur – Udipur 132 kV Transmission Line.

Bidders shall offer the OPGW and their accessories from reputed manufacturer. The contractor shall ensure complete supervision by competent technical personnel(s) of the OPGW manufacturer during installation, testing and commissioning of the whole OPGW system in totality under the project. The supervision shall also include the on-site training to the Employer's Representative(s).

8.2 Technical Requirements

The optical fiber ground wire (OPGW) shall have supporting cross section of 68 mm2. The ground wire of the 132 kV line shall be a steel wire (or Aluminium clad steel wire) with an OPGW Composite Fiber Optic communication cable in the center. The Optical Fiber Cable, containing 24 single-mode optical fibers shall be embedded loosely inside the protective tube. The protective tube shall be of aluminum alloy or stainless steel. Both fiber optic and stranding part of OPGW shall comply with this Specification, and with the following standards:

Single mode fibers	**ITU-T (former CCITT) G. 652**
Optical fiber cables	IEC 60793-1 & 2
	IEC 1089/91, IEC 60889/87
Stranding part	IEC 60104/87; BS 3242

The earth wire shall be suitable for the climatic conditions with no attenuation changes or negative effects on the cable, and compatible with the stringing condition of the phase conductor. Under no condition shall the OPGW sag exceed the conductor sag.

The optical fiber shall be made of germanium doped silica glass or pure silica glass. It shall have a primary coating made of silicone or similar material with physical and mechanical properties at least those of silicone (acrylic or similar).

The tube shall be made of suitable material sufficiently strong to hold its shape and provide protection for the optical fibers against deformation and friction. The strength member of the fiber optic cable shall provide protection against buckling, kinking and strain. The material to be used shall be fiber reinforced plastic.

The direction of lay of the outer layer of strands shall be right hand. Lay ratio of any layer shall be not greater than the lay ratio of the layer immediately beneath it. The make up of ground wire shall be such

that the strand shall remain and shall not twist when the conductor is cut. The earth wire shall be manufactured so that no twisting occurs when subjected to axial loads, i.e. when unrolling and stringing.

All wires used in the manufacture of the earth wire shall be free from protrusion, sharp edges, abrasion and any other imperfections.

No jointing of the aluminium clad steel wires shall be permitted.

There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable.

The creep characteristic of the finished earth wire shall be of virtually unvarying uniformity.

Optical fibers

All fiber installed as a part of this Contract shall have a minimum life of 30 years from the date of final acceptance.

The OPGW shall include minimum 24 fibers. The main optical characteristics of the OPGW are shown in the Appendix (Schedule 8A).

The other characteristics of the OPGW shall be as follows:

Outer diameter	:	11.4 mm
Cable weight	:	approximately 487 Kg/km
Calculated breaking load	:	86.6 kN
Modulus of elasticity	:	162 kN/mm2
Coefficient of thermal expansion	:	3.0x10-6 per degree K
Nominal short time current capacity at Initial/final temperature 20/200 0C	:	5.5 kA (min)
DC resistance at 20 ^{0}C	:	Not more than 1.247 ohm /km

Attenuation

The attenuation coefficient for wavelengths between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than + 0.05 dB/km.

The attenuation coefficient for wavelengths between 1535 and 1565 shall not exceed the attenuation coefficient at 1550 mm by more than + 0.05 dB/km. The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1 dB.

The cable shall consist of single mode dual-window color coded optical fibers. There shall be no factory splices within the cable structure.

8.3 Optical Fiber Identification

Color-coding is essential for identifying individual optical fibers and groups of optical fibers. Individual optical fibers within a fiber unit and fiber units will be identifiable using a color-coding scheme. The color-coding system shall be discernible throughout the design life of the cable.

Each cable shall be traceable of each fiber back to the original fiber manufacture's fiber number and parameters of the fiber.

If more than the specified numbers of fibers are included in any cable, the cable manufacturer shall test the spare fibers and any defective fibers shall be suitably bundled, tagged and identified at the factory by the fiber manufacturer.

Fiber	Fiber No. & Color					
Blue tube	1	2	3	4	5	6
	Blue	Orange	Green	Brown	Gray	White
Orange tube	7	8	9	10	11	12
	Blue	Orange	Green	Brown	Gray	White
Green tube	13	14	15	16	17	18
	Blue	Orange	Green	Brown	Gray	White
Brown tube	19	20	21	22	23	24
	Blue	Orange	Green	Brown	Gray	White

8.4 Buffer Tube

Loose tube buffer construction shall be applied. A buffer for protection from physical damage shall surround the individually coated optical fiber(s) during fabrication, installation and performance of the cable. The fiber coating and buffer shall be strippable for splicing and termination. The inside diameter of the buffer tube shall be of appropriate size to allow free movement of the fibers during cable Contraction or elongation resulting from thermal, tensile or vibration loads.

Buffer tubes shall be sleeved over multiple fibers forming a fiber unit. A fiber unit may consist of up to 6 fibers, individually identifiable utilizing the color code in conformance with EIA 359 A.

8.5 Optical Fiber Termination and Splicing

Suitable splice boxes (enclosures) shall be provided to encase the optical cable ends and fusion splices in protective, moisture and dust free environment. The splice boxes shall be designed for the storage and protections of a minimum of 12 fibers cables and provide access through locked doors.

Fiber-optic cable of adequate length shall be provided so that all splicing can be performed at ground level at the towers. All splicing and necessary material shall be included in the price schedule presented by the Contractor.

8.6 Outdoor Splice Boxes

Splice boxes provided by the Contractor for outdoor use shall be suitable for use with the cable type provided as part of this Contract. The splice boxes shall be appropriate for mounting on steel structures and accommodate pass-through splicing and fiber terminations.

The splice box, including organizer/ splice trays, shall be designed to seal and protect the fiber cable splices from the environment defined in this specification and it shall provide easy access for any maintenance function.

All splice boxes shall be of metal construction that are clean and smooth finished, treated to resist rust, accommodate the storage of a minimum of 3 meters of coiled fiber and allow easy access to the splice trays. In addition there shall be a steel frame to coil up about 10 meters of OPGW outside the protection box.

8.7 Test

The testing must be done by recognized equipment and it shall be possible to produce a computerized print out from the computer and the software, all of which (lap top computer, printer and software) must be included in the testing, commissioning or installation unit prices.
There are different test series to assure the quality of OPGW:

- Routine test (in–process testing according to internal quality plan)
- Factory acceptance test (FAT, witnessed by customer)
- Type test (only in case of a basic new design, repetition in exceptional cases)

OPGW tests shall be in accordance with applicable standards or agreements between Employer and Contractor / manufacturer.

As a general rule the tests will be performed according IEC 60794-4-10.However, if necessary tests can be done according to IEEE Std1138.

8.8 Maintenance

To maintain the cable the Contractor shall propose suitable equipment and necessary training for the Employer personnel to execute the work.

8.9 Joints

Number of Joints shall be kept to a minimum. Approved equipment and methods must be used to test the cable from both ends.

8.10 Particular Requirement for OPGW Earth Wire fittings and accessories

The associated fittings and other accessories have to satisfy the specific function of OPGW and fiber optics requirements for a total integrity of their components. The best way to achieve these goals shall be in application of suitable performed products. A brief description of the accessories is as follows:

a. Suspension Assembly: Suspension assembly shall consist of:

- armor grip suspension clamp (aluminum alloy hyper formed armor rods and suspension clamp);
- associated hardware for earth wire suspension:
- Flexible grounding loop connection.

b. Tension Assembly: The tension assembly shall consists of:

- Hyper formed alum weld dead end grip;
- associated hardware for earth wire attachment (shackle, link, clevis, clamps);
- Flexible grounding loop connection.

c. Vibration Dampers

Dampers where necessary, shall be of Stockbridge type installed complete with the armor rods of the size suitable to the earth wire size.

d. Fiber Optic Splice Closure-Joint Box

The fiber optic splice closure allows clamping of the cables to be spliced. It shall have following characteristics:

- The splice capacity for minimum 12 single-mode fibers from metal free optical cable with loose tube construction;
- waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
- box and cable glands tightened by sealing compound.

Installation height shall be 1.5 m above the anti-climbing devices of the towers.

e. Fiber Optic Hood Closure-Terminal Box

The fiber optic splice closure allows termination of OPGW on the substation gantry and interface with the underground fiber optic cable leading into the control building. It shall have the following characteristics:

- the cable glands for accepting of one metal free optical cables with minimum 12 single-mode fibers and loose tube construction;
- waterproof housing of the closure aluminum or stainless steel construction with protection class IP 65 of IEC 60529;
- box and cable glands tightened by sealing compound.

It shall be installed on the terminal gantry 1.5 m above ground level.

8.11 Payment for OPGW and accessories

Payment for the supply and installation for the contract item "Optical fiber ground Wire (OPGW) and accessories" will be made at the unit bid price. Therefore, in the Price Schedule, the unit bid price shall include full compensation for all the costs incurred in furnishing all materials, equipment, labors and all other operations related to OPGW conductor and accessories fabrication, delivery etc.

8.12 OPGW Tests

The following tests shall be conducted once on sample/samples of OPGW for every 50 km of production from the manufacturing facility:

- Structure and dimension test
- Transmission characteristics test
- Characteristics test of ACS
- UTS test

8.13 Indoor Splice box / Optical Distribution Frame Construction and Design

The indoor splicing box/ optical distribution frame shall be of the wall mounted type and accommodates pass-through the splicing and interconnection for the equipment.

APPENDIX - 8A: TECHNICAL PARTICULARS OF OPTICAL GROUND WIRE (OPGW)

a. STANDARD

Aluminum alloy wires	IEC 104 type A
Aluminum clad steel wire	IEC 1232
Cable construction	IEC 1089 (where applicable)
Optical Unit	ITU-T (former CCIT) G 652

b. PROPERTIES OF THE OPTICAL FIBRES

Single mode fibers

Dimensions and geometry of fibre	according to ITU-T G.652
Fibre attenuation at 1310 nm at 20^0C max.	0.4 dB/km
Fiber attenuation at 1550 nm at 20^0 C max.	0.25 dB/km
Attenuation deviation at 1310 nm and 1550 nm	0.1 dB/km within -45^0C to 80^0C
Other properties of fiber	according to ITU-T G.652

Chapter 9: ERECTION, STRINGING AND MISCELLANEOUS WORKS

9.1 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 or Employer's representative 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 only not be allowed without the written approval of the Employer or Employer's representative.

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 within one week from the time the support is erected. The bolt tightening shall be as follows:

Size of Bolt	Tightening Torque (kg.cm.)
16	1000-1200
20	1400-1800

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 Contractor shall notify the Employer two weeks before the supports are ready for inspection. The inspection and correction of defects if any shall be complete before the start of the stringing operation.

Damaged galvanizing shall be repaired on site by galvanizing paint and as specified in accordance with Article 1.7 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 the wrench set. The punched area shall immediately be coated with zinc paint.

9.1.1 Payment

Payment for the contract item Steel tower erection will be made at the unit price bid "Erection of tower with its body and leg extensions". Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, tools, labours etc. for erection work related to this item.

9.2 Conductors Stringing

At least 3 months before conductor stringing commences, 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.

Full use shall be made of maximum conductor lengths in order to reduce the number of mid span joints to a minimum.

There shall not be more than one joint per conductor in any one span, and tension joints shall not be less than 15 meters from any conductor clamp. No tension joints shall be used:

- In section of less than 3 spans between tensions supports.
- In spans over navigable rivers, buildings, power lines, telecommunication lines, public roads and in any span subject to special way leave conditions or in any adjacent span.

Conductor repair sleeves shall not be used without the permission of the Employer or Employer's representative.

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 OPGW shall be erected with such sags that everyday temperature in still air and 20 degree C temperature with maximum wind pressure, the final tensions shall provide factors of safety on the ultimate tensile strength of the conductor. The Contractor shall submit erection and final sag and tension charts for each type of conductor. These charts shall plot inter-related curves of tensions against equivalent span lengths, and actual span lengths against sags, at temperatures of 0^0 C, 20^0C, 32^0C, 40^0C, 60^0C and 80^0C in still air conditions, and shall 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.

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 or Employer's representative.

At the end of the guarantee period the specified ground clearance plus the conductor cree-page allowance shall not be infringed, in addition, the sag of any phase conductors in the same span.

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 recalibrate 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 oxidization.

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.

The Contractor shall identify the spans where aeronautical signs on the earth wire may need. However instruction from the Employer to put such signs at any span shall be fulfilled without any additional cost to the Employer.

Payment

Payment for the contract item conductor stringing will be made at the unit price bid "Stringing of Conductor". Therefore in the schedule the unit bid price shall include full compensation for all cost incurred in furnishing all materials, equipment and labor for installation of insulators strings, jumpers, hardware, stringing and any other related works to this item. No additional payment will be made for any restringing and rearrangement of the existing circuit necessitated by the interconnection of the existing line with the Tee-off tower for the new line. Measurement for the payment shall be based on the conductor km calculated by addition of the horizontal distance between towers.

Shutdown

For the stinging work of the lines, the Contractor shall request the Employer for the shutdown of existing transmission and/or distribution lines, where necessary, at least 15 days in advance. The request letter or form shall include the place of work and duration of shutdown needed. The period of shutdown shall be as minimum as possible. The Employer has right to decrease the justified period of shutdown, if requested period of shutdown by Contractor is excessive and to shift the date of shutdown.

The Contractor shall complete the work, during the shutdown within the stipulated time period. If the Contractor fails to complete the work within the stipulated time limit, the Employer will claim the amount of money arising from the loss of energy not transmitted or distributed.

Chapter 10: INSPECTION, TESTING AND COMMISSIONING

10.1 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.

10.2 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.

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

10.2.1 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.

10.2.2 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.

10.3 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.

10.4 Test at Manufacturers Works

10.4.1 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.

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.

10.4.2 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.

10.4.3 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.

10.5 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.

10.5.1 Tests on Tower

Test on each type of towers to be supplied, shall be made at the manufacturer's plant. The number of tower test, if required, is given in price schedule.

The Contractor shall give Employer not, less than 30 days advanced notice, in writing or by fax, of the date when towers will be ready for tests. Employer reserves the right to waive the requirement for performing any or all tests. Should Employer exercise this right, the applicable unit prices for performing the test will be deducted from the total contract sum. The Contractor will not be entitled to any additional compensation by reason of such waiving.

Each test shall be performed in accordance with the following requirements:

a. Tower: The tower shall be fabricated from approved detail drawings in a manner as close to final production procedures as is practicable. The tower shall be complete in every detail.
b. Erection: The tower shall be erected on rigid foundation using the specified tower and bolts and nuts shall be tightened to the specified torque. The vertical axis through the center of gravity of the erected tower shall not be out of gravity of the erected foundation and shall not be out of plumb by more than 1 cm for every 500 cm height.
c. Rigging: The Contractor shall submit for approval as to compliance with the specifications, diagrams showing the proposed methods of applying loads and measuring deflection.
d. Loading: All test loads corresponding to conductor and overhead ground wire loading shall be applied directly to the regular attachment. Details shall be provided for these loads. Test wind loads equivalent to wind loads on the tower shall be applied where convenient and in such a manner that the summations of applied load and overturning moment are as close as possible to the actual behaviour as designed. Extra compressible member is not allowed for use of applying wind loads on tower. To ensure application of full-test loads to the tower, friction losses in rigging shall be added to the rigging loads.
e. Load Programs: The contractor shall program the tests to most favourably demonstrate that the towers will carry all design loads and conditions specified in the loading diagrams. Test wind loads on tower shall be the same as applied in design calculation.
f. Deflection Measurements: Deflections shall be recorded for the "before-load", "load-on" and "load-off" condition to provide longitudinal and transverse deflections at the tower top canter, at the elevation of the middle cross arm (s) and at least one intermediate point of tower body.
g. Design Load Tests: The initially applied loads and the increment of loading shall be 25 percent of the loads given in the loading diagrams. Each load increment shall be maintained for not less than two minutes for each assumption except under maximum (full) design loads the period of five minutes shall be maintained and during which time there shall be no slacking off or adjustment of the loads. Should it become necessary to adjust the loading, the two or five minutes period shall start after the loading is stabilized and constant. All test loads shall be removed completely before the loads for testing under different assumptions are applied.
h. Destruction Tests: After the successful completion of the load tests, the tower shall be further tested to destruction by increasing the transverse loads under any condition specified by Employer in increments not to exceed five per cent of full design transverse loads. The vertical and/or longitudinal load (s) is kept constant at their full design values while deflections are being recorded.
i. Modification of Tower Components: Any conspicuous yielding or any failure of any part of the tower under any of the tests specified in sub-article shall be considered a defect. If a defect develops, the Contractor shall modify his design of the tower and send to Employer for approval. The modified tower shall then be retested at the Contractor's expense (including the cost of witness, if any) until satisfactory results are obtained.

j. Material Tests: Steel materials used for tested towers shall be subject to tension or bend test in accordance with ASTM A370. Tests shall be performed by the Contractor at no additional cost to Employer. The test specimens shall be selected as follows:

- Two sets selected from the destructed members of each tested tower.
- Two sets selected from the undisturbed members of each tested tower.

k. Reports: The Contractor shall furnish four certified copies of full reports of all tower and material tests, the calibration of the dynamometers or gauges, including clear photographs of the test set-ups and nature of all failures, diagrams showing deflection of towers at each interval of loading, details diagrams deflection records.

10.5.2 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.

10.5.3 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.

10.5.4 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.

10.5.5 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.

10.5.6 Radio interference tests

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

10.6 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.

10.7 Conductors

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

10.8 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:

10.8.1 Operational tests

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

10.8.2 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.

10.8.3 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.

10.9 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.

-	Tower Type DA with extension +9m	2 persons, 1 visit
-	Tower Type DB with extension +9m	2 persons, 1 visit
-	Tower Type DC with extension +9m	2 persons, 1 visit
-	Tower Type DD with extension +25m	2 persons, 1 visit
-	OPGW	2 persons, 1 visit
-	Conductor	2 persons, 1 visit
-	OPGW	2 persons, 1 visit
-	Insulators	2 persons, 1 visit

- Hardware / fittings 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.

10.10 Site Tests

10.10.1 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.

10.10.2 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.

10.10.3 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.

10.10.4 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.

10.10.5 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.

10.10.6 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.

10.10.7 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.

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.

10.10.8 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.

10.11 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:

10.11.1 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, suspectance 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.

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.

10.11.2 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 132 kV overhead lines and shall be as follows:

Line Voltage	D.C Test Voltage to Earth
132 kV	187 kV

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.

10.12 Field test quality plan

A field test quality plan is given in the appendix-10.1. The Contractor shall provide necessary information to the Employer / site engineer so that the tests are conducted and results recorded well.

APPENDIX - 10.1: FIELD QUALITY PLAN FOR TRANSMISSION LINES

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
1.	Detailed Survey	a. Route alignment	Optimization of route length	a. Preliminary survey. b. Topographical map c. Tower Spotting Data	Contractor	100% at Field	100% based on record documents	To be notified by the Employer
		b. Route profiling & tower spotting.	1. Ground clearance. 2. Cold wt. Span 3. Hot wt. Span 4. Sum of Adj. Span (wind span) 5. Angle of Devn.	a. Sag template b. Tower Spotting data c. Route alignment	Contractor -do- -do- -do- -do-	100% at Field -do- -do- -do- -do-	100% based on record documents -do- -do- -do-	To be notified by the Employer
2.	Check Survey	Tower Location & Final Length	i) Alignment ii) Final Length	a. Route alignment b. Tower Schedule c. Profile	Contractor -do-	100% at Field -do-	i) All angle towers in plains and 50% in hilly terrains. ii) Final length to be checked on 100% basis based on records/documents	To be notified by the Employer
3.	Detailed Soil Investigation	a. Bore log	1. Depth of bore log 2. SPT Test	As per Employer Specification	Contractor	100% at Field	To witness 20% at Field	To be notified by the Employer

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
			3. Collection of samples					
3	Tower Foundation	b. Tests on samples	As per tech. Specs.	As per Employer Specification	Lab appd. By Employer	100% by testing lab	Review of lab test results	To be notified by the Employer
		1. Cement	1. Source approval	Source meeting Employer Specification/Approved vendor	Contractor	As proposed by Contractor	To verify the proposal based on the supply made and factory test results.	-do-
			2. Physical tests	As per specification	Samples to be taken jointly with Employer and tested at Employer approved lab	Review of all MTC's and one sample for every 500 MT	100% review of lab test results	-do-
			3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	100%% review of MTC by Contractor	100% review of MTC	-do-
		2. Reinforcement Steel	1. Source approval	To be procured from main producers only.	Contractor	As proposed by Contractor	To review the proposal based on the test reports.	-do-
			2. Physical and Chemical analysis test	As per specification	Contractor to submit MTC	All MTC's	100% review of MTC	-do-
		3. Coarse Aggregates	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the	To review the proposal based on the documents	To be notified by the Employer

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
						quarry and based on the test results of Joint samples tested in Employer approved lab		
			2. Physical tests	As per document at Annexure-3 of this FQP at page 16	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-
		4. Fine aggregate	1. Source approval	Source meeting Employer Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Employer approved lab.	To review the proposal based on the documents.	- do-
			2. Physical test	As per Annexure-4 of this FQP at page 17	Samples to be taken jointly and tested in Employer approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	- do-
		5. Water	1. Cleanliness (Water	Employer	Contractor	100% visual	Verification at random	- do-

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
			shall be fresh and clean)	Specification		check at Field		
			2. Suitability of water for concreting	Employer Specification	Contractor	100% Visual Check at Field	Verification at random	- do-
		Foundation Clasification	1. Visual observation of soil strata 2. Ground water level 3. History of water table in adj. Area/surface water 4. Soil Investigation wherever required	Employer Specification	Contractor	100% at Field	100% at Field	- do-
		1. Bottom of excavated earth	Depth of foundation	Appd. Drgs.	Contractor	100% at Field	100% check by Employer	- do-
		2. Stub setting	1) Centre Line	-do-	-do-	-do-	-do-	-do-
			2) Diagonals					
4.	Tower Erection	1. Materials a. Tower member/bolts & nuts/washers/accessories	Visual checking for 1. Stacking 2. Cleanliness 3. Galvanizing	Appd. Dwg./BOM	Contractor	100% at stores	100% verification of records	- do-

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
			4. Damages					
		2. Erection of Super-structure	1. Sequence of erection	As per Appd. Drgs. / Employer specification	Contractor	100% at field	100% check	- do-
			2. Check for completeness	-do-	-do-	-do-	-do-	-do-
			3. Tightening of nuts and bolts	-do-	-do-	-do-	-do-	-do-
			4. Check for verticality	-do-	-do-	-do-	-do-	-do-
			5. Tack welding for bolts & nuts	Employer Specification	Contractor	100% at Field	100% Check	- do-
		3. Tower footing resistance (TFR)	TFR at locations before and after earthing.	Employer Specification	Contractor	100% at Field	20% locations to be verified	- do-
5.	Stringing	1. Materials						- do-
		a. Insulators	1. Visual check for cleanliness/glazing/cracks/and white spots.	Employer Specification	Contractor	100% at Field	100% verification of records and to carry random checks 10%	- do-
			2. IR Value	(min. 50M Ohms)	-do-	One test per sample size of 20 for every lot of 10,000	To verify Contractor's records 100% and joint check 20% of total tests	-do-
			3. E&M test	-	Insulator supplier	a. 20 per 10,000 for discs b. 3 per 1500 for long rod	Collection of samples, sealing them and handing over by Employer to Insulator supplier	Tests to be witnessed/ Appd. at Manufacturer's works

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
			4. Traceability (Make/batch No./Locations where installed)	Packing list/CIP	Contractor	100% at field	100% Review of records	To be notified by the Employer(NEA)
		b. Conductor	On receipt, 1. Visual check of drum.	Packing list	Contractor	100% at stores	20% check	To be notified by the Employer(NEA)
			2. Check for seals at both ends, and Employer sticker on outer end	-do-	-do-	-do-	-do-	-do-
			3. Check depth from top of flange to the top of the outer most layer	-do-	-do-	-do-	-do-	-do-
		c. OPGW	Check for seals at both ends	Packing list	Contractor	100% at stores	20% check	-do-
		2. Field activity						
		a. Before Stringing	Readiness for stringing	Stringing procedures as per Employer specification	Contractor	Readiness certificate to be submitted by the Contractor	Review of Certificate	-do-
		b. During stringing	(Conductor /OPGW)					-do-
			1. Scratch/cut check (Visual)	Appd. Drawings/ Employer Specn.	Contractor	100% at Field	100% record & Field check 20%	-do-
			2. Repair sleeve	-do-	-do-	-do-	-do-	-do-
			3. Mid span Joints	-do-	-do-	-do-	-do-	-do-

S. No.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing Agency	Check/Testing Extent	Counter Check/Test by Employer	Accepting authority in Employer
			4. Guying (in case of towers not designed for one side stringing)	Appd. Guying arrangement/Employer specn.	-do-	-do-	100%	-do-
		c. After stringing	Check for,					
			1. Sag/Tension	Sag tension chart/tower Spotting data	-do-	-do-	100% record & Field check 20%	-do-
			2. Electrical clearances	As per appd. Drgs./Employer specifications	-do-	-do-	-do-	-do-
			i) Ground clearance	-do-	-do-	-do-	-do-	-do-
			ii) Live metal clearance etc.	-do-	-do-	-do-	-do-	-do-
			3. Jumpering	-do-	-do-	-do-	-do-	-do-
			4. Copper bond	As per Appd. Drgns./Employer Specification	Contractor	100% at Field	100% record & Field Check 20%	-do-
			5. Placement of damper	As per Specn./drgs/ placement chart	-do-	-do-	-do-	-do-

APPENDIX - 10.2: PRE – COMMISSIONING PROCEDURES FOR TRANSMISSION LINES

1.1 Introduction

Over all procedure, safety rules, Statutory Requirements, dispatch procedures, switching sequences, observations, passing criteria and documentation of test results have been documented in this APPENDIX-II.

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

The detailed inspection/test procedures for each activity have been elaborated in Chapter 10 and Appendix-I separate section of this documentation. The contents are as following:

1. Definition
2. Overall Procedures
3. Safety procedures
4. Inspection
5. Statutory Requirements
6. Handing over
7. Protective system
8. Dispatch procedures
9. Switching procedures
10. Testing
11. Energization
12. De-energization
13. Observations and duration
14. Passing criteria
15. Documentation

1.2 Definition

"Main Transmission Lines" means all high pressure cables and overhead lines (not being an essential part of the distribution system of a licensee) transmitting electricity from a generating station to another generating station or a sub-station, together with any step-up and step-down transformers, switch-gear and other works necessary to and used for the control of such cables or overhead lines, and such buildings or part thereof as may be required to accommodate such transformers, switch-gear and other works and the operating staff thereof;

"Power System" means a system under the control of the Government or any other statutory body of Generating Company or other agency and having one or more:-

- Generating station;
  Or
- Main transmission lines and sub-stations;
  Or
- Generating stations and main transmission lines and substations;

"Load Dispatch Centre" means the Centre so designated where the operation of Integrated Nepal Power System constituting the country's power system is coordinated;

"Sub-Station" means a station for transforming or converting electricity for the transmission or distribution thereof and includes transformers, convertors, switch-gear, capacitors, synchronous condensers, structures cables and other appurtenant equipments and any buildings used for that purpose and the site thereof, a site intended to be used for any such purpose and any buildings used for housing the staff of the sub section;

"Tie-Line" means a line for the transfer of electricity between two power systems together with switchgear and other works necessary to, and used for the control of such line.

1.3 Overall Procedure

First it is to be ascertained that the transmission line to be energized is ready for operation and has been properly handed over (released) in writing. This will include all safety aspects, statutory clearance, and final inspection by the Employer and regulatory body, if any.

Instructions for the work and supervision are given by the test leader (Line in charge). However all switching and all operational activities will be executed by the regular operators.

Line charging instructions received from LDC are clearly understood by the Line in charge and doubts, if any, are to be got clarified prior to the Energization of the line.

Once the line is handed over for charging no work shall be permitted without a valid WORKPERMIT.

When the whole system has been energized, including the AC line, it will be kept in this state for 8 hours or more for "soaking" with continuous inspection and monitoring.

1.4 Safety Procedures

Energization implies an abrupt and serious change of the working conditions in the plant. In order to avoid serious accidents, thorough information must be imparted to all personnel involved in the construction of transmission line. It should be ensured that due publicity has been made to the public in all the villages/areas along the line route cautioning them against climbing the towers etc. and that the line is proposed to be charged on so and so date. It is also to be confirmed that the AGENCIES involved in the construction activities shall not carry out any job on the said line without a valid WORK PERMIT.

It shall be ensured before charging that all men, material, Tools and plants and any temporary earthing on any part of the entire length of line are removed.

It must be ensured that any power supply / low voltage charging used as anti-theft measure must be disconnected and isolated to avoid accidental connection.

All equipment tests and pre-commissioning tests must have been completed, reterminated (in case cables were isolated for testing purpose) and documented.

The system must be formally declared ready for energization and handed over for operation in writing.

1.5 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:

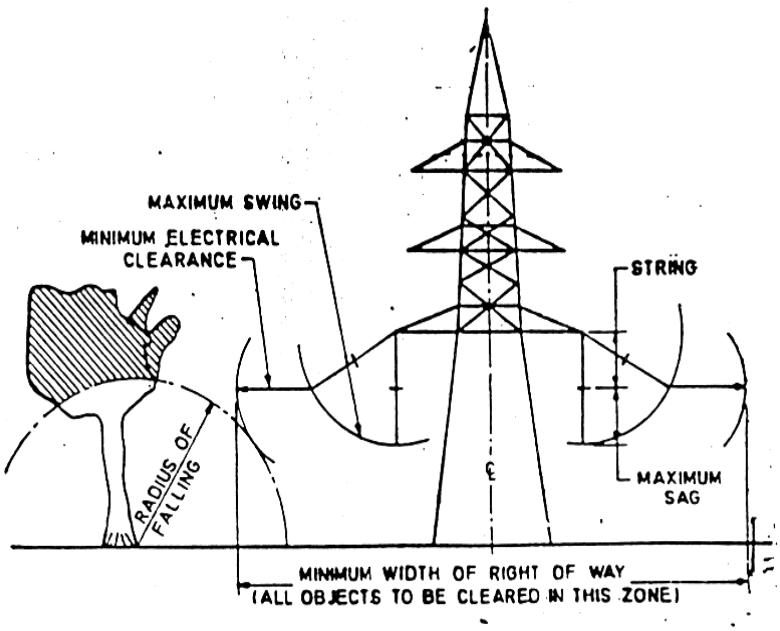
Such an inspection shall include:

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)

1.5.1 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.



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.

CLEARANCE FOR RIGHT OF WAY

TRANSMISSION VOLTAGE IN KV	MINIMUM RIGHT OF WAY (IN MTRS)
132	18

1.5.2 Electrical Clearance

In case of line crossings, clearance between lowest conductor of line and top conductor of the other line shall be adequate as follows:
(Minimum clearances in mm between lines when crossing each other)

Sl. No.	Nominal System Voltage	132 kV	220 kV	400 kV
1.	132 KV	3500	4580	5490
2.	220 KV	4580	4580	5490
3.	400 kV	5490	5490	5490

Jumpers in the tension tower are properly intact with conductor and form a parabolic shape in order to achieve adequate clearance from super steel structure.

1.5.3 Ground clearance

Normally at the time of construction adequate clearance is provided between lowest conductor and ground, but due to delay in charging/commissioning there arc chances of dumping/heaping soil, earth and concrete etc. or staking bricks etc. which may cause reduction in ground clearance. In such cases the stored materials shall be removed.

Ensure that there is no temporary or permanent construction of houses or shades below the line. If the same has been constructed they shall be removed before charging.

The ground profile at the time of commissioning shall be checked with the profile approved at the time of check survey.

Ground clearance of lowest conductors at critical points/where ever the lowest conductor is touching the ground shall be checked in the field from any of the prevalent method and the values of ground clearance at these critical points shall be recorded in the prescribed format.

In case of hilly Terrain and for building clearance, the side clearance from conductors and jumpers at critical points shall also be checked and recorded for all phases of conductor/earth wire towards hill/ building side.

1.5.4 Clearance for Telephone line crossings

The minimum clearances between the conductors of the power line and telecommunication lines are specified as follows:

Sl. No.	Voltage (kV)	Clearance (mm)
1.	132 KV	3500

The vertical clearances between conductors and between conductor and earth-wire shall be checked randomly say in any one span of all sections and 10 sections of hilly areas from single line diagram of the towers.

1.6 Foundation and Revetments / Protection Work

1.6.1 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.

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.

1.6.2 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.

1.7 Tower and Tower Accessories

1.7.1 Normal Tower

After completion of a transmission line, all the towers shall be thoroughly checked before charging the line. Special attention shall be given to the points as mentioned below:-

- Deformed/Buckled/missing/Rusted Members and Nuts and Bolts

It is to be ensured that no members are bend, deformed or rusted have been used in towers and if so, the same shall be replaced.

If any members is found missing, a new member shall be Fixed as per erection drawing of Towers.

Nuts shall be sufficiently tightened for the required Torque specified in the Approved Drawing. Minimum 2/3 complete threads shall be projected outside the nut. All bolts shall have their nuts facing outside of the tower for Horizontal connection and Downwards for Vertical connections.

Nuts & bolts shall be properly tack welded/punched as per the specification and proper zinc rich paint shall be applied. It shall be ensured that the circular length of each welding shall be at least 10mm.

It shall also be ensured that all extra blank holes provided on tower members are filled with correct size of nuts & bolts.

1.7.2 Special Towers

In addition to the above checks for towers, ladders and platforms provided in special towers shall be properly tightened and no foreign material shall be left out on such platforms.

1.7.3 Earthing of Towers

Ensure that proper earthing of tower has been done and earthing strip is neither damaged nor broken and is properly fixed to the stub.

In case of counter poise earthing, it is to be ensured that earthwire is sufficiently buried in the ground and no where it has drag out during cultivation. The length of counter-poise is normally 30 mtrs as per Technical Specification.

Before charging of the line, ensure that resistance is below 10 ohms. If the value (before stringing) has been recorded higher than 10 ohm earthing shall be changed to counterpoise type.

Earthing of special towers shall be verified as per approved drawings applicable for special towers/special foundation. (In case of anchor foundation bolt/anchor plate welded with last leg of special tower.)

1.7.4 Tower accessories

All the danger plates, number plates, circuit plates, and phase plates shall be in position & and as per the specification.

All plates shall be properly tightened.

It shall be ensured that phase plates are fixed in correct phase sequence. Specially at transposition towers, the phase plates in the correct phase sequence shall be provided at each towers or end tower as per the specification of the line.

It shall be ensured that the anti-climbing device (ACD) is provided, at the suit-able height of tower. In case of barbed wire ACD, barbed wire shall be tightly fixed.

It shall be ensured that the step bolts (for normal towers) are provided upto the peak of tower. Any missing step bolts shall be replaced.

Fixing of birds guards (wherever applicable) shall be ensured.

1.8 Hardware Fittings

Tightening of all bolts and nuts are to be checked upto specified torque.

Check the fixing of all security clips (W/R type clips).

Surface condition of corona control rings and distance/alignment between Tower side arcing horn (wherever applicable) and line side arcing horn/corona control ring to be checked as per approved drawings.

To restrict the swing of jumpers, the provision of Pilot strings in case of Tension Towers shall be verified from the approved drawings.

1.9 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.

1.10 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).

1.11 Accessories for Conductor and Earth Wires

1.11.1 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.

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/earth wire 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.

1.11.2 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.

1.11.3 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.

1.11.4 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.

1.11.5 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.

1.12 Aviation Warning / Obstruction Signals (Lights / Globules / Painting)

It shall be ensured that following measures have been taken in the line/ Towers falling within obstruction zone of civil aviation and defence establishments as per their requirement and the specification.

1.12.1 Day markers

Painting of Full/Top portion of Towers with Red/Orange and White Paints.
Globules on earth wires have been provided.

1.12.2 Night markers

It shall be ensured that proper aviation lights at the peak level/at specified heights of towers have been provided along with Solar panels/Battery banks/Control cubicles and other accessories as per specification. The functioning of lights with simulation to be checked / verified.

1.13 Statutory Requirement

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

1.14 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.

1.15 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.

1.16 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.

1.17 Testing and Measurement Procedures

1.17.1 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

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.

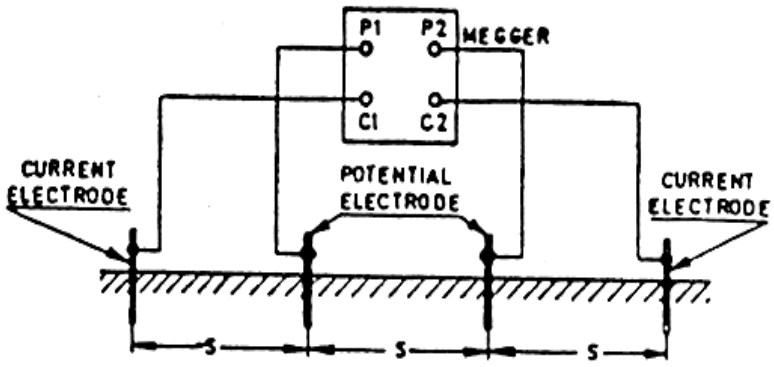


fig : 2 Test connection for a four terminal Megger

1.17.2 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.

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

A simple method of continuity test is illustrated below:

Once the insulation test is completed and the results confirms no short circuit carry the following:

SENDING END	RECEIVING END	RESULTS (OHMS)
CLOSE R-Ph GS	Insulation Resistance R- Ph	ZERO/LOW
OPEN Y – Ph GS	Insulation Resistance Y-Ph	HIGH
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
CLOSE Y – Ph GS	Insulation Resistance Y-Ph	ZERO/LOW
OPEN B-Ph GS	Insulation Resistance B-Ph	HIGH
OPEN R-Ph GS	Insulation Resistance R-Ph	HIGH
OPEN Y–Ph GS	Insulation Resistance Y-Ph	HIGH
CLOSE B-Ph GS	Insulation Resistance B-Ph	ZERO/LOW

Notes:

1. GS means GROUND SWITCH.
2. During above test all other GS shall remain open.

If the above test results are OK it confirms the continuity of the line.

The continuity Test of the line with proper phase indication or phase marking can be checked by continuity test as described below:

SENDING END	RECEIVING END INSULATION RESISTANCE BETWEEN	RESULTS (OHMS)
CONNECT R&Y PHASE B-PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	ZERO OR LOW HIGH HIGH
CONNECT R & B PHASE Y PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	HIGH HIGH ZERO OR LOW
CONNECT Y & B PHASE R-PHASE & ALL GS OPEN	R PHASE & Y PH Y PHASE & B PH B PHASE & R PH	HIGH ZERO OR LOW HIGH

If the test results are OK it confirms that marking of the phases are in order.

Phase Sequence

Once the line is charged from one end, without closing the Breaker at the other end the Phase sequence is to be checked from the CVT/PT output by the help of Phase Sequence Meter.

In case there are other feeders available Phase sequence is to be RECHECKED by the measurement of secondary voltage of both the Feeders (New line & available charged line).

Let the secondary Voltage of CVT/PT is 110 volts (ph to ph) for both the Circuit. In case of correct Phase Sequence the voltage reading shall be as follows:

NEW CIRCUIT	OLD CIRCUIT	VOLTAGE
R-Phase	R-Phase	0
R-Phase	Y-Phase	110
R-Phase	B-Phase	110
Y-Phase	R-Phase	110
Y-Phase	Y-Phase	0
Y-Phase	B-Phase	110
B-Phase	R-Phase	110
B-Phase	Y-Phase	110
B-Phase	B-Phase	0

In case the results are not matching the phase sequence in to be rechecked and reconfirmed before closing the breaker.

1.18 Energization

Execution of the energization is simply the last event in the switching sequence, switching of the close control button for the relevant circuit breaker.

1.19 De-Energization

Instructions about de-energization will be given only if this is part of the test. Otherwise de-energization will be considered part of regular operation.

1.20 Observation and Duration

Visual and audible inspection (look and listen) of the relevant equipment and reading of permanent instrumentation will be made.

The system shall be charged at least for 8 hours. During this time continuous monitoring and inspection will be maintained in control room, auxiliary systems areas and switch yards.

This will include frequent, scheduled inspection of all equipment and reading of all permanent instruments and recorders, and surge arrester counters, especially system parameters as per standard procedures adopted by the Employer.

1.21 Passing Criteria

Neither insulation breakdown nor protective system actions must occur. No irregular equipment behaviour (noise, vibration, high temperature) is permitted.

Corona discharges may not be "unreasonable". Local discharges that may be attributable to sharp points shall be carefully located and recorded. After termination of the energization the equipment shall be closely inspected and the points rounded or covered.

No unscheduled changes of system nor of equipment parameters is permitted during the 8 hour energized condition.

Measurement of Line Parameters

The Contractor shall conduct measurement of Line parameters as per international practice.

High voltage Tests

The Contractor shall conduct high voltage tests as per international practice.

1.22 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.

Chapter 11: TECHNICAL SCHEDULE

11.1 Schedule A.1

System and Line Data

ITEM	DESCRIPTION	UNIT	DATA
1.	**System Data**		
1.1	System Nominal Voltage	kV	132
1.2	System Maximum Voltage	kV	145
1.3	System Nominal frequency	Hz	50
1.4	**Line Data**		
1.4.1	Kirtipur - Udipur 132 kV Double Circuit Tower	Km	11.5
1.4.2	Line Conductor		ACSR - CARDINAL
1.4.3	Ground Wire		OPGW

Altitude and Basic Insulation Level

The Proposed 132kV double circuit Transmission line shall traverse through undulated landscape in the areas of Kirtipur – Udipur. The variations of altitudes of the proposed 132kV transmission line ranges from 604 m above MSL to 1000 m above MSL.

The stretches, and approximate length of the 132 kV transmission line is given in the following table.

Altitude Zone	Section	Alignment Points	Approximate Length of the Transmission Line (m)
			Total
Up to 1,000 m	Udipur-BajarKhutta	AP0 – AP0A	382.04
	BajarKhutta – BajarKhutta	AP0A – AP1	582.29
	BajarKhutta – Panditthok	AP1 – AP2	1011.07
	Panditthok – Thapadanda	AP2 – AP3	598.21
	Thapadanda – Gariswara	AP3 – AP4	647.09

	Gariswara – Gariswara	AP4 – AP5	472.84
	Gariswara – Odare	AP5 – AP6	685.73
	Odare – Basnetgaun	AP6 – AP7	802.54
	Basnetgaun – Basnetgaun	AP7 – AP8	529.83
	Basnetgaun – Dhodeni	AP8 – AP9	783.98
	Dhodeni – Dhodeni	AP9 – AP10	241.98
	Dhoden – Bansar	AP10 – AP11	643.35
	Bansar – Khinchokbesi	AP11 – AP12	640.76
	Khinchokbesi – Khinchokbesi	AP12 – AP13	689.79
	Khinchokbesi – Miduswara	AP13 – AP14	1084.55
	Miduswara – Kirtipur	AP14 – AP15	697.08
	Kirtipur – Kirtipur	AP15 – AP16	673.83
	Kirtipur – Kirtipur	AP16 – AP17	333.62

132kV Transmission Lines in different altitude zones shall be designed in compliance with the following Basic Insulation Levels (BIL)

Altitude Zone	Highest Voltage for Equipment U_m in kV (rms value)	Short-duration power frequency withstand voltage – kV (rms value)		Lightning Impulse withstand voltage – kV (peak value)	
		Required	Selected	Required	Selected
Up to 1,000 m	145	275	275	650	650

11.2 Schedule A.2

DESIGN DATA

ITEM	DESCRIPTION	UNIT	DATA
1.	**Temperature**		
1.1	Maximum ambient temperature	^{0}C	32

1.2	Minimum ambient temperature	^{0}C	0
1.3	Maximum temperature of conductor	^{0}C	85
1.4	Everyday temperature of conductor	^{0}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
1.4	Terrain Roughness Co-efficient (K2)		1.08
But Gust factors corresponding to terrain category –II shall be considered for conductors/earth wire, Tower and Insulator for arriving the wind load.			
The corresponding Design Wind Pressure on towers, conductors and insulators shall be obtained from the relation $Pd=0.6V^2$.			

11.3 Schedule A.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	7.1
2.	Residential areas	7.1
3.	Roads and streets	8.0
4.	Highways	8.0
5.	To metal clad or roofed buildings or building or structures upon which a man may stand	5.0
6.	Power lines (above or below)	3.5
7.	Telecommunication lines	3.5
8.	River and other areas	7.1

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.

11.4 Schedule A.4

TOWER TYPES

Type of Tower	Deviation limit	Typical use
DA	a) 0 deg.-2 deg.	To be used as tangent tower.
DB	a) 2 deg.-15 deg.	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) Also to be designed for anti-cascading condition.
	b) 0 deg.	b.1) To be used as Section Tower
DC	a) 15 deg.-30 deg.	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) Also to be designed for anti-cascading condition.
DD	a) 30 deg.-60 deg.	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).

2.	DESIGN SPANS			WEIGHT SPAN (m)			
ITEM	TOWER TYPE DOUBLE CIRCUIT	BASIC SPAN (m)	WIND SPAN (m)	Normal Condition (Maximum)	Normal Condition (Minimum)	Broken Wire Condition (Maximum)	Broken Wire Condition (Minimum)
2.1	DA	350	350	488	208	192	104
2.2	DAL	700	900	960	-960	576	-576
2.3	DB	350	350	960	-960	576	-576
2.4	DC	350	350	960	-960	576	-576
2.5	DD/DDE	350	350	960	-960	576	-576

11.5 Schedule A.5

TOWER OUTLINE CONFIGURATION

Refer to drawing

11.6 Schedule A.6

FACTOR OF SAFETY

ITEM	DESCRIPTION	MINIMUM FACTOR OF SAFETY
1.	Tower Foundations	
1.1	All types of suspension(DA) and small angle(DB) towers	1.1
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	Compete 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	2.5
3.2	Ground wire at still air everyday temperature based on earth wire ultimate tensile strength	5.0
3.3	Complete tension assembly at ground wire maximum working tension	4.0
3.4	Complete suspension assembly at maximum vertical load	4.0

11.7 Schedule A.7

TOWER PARTICULARS

ITEM	DESCRIPTION	UNIT	MINIMUM VALUES
1.	Unit Stresses		
	The quality of steel used for support members and bolts		
1.1	Structural Mild Steel:		
1.1.1	Structural Members		
	i. Tension based on net sectional area	kg/cm^2	2600
	ii. Axial compression based on gross sectional area	kg/cm^2	As per IS:802

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
2.2	Braces	NA	200
2.3	Redundant members	NA	250
2.4	Members loaded in tension only	NA	400

11.8 Schedule A.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

11.9 Schedule A.9

LONG ROD POLYMERIC INSULATORS

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

ITEM	DESCRIPTION	UNIT		
			Altitude ≤ 1,000m	Altitude < 2,160 m
1.	Insulator type		Log Rod Polymeric	
2.	Highest system voltage	kV	145	

ITEM	DESCRIPTION	UNIT		
			Altitude ≤ 1,000m	Altitude < 2,160 m
3.	System frequency	Hz	50	
4.	Rated lightning impulse withstand voltage	kV_{peak}	650	1050
5.	Rated power frequency withstand voltage(wet)	kV_{rms}	275	460
6.	Minimum Creepage distance as multiplied arcing distance	-	2.5	
7.	Minimum mechanical failing load			
7.1	Suspension rod	kN	90	
7.2	Tension rod	kN	160	
8	Factor of safety under maximum loading condition			
8.1	Insulator set		3.3	
8.2	Fittings		4.0	
9.	Overall length of insulator string		As per standards	
10.	Standards		IS / IEC	

11.10 Schedule A.10

LINE CONDUCTOR

ITEM	DESCRIPTION	UNIT	DATA
1.	ACSR "Cardinal"		
1.1	Conductor size	mm^2	547.3
1.2	Conductor type		ACSR Cardinal
1.3	Number and size of wires		
1.3.1	Aluminum	No. Dia mm	54 3.38
1.3.2	Steel	No. Dia mm	7 3.38
1.4	Cross section	kV	
1.4.1	Aluminum	mm^2	484.50
1.4.2	Steel	mm^2	62.81
1.4.3	Total	mm^2	547.3
1.5	Conductor diameter	mm	30.42
1.6	Ultimate strength	Kg	15,381
1.7	Standard mass of conductor	Kg/km	1833
1.8	Electrical D.C. resistance at 20 ®C	Ohm/km	0.05979
1.9	Standard un jointed length on reel	m	2,000
1.10	Modulus of Elasticity	kg/Sq mm	7,036
1.11	Mass of zinc coating	gm/sq. m	250

ITEM	DESCRIPTION	UNIT	DATA
1.12	Co-efficient of Linear Expansion	per ®C	19.3 x 10-6
1.13	Direction of Lay of outer	-	Right Hand
1.14	Standards	BS 215 PART 2 IEC 1089 / IS 398 PART 2	

11.10 Schedule A.11

OPTICAL FIBER GROUND WIRE (OPGW)

ITEM	DESCRIPTION	UNIT	DATA
1.	Outer diameter	mm	11.4
2.	Breaking load	kN	86
3.	Modulus of elasticity	kN/mm^2	162
4.	Coefficient of thermal expansion	1/degree K	$3.0 X 10^{-6}$
5.	Nominal short time current capacity at initial/final temperature 20/200 oC	kA	5.5
6.	DC resistance at 20 oC	Ohm/km	1.247
7.	Single mode fiber	ITU-T G.652	
8.	No. of single mode optical fibers		24
9.	**Fiber attenuation at**		
9.1	1310 nm at 20oC max.	dB/km	0.4
9.2	1550 nm at 20oC max.	dB/km	0.25
10.	Attenuation deviation at 1310 nm and 1550 nm	dB/km	0.1 (within -45^0C to 80^0C)
11.	Standards		
11.1	Aluminium alloy wires	IEC 104 type A	
11.2	Aluminium clad steel wire	IEC 1232	
11.3	Cable construction	IEC 1089	
11.4	Optical Unit	ITU-T (former CCIT) G 652	

11.12 Schedule A.12

MATERIAL FOR TOWER GROUNDING

ITEM	DESCRIPTION	DATA
1.	Ground rods	
1.1	Galvanized steel angle	50 x 50 x 5mm steel angles 2m long
2.	Ground wire	
2.1	Galvanized steel wire/ strip	38mm2 / strip 7/2.6mm
3.	Connection of ground electrode with stub angle	
3.1	For connection of steel angle:	Steel wire as above

11.13 Schedule A.13

FOUNDATION APPLICATION SCHEDULE

FOUNDATION TYPE	APPLICATION	SOIL DESCRIPTION
I. "Spread Footing"	For use with all 132kV lattice tower types DA DB DC DD/DDE	Soil capable of being excavated with vertical wall limit bearing capacity 2.5 kg/sq. cm. Assume cone of earth 30 degrees. Dry Cohesive Material – Stiff clay. Some silt and sand. Not readily excavated by shovel alone. Cannot be molded by finger pressure and intended by thumb. Blow count 8 to 10. Granular Material- Compacted sand. Some silt and gravel. Difficult to excavate by shovel alone. Relative density over 60%. Blow count 10 to 20.
II "Spread Footing"	For use with all 132kV lattice tower types DA DB DC DD/DDE	Soil capable of being excavated without appreciable sloughing. Limit Bearing Capacity 1.25 kg/sq. cm. Assume cone of earth 15 degrees. a) Cohesive Material – Soft to medium clay. Some silt and sand. Can be excavated by shovel alone and molded by medium finger pressure. Blow count 4 to 8. Granular Material – Loose to medium sand and silt. Easily excavated by shovel alone and moulded by medium finger pressure. Blow count 4 to 10, paddy fields. When the top layer of soil upto 1.5m each black cotton/Loose Silty Sandy soil and followed by normal dry cohesive ordinary soil. And where subsoil water table is met at 1.5m or below the ground level. b) For all the above soils and where subsoil water table is met less than 0.75m or below the ground level. Fully submerged soil consisting top layer of black cotton soil/Loose silty sandy soils followed by ordinary fine grained soil strata. c) Wet fissured/disintegrated rock, hard gravel, Kankar and limestone, Later it .
III "Spread Footing"	For use with all 132kV lattice tower types DA	Hard Rock/ordinary soil followed the hard rock.

DB
DC
DD/DDE

11.14 Schedule A.14

INSEPTION TESTS AT MANUFACTURE'S PLANT

ITEM	DESCRIPTION	DATA
1.	Rolled Steel Angles and Bolts	
1.1	Tensile strength test and chemical analysis, zinc coating test Full scale tower load test to destruction	Steel Mill Certificates IEC 652
2.	Insulators	
2.1	Temperature cycle test, mechanical failing load test	IEC 383 & IEC 575
2.2	Porosity test, continuity of zinc coating	BS 137
2.3	Electrical test on complete insulator strings	ANSI C-29.1
3.	Insulator Fittings	
3.1	Routine and sample mechanical tests	BS 3288
3.2	Galvanizing tests	BS 729
4.	Clamps and joints	
4.1	Mechanical and electrical type tests, galvanizing and mechanical routine tests	BS 3288 BS 729 ISO
5.	Dampers	
5.1	Fatigue resistant tests	
5.2	Test of clamp slippage resistance	BS 729
5.3	Galvanizing tests	ISO
6.	Line Conductor and earth wire	
6.1	Mechanical test, galvanizing test and resistivity test, ultimate tensile stress of complete conductor	IEC 209 BS 2677

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.

(Bidder's Name)

1. TOWER

S. No.	Description	Unit	DA	DB	DC	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				

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	OPGW	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				
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.

(Bidder's Name)

1.0 ACSR Conductor

S. No.	DESCRIPTION	UNIT	REQD.	OFFERED DATA
	Manufacturer's Name			
	Country of origin			
	Applicable Standard			
	Years of Manufacturing Experience	Years		
	ISO Certificate submitted	yes/no	Yes	
	Manufacturer sales record submitted	yes/no	Yes	
1	Code word		CARDINAL	
2	Aluminum Wires :	no/mm	54/3.38	
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	7/3.38	
3.2	Lay outer layer	mm		
3.3	Steel quality (Grade)			
4	Overall diameter of conductor	mm	30.42	
5	Maximum DC resistance of conductor at $20^{O}C$	ohms/km	0.05979	
6	Maximum AC resistance of conductor at 20^{O} C	ohms/km		
7	Ultimate tensile strength of conductor	kg	15381	
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	1833	
12	Equivalent coefficient of linear expansion of complete conductor 10^{-6}	per ^{O}C		
13	Standard length of conductor on drum	m	2000	
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		

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 of1 % 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	Yes	
21.1	List of Type Test Reports submitted			
22	Drawing of Conductor submitted	Yes/No	Yes	
23	Drawing of Drum submitted	Yes/No	Yes	

Signed: .....

As Representative for: .....

Address: .....

Date: .....

(Bidder's Name)

3.0 Insulators and Fittings

S. No.	DESCRIPTION	UNIT	COMPOSITE LONG ROD INSULATOR	
			TENSION	SUSPENSION
	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 lightening 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	kN kN		
	b) Tension Rod			
11	Factor of safety under maximum loading condition			
	a) Insulator			
	b) Iron fitting (if any)			
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: .....

(Bidder's Name)

4.0 Technical Particulars of Optical Fiber Ground Wire (OPGW)

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	mm2		
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		
9	Maximum weight of Cable drum	kg		
10	Optical Ground Wire			
10.1	Optical fiber type	mode		
10.2	No. of optical fiber	Nos.		
10.3	Lay of outermost layer			
10.4	Cross sectional area	Sq mm		
10.5	Fiber Diameter	µm		
	a. Mode field diameter			
	b. Cladding Diameter			
10.6	Standard			
	a. Single mode fiber			
	b. Optical Fiber Cable			
	c. Stranding part			
11	Optical attenuation at wave length			
11.1	1310mm	dB/km		
11.2	1550mm	dB/km		

12	Short circuit carrying capacity	kA*sec		
13	Fiber optic fitting and accessories			
13.1	Suspension assembly			
13.2	Tension assembly			
14	Vibration dampers			
14.1	Type			
14.2	Weight	kg		
14.3	Distance from clamp mouth to attachment point	mm		
	a. 1st damper			
	b. 2nd damper (if required)	mm		
15	Type Test Report Submitted	Yes/No		

Deviations from technical requirements and reasons for such deviations:

Signed: .....

As Representative for: .....

Address: .....

Date: .....

(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	