

BIDDING DOCUMENT

FOR

Construction of tower for Forest locations for 132 Kv S/c line on D/C tower
from Salakati to APM

VOLUME – 2

TECHNICAL SPECIFICATION
(EMPLOYER'S REQUIREMENT)



ASSAM ELECTRICITY GRID CORPORATION LIMITED

BID IDENTIFICATION NO:- AEGCL/MD/TL-87/Bid/Forest

VOLUME-2
TECHNICAL SPECIFICATION
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This Section of the specification covers design, manufacture, testing at works of suspension and tension string insulator assemblies for 132 kV transmission lines.

6.1.0 STANDARDS

6.1.1 The suspension and tension string assemblies, insulator discs and hardware offered, material and processes adopted in the manufacture of insulator discs and hardware shall conform to the provision of the following Indian Standards or equivalent other international standards:

- (1) IS: 731 Specification of porcelain insulators for overhead power lines.
- (2) IS: 2486 Specification of insulator fittings for overhead power lines.
- (3) IS: 2026 Specification for recommended practice for hot dip galvanising of steel
- (4) IS: 2633 Specification for method for testing uniformity of coating on zinc coated articles.
- (5) IS: 2107 Specification for white hearth malleable iron castings.
- (6) IS: 2108 Specification for black hearth malleable iron castings.

6.2.0 INSULATOR AND STRINGS

The insulators of the strings shall consist of disc insulators with normal sheds for a three phase, 50 Hz, effectively earthed 132 kV transmission system in a lightly polluted atmosphere. Insulators shall be long rod type with Ball and socket connections.

6.3.1 Insulators shall have normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-815.

6.3.2 Supplier quoting for long rod insulators made of electro porcelain shall also supply intermediate ball pins and intermediate arcing horns along with long rod insulators.

The price of these items shall be considered as including in the price of long rod insulators.

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

Ball and Socket Designation

The dimensions of the balls and socket shall be of following designation for different for disc insulators in accordance with the standard dimensions stated in IS 2486-(Part-II)/IEC:120:-

Sl. No.	Rating of Insulators	Designation of Ball & socket as per IEC: 120
i)	70 KN	16 mm, AltB
ii)	90 KN	16 mm, AltB
iii)	120 KN	20 mm
iv)	160 KN	20 mm

2.4 Dimensional Tolerance

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

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

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

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

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

2.5 Intermediate Ball Pin Designation

The dimensions of the intermediate ball pin shall be in accordance with the standard dimension stated in IEC:471.

2.6 Intermediate Arcing Horn

2.6.1 For Insulator strings with long rod insulators besides the arcing horn on tower side of hardware fittings, intermediate arcing horns along with fixtures and fasteners as shown in the specification shall also be provided.

The total effective arcing distance shall be 3050 mm for 400 kV line, 1800 mm for 220 kV line and 1200 for 132 kV line under nominal dimensions of insulator.

2.6.2 The spark gap shall be so adjusted to ensure effective operation under actual field coordination.

2.7 Inter Changeability

The long rod insulators with ball and socket connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC standards.

2.8 Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localised pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

2.9 Maintenance

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

2.9.2 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.

2.10 Materials

2.10.1 Porcelain

The porcelain used in the manufacture of long rods shall be alumina type. It shall be sound, free from defects and thoroughly vitrified and smoothly glazed.

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

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

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SCHEDULE – I

GUARANTEED PARTICULARS AND MANUFACTURING DATA

SECTION-1

SCOPE AND GENERAL TECHNICAL CONDITIONS

1.1.0 INTENT OF THE SPECIFICATION

1.1.1 This Volume of the specification deals with the information & criteria for manufacture, supply, erection, testing and commissioning and setting to work of 132 KV Transmission lines, tower super structures, conductor, insulators, ground wire and accessories and erection of 132 KV Transmission lines as "Turnkey Contract" as defined in Volume 1.

1.2.0 SCOPE

1.2.1 The work involves design (as applicable), engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, civil foundation work, erection and commissioning at site.

1.2.2 The scope under this Bid covers briefly the following:

- (i) The work includes supply, foundation, erection, stringing, testing and commissioning works at Bhairav hills reserve forest and supply(except tower superstructure), stringing, testing and commissioning works at Nandangiri reserve forest.
- (ii) The Employer has already conducted a route survey with modern technique of survey of the line. The documents of the original route survey of the lines will be made available to the successful Bidder.
- (iii) Fabrication & supply of all type 132 kV transmission line towers and tower material as per the design as per drawings supplied by the Employer including bolts, nuts, washers, hangers, shackles and all type of tower accessories like phase plates, number plates, danger plates, anti-climbing devices.
- (iv) Supply of conductor, earth wire, hardware fittings, conductor & earth wire accessories.
- (v) Casting of tower foundations as per the drawings supplied by the Employer.
- (vi) Erection of towers, tack welding of bolts and nuts including supply and application of zinc rich primer & enamel paint, painting of towers for aviation requirements (if required)
- (vii) Supply & providing tower earthing, supply & fixing insulators, insulator strings.
- (viii) Stringing of conductor & GROUND WIRE along with all necessary line accessories.
- (ix) Testing & commissioning of the erected transmission lines.
- (x) Other items not specified in this specification and / or Bid form, price and other schedules but are required for the successful completion, commissioning, efficient operation & reliability of the transmission lines, unless specifically excluded in the specification.

1.2.3 The various item of work is described very briefly in the schedule of Bid Form, prices & Other Schedules. The various items as defined in these schedules shall be read in conjunction with the corresponding section in the technical specifications including amendments and, additions if any.

The Bidder's rates shall be based on the description of activities in the schedules as well as necessary operations detailed in Technical Specifications.

- 1.2.4 It is not the intent to specify completely herein, all details of design and construction of the equipment and accessories, However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the bidder's guarantees in a manner acceptable to the Purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance therewith.
- 1.2.5 Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as a part of the bidder's scope supply, unless and until mentioned very clearly in exclusions.
- 1.2.6 The rates quoted shall include minor details which 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.
- 1.2.7 The rates quoted shall be inclusive of all plant equipment, men, material, skilled & unskilled labour etc. essential for satisfactory completion of various works.
- 1.2.8 All measurements for payment shall be in SI Units; lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square metres and volume in cubic metres, rounded off to two decimal places.
- 1.2.9 This specification includes supply of hardware fittings and all type of accessories for Conductor and GROUND WIRE as detailed in the specification. Contractor shall clearly indicate in their offer, the source from where they propose to procure these materials in appropriate schedule of Bid Form, prices & other schedules. The technical description of these items is given in subsequent sections of this volume.
- 1.2.10 All raw material such as Structural Steel, Zinc for Galvanizing, reinforcement steel and cement for tower foundations, coke and salt for tower earthing , conductor / earth wire, insulators, line hardware etc. bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase/ number plates etc. required for tower manufacture and erection shall be included in the contractor's scope of supply. Bidders shall clearly indicate in their offer, the source from where they propose to procure the raw materials and the components.
- 1.2.11 ***The tentative Schedule of Quantities are furnished in Annexure-I, Annexure-II and Annexure-III at the end of this Section. Bidders are requested to note the following points:***
- (a) ***The items mentioned in these Annexure shall only be used while preparing the Price Schedules. If any items which is not specifically mentioned in Annexure-I annexure-II and Annexure-III; but required to complete the works as per Specification shall deemed to be included in any of the items of these Annexure. Additions, deletions or modification of these items while preparing the Price Bid by the Bidder shall render his bid non responsive.***
- (b) ***The quantities are provisional in nature and for bidding purpose and for bid comparison purpose only. Quantities may vary to the extent of (+) 15 % to (-) 15% in terms of total Contract Price.***
- 1.2.12 The quantities mentioned in Schedule-I and Schedule-II are based on the walkover survey made by the Employer. It is expected that the Contractor will further optimise the requirement towers and tower foundations based on the detailed and Check Survey made by the Contractor.

1.3.0 DETAILS OF TRANSMISSION LINE ROUTES AND TERRAIN

- 1.3.1 The route alignment survey has been carried out by the employer. The details collected through surveys viz, the line route, general soil characteristics, crossings, accessibility, infrastructure details etc will be provided to the successful Bidder.
- 1.3.2 Bidders may visit the line route to acquaint themselves with the terrain etc., of the proposed transmission lines. For this purpose they are requested to contact the following address:

The Chief General Manager(PP&D)
Assam Electricity Grid Corporation Limited,
Bijulee Bhawan,
Paltan Bazar, Guwahati – 781 001,
Assam

1.4.0 CONTRACTOR TO INFORM HIMSELF FULLY

- 1.4.1 The contractor should ensure that he has examined the General Conditions, Specifications and Schedules as brought out in Volume-1 and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.
- 1.4.2 The Employer shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Employer

1.5.0 ACCESS TO THE LINE AND RIGHT OF WAY

- 1.5.1 *Right of way and the way leave clearances shall be arranged by the Employer in accordance with the work schedules. Employer will secure way leave and right of way in the Forest area also (if any). However, it is responsibility of the Contractor to clearing of all obstacles along the right of way of the transmission line routes, like cutting of trees, jungles and removal of structures etc. The Bidder shall include the cost of this works in rates quoted for survey/erection/stringing of the lines.*

1.6.0 BASIC TECHNICAL DATA

1.6.1 Service Conditions :

The lines covered under this contract are to run entirely in the State of Assam, India and shall be suitable for the tropical climatic conditions prevailing in the area as listed below.

a)	Peak ambient day temperature in still air	-	45°C
b)	Minimum night temperatures	-	0°C
c)	Reference ambient day temperature	-	45°C
d)	Relative Humidity	a) Maximum	- 100 %
		b) Minimum	- 10 %
e)	Altitude:	Below 1000 M above MSL	
f)	Maximum wind pressure:	As per IS: 802 latest code (Zone-6)	
g)	Other Data:	Refer Meteorological data pertaining to the locations.	

1.6.2 Basic System Data

SL. No	Description	132 KV
1.	Nominal system voltage KV rms	132
2.	Highest system voltage KV rms	145
3.	System of grounding	Solidly Grounded
4.	Impulse insulation level KV peak	650
5.	Power frequency withstand voltage (wet) KV rms	260
6.	Protective shielding angle against direct lightning	NOT EXCEEDING 30 ⁰
7.	Minimum Corona extinction voltage at 50Hz AC system Dry condition (phase to earth)	Not less than 154 kV
8.	Accessories for conductor and Earth wire	<ul style="list-style-type: none"> i. Preformed armour rods ii. Mid-Span compression joints iii. Repair sleeves iv. Flexible copper bonds v. Vibration dampers vi. Suspension clamps for earth wire vii. Tension clamp for earth wire
9.	Insulator String Hardware	<ul style="list-style-type: none"> i. Anchor shackle ii. Chain link iii. Yoke plate iv. Ball clevis v. Arcing horn holding plate vi. Socket clevis vii. Arcing horns viii. Clevis eye ix. Free centre type/armour grip suspension clamp for suspension strings x. Compression type dead end clamp xi. Balancing weight

1.6.3 Basic Design Parameters

Item	Particulars	132 kV Line (Single/double- 3phase) with ACSR		
1. SPAN	(i) Normal span (Design Span)	335 M		
	(ii) Wind span	335 M		
	(iii) Weight span, both span (total)	Suspension		Tension
		a) Maximum	505 M	505 M
	b) Minimum	185 M	0 M	
(iv) Weight span, one span	Suspension		Tension	
	a) Maximum	315 M	315 M	
	b) Minimum	100 M	-200 M	
2. TEMPERATURE RANGE		Conductor	Earth Wire	
	(i) Maximum	85 ⁰ C	53 ⁰ C	
	(ii) Minimum	0 ⁰ C	0 ⁰ C	
	(iii) Every Day	32 ⁰ C	32 ⁰ C	
3. Wind Speed Zone	Wind Speed Zone	Zone – 5 as per IS : 875		
4. CONDUCTOR	(i) Material	ACSR		
	(ii) Number of strands & size	Al: 30/ 3.00 mm		
		St: 7/ 3.00 mm		
	(iii) No. of conductor per phase	1		

Item	Particulars	132 kV Line (Single/double- 3phase) with ACSR
5. Optical GROUND WIRE	(i) Type	As per technical Specs provided
	(ii) Size	As per technical Specs provided
	(iii) No. of Optical GROUND WIRE	1
6. Wind Speed Zone	Wind Speed Zone	Zone – 5 as per IS : 875
7. Wind pressure	Maximum wind pressure up to a height of 10 M about mean retarding force	720 N/m ²
8. GROUND CLEARANCE (Under maximum sag)	(i) Rough country	6100 mm plus sag corrections
	(ii) Across and along all roads and paths	6100 mm Plus sag corrections & allowances
10. Tension Limits	(a) For conductor and ground wire	
	(i) at 32 ^o C & no wind	25 % of UTS
	(ii) at 32 ^o C & full wind	70 % of UTS
	(iii) at 0 ^o C & 36% of full wind	70 % of UTS

1.7.0 DRAWINGS AND DOCUMENTS

1.7.1 In addition to those stipulated in clause regarding drawings in Volume -1, the following also shall apply in respect of Contractor Drawings.

1.7.2 Each drawing submitted by the Contractor for approval of the Employer 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.

1.7.3 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 neither all technical requirements nor 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 of their consequences.

1.7.4 All drawings shall be prepared using AutoCAD software . Drawings which are not compatible to AutoCAD software shall not be acceptable. After final approval all the drawings shall be submitted to the Employer.

1.7.5 The following is the general list of the documents and drawings that are to be approved by the Employer:

- a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
- b) Final survey report and profile drawings showing all details such as ground clearance, tower locations, deviation angle etc.
- c) Tower schedule and foundation classification for individual tower locations

- d) Tower structural drawing and bill of materials.
- e) Soil Investigation report.
- f) Foundation working drawings/excavation Plan.
- g) Tower footing earthling drawing.
- h) Stringing procedure and stringing chart.
- i) Quality plans for fabrication and site activities including Quality System.
- j) Sub-vendors approval, etc.
- k) Line material drawings.
- l) Type test report for line materials.

1.7.6 All Designs / Drawings / Calculations/ Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

1.8.0 QUALITY ASSURANCE AND INSPECTION

1.8.1 Quality Assurance

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 outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. 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 Contractors key personnel.
- d) The procedure for purchases of materials, parts components and selection of sub-Contractors 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 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 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 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.

1.8.2 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 Employers 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 Contractors/his vendors Quality Management and Control Activities.

1.9.0 TESTS AND STANDARDS

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

- 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.
- 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.
- 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.
- 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.
- The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Employer.
- 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 or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Programme.
- For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

1.10.0 TEST REPORTS

1.10.1 Equipment, which has never been tested for critical performance, shall not be accepted. In such cases, a promise or agreement by a bidder to have the equipment tested after award of a contract is not acceptable.

1.10.2 All Bids must be accompanied by the Type/Performance Test Certificates of equipment offered (refer **Clause 1.10.5** below). Such type test certificates shall be acceptable only if:-

- (a) Tests are conducted in an independent and well known testing laboratory, or
- (b) Tests are conducted in manufacturer's own laboratory. In this case (i) the laboratory must have ISO 9000 (or its equivalent) series certification; and (ii) tests have been witnessed by technically qualified representatives of earlier clients or purchaser.

- 1.10.3 **Test reports to be acceptable must be related directly to the equipment/material offered i.e. it is fully identical in design, rating and construction with the equipment for which the type test certificates have been submitted. Test reports for of similar equipment /materials are acceptable with commitment to perform the type/performance tests free of any charge on the particular equipment after the award of contract.**
- 1.10.4 **Type Test Reports older than ten (10) years on the date of Technical bid opening shall not be accepted.**
- 1.10.5 **Full Type Test /Performance Test Reports of at least the following equipment must be submitted along with the Bid: -**
1. **Power Conductors.**
 2. **Disc Insulators.**
 3. **GROUND WIRE**

1.11.0 GUARANTEED TECHNICAL PARTICULARS

- 1.11.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders with Technical Bid in the prescribed schedules of the Specifications. The Bidder shall also furnish any other information's as in their opinion is needed to give full description and details to judge the item(s) offered by them.
- 1.11.2 The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (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 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.

1.12.0 COMMISSIONING SPARES

- 1.12.1 It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.
- 1.12.2 These spares shall be received and stored by the Contractor at least 3 months prior to the schedule date of commencement of commissioning of the respective equipment and utilized as and when required. The unutilised spares and replaced parts, if any, at the end of successful completion of performance and guarantee test shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Project Manager.

1.13.0 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER REGULATIONS

- 1.13.1 The contractor shall note that all overhead power lines shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to the power lines shall be consulted, if necessary, in regard to the rules and regulations that may be applicable. Highway department and aerodrome authorities shall also be consulted whenever power lines run near or across the area under their jurisdiction.

1.14.0 CONTRACTOR'S REQUIREMENT

- 1.14.1 The Contractor should be in possession of a valid E.H.V. Electrical Licence issued by the Chief Electrical Inspector, Govt. of Assam, as per the provision of Law. An attested copy of the aforementioned Licence must be handed over to the Owner for his record prior to handing/ taking over of sites. The Employer/ his representative will give necessary assistance to the contractor in obtaining license from statutory authorities.
- 1.14.2 All the works shall also be inspected by the Chief Electrical Inspector, Govt. of Assam or his authorised representatives. It is the responsibility of the Contractor to obtain pre-requisite commissioning clearance of any equipment from the said Inspectorate. The Contractor will pay necessary fees to the Inspectorate, which it may levy.
- 1.14.3 It is obligatory on the part of contractor to obtain prior approval from the Employer regarding the guaranteed technical particulars of all the equipment ordered on the vendors before effecting purchase.
- 1.14.4 The Contractor shall provide necessary drawings and documents required by statutory authorities and obtain the approval before taking up erection. The Employer/ his representative will give technical assistance to the contractor in obtaining approval from statutory authorities.

Annexure -1 SCHEDULE OF QUANTITY

(Note[∅]: Please refer BOQ)

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2.

SECTION-2

SURVEY AND OPTIMISATION OF TOWER LOCATION

(TECHNICAL SPECIFICATIONS)

2.1.0 SCOPE

2.1.1 Verification / review of the line route of original route survey. The Employer has already conducted a route survey with modern technique of survey of the line. However, the Contractor will be required to do the detailed and check survey of the entire line. The Contractor shall carry out any such modifications to the original route survey as and where required. The documents of the original route survey of the lines will be made available to the successful Bidder. Under the Check Survey following activities are included in the scope of this Bid:

- a) Review and verification of tower spotting data of original route Survey reports and optimisation of tower locations.
- b) Preparation of final route profile, tower schedule, tower plotting data etc after Check Survey.
- c) Locating and peg marking the tower positions on ground conforming to the approved profile and tower schedule.

2.1.2 The Contractor should note that Employer will not furnish the topographical maps prepared by Survey of India but will make available any assistance that may be required in obtaining the topographical maps.

2.2.0 DETAILED AND CHECK SURVEY

2.2.1 The detail and check survey shall be conducted to locate and peg mark the tower positions on ground conforming to the supplied profile and tower schedule. In this process, it is necessary to have the pit centres marked according to the excavation marking charts. The levels, up or down of each pit centre with respect to the centre of the tower location shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters. Unequal leg extensions may be provided to reduce benching and leg revetment.

2.2.2 While carrying out the Check Survey works following stipulations shall be followed.

2.2.3 All elevations shall be referenced to benchmarks established by the survey of India. Levelling operations shall begin and end at benchmarks approved by the Employer.

2.2.4 During the levelling of the profile check surveys will be affected at intervals not exceeding 50 kilometres with benchmarks of known elevations. The difference in elevations as surveyed by Contractor and as declared by the survey of India for these benchmarks shall not exceed the precision required for 3rd order surveys, i.e. $e < 24/k$, where K is the distance between benchmarks in km and e is the distance in elevations in mm.

2.2.5 All-important objects and features along the transmission line, centreline (railways, highways, road, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

2.3.0 FINAL PROFILING AND TOWER SPOTTING

- 2.3.1 Based on the original survey (reconnaissance) report supplied by the Employer and after making the Detailed & Check Survey the Contractor shall prepare the final tower plotting data and profile based on sag template prepared fresh by the Contractor himself.
- 2.3.2 Profile shall be plotted and prepared to scale of 1 :2000 horizontal & 1 :200 vertical on 1.0, 10 mm squared paper as per approve procedure. Reference levels at every 20 metres along the profile are also to be indicated on the profile besides, R/Ls at undulations. Areas along the profile Sheet, in the view of the contractor, are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels be too high, the chart may be broken up accordingly to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be 594 mm wide in accordance with the relevant standard. For 'as built' profile these shall be in A 1 size.
- 2.3.3 With the help of prepared sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:
- a) **Span**

The number of consecutive spans between the section points shall not exceed 15 spans or 5 Km in plain terrain and 10 spans or 3 km in hilly terrain. A section point shall comprise of tension point with C type or D type towers as applicable.
 - (b) **Extension**

An individual span shall be as near to the normal design span as possible. In case of an individual span where ground clearance cannot be maintained with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed as stipulated elsewhere in this specification.
 - (c) **Loading**

There shall not be any upward force on suspension towers under normal working conditions and the suspension towers shall support at least the minimum weight span as provided in the designs. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the towers failing which tension towers designed for the purpose shall be employed at such positions.
 - (d) **Benching**

In hilly/mountainous regions, when benching might be required, Contractor shall make contour measurements along with the calculation for the volume of Benching and revetment, so that a decision can be made whether to accept benching and/or use unequal leg extensions for a particular site. Benching shall be resorted to only after approval from Employer.
 - (e) **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 specified with maximum conductor sag. At all national highways tension towers shall be used and crossing span will not be more than 250 meters.

(f) **Railway Crossings**

The entire railway crossings coming-en route the transmission line has already been identified by the Employer. At the time of check survey, the railway crossings shall be finalised as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987)

- i The crossing shall normally be at right angle to the railway track.
- ii The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track
- iii No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.
- iv Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained at 17.90 metres.
- v The crossing span will be limited to 300 meters.

The approval for crossing railway track shall be obtained by the Employer from the Railway Authority, however, six copies of profile and plan, tower and foundation design and drawings required for the approval from the Railway Authority shall be supplied by the Contractor to the Employer.

(g) **River Crossings**

In case of Major River crossing towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be 'A' type tower. For navigable rivers the clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to highest flood level (HFL) and shall be 15.0 meters with maximum conductor sag.

(h) **Power line Crossings**

Where this line is to cross over another line of the same voltage or lower voltage, any available tower with suitable extensions shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules / IS: 5613 as amended up to date. In order to reduce the height of the crossing towers it may be advantageous to remove the ground-wire of the line to be crossed (if this is possible and permitted by the Employer of the line to be crossed). 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.

(i) **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.

The design minimum clearance between the 220kV Conductors and telecommunication lines shall be with maximum conductor sag.

(j) **Details En-route**

All topographical details, permanent features, such as trees, building etc. 50m on either side of the alignment shall be detailed on the profile plan.

(j) **Clearance from Ground, Building, trees etc**

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 / IS 5613 as amended up to date.

2.3.4 The final sag-template curve diagram, profile sheets, duly spotted, along with the schedules indicating type of towers, type of foundations, wind span, weight span, angle of deviation, river or road crossing and other details shall be submitted for the approval of the Employer. After approval, the Contractor shall submit six more sets of the approved reports along with one set of reproducible of final profile drawings to the Employer for record purpose

2.3.5 The Contractor shall also submit two numbers of the final template, prepared on rigid transparent plastic sheet to the Employer for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.

2.4.0 SOIL RESISTIVITY MEASUREMENT

2.4.1 Soil resistivity along the route alignment shall be measured in dry weather by four-electrode method keeping inter-electrode spacing of 50 meters. For calculating soil resistivity formula $2\pi ar$ (where $a=50$ metres and r = megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 kms along the route of transmission lines. In case soil characteristic, changes within 2 to 3 kms, the value shall also have to be measured at intermediate locations. The megger reading and soil characteristics shall also be indicated in the soil resistivity results.

2.5.0 SOIL TESTING

2.5.1 Type of foundation has already been classified. However soil testing in some locations may be required depending upon the site condition. Accordingly each foundation shall be classified to one of the four types specified in section - 4 of this Volume and approval shall be taken from the competent authority of AEGCL

2.6.0 RIGHT OF WAY, TREE CUTTING ETC.

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

2.6.2 Any way leave, which may be required by the Contractor for survey, shall be arranged by the Employer as required by work programme.

2.6.3 To evaluate and tabulate the trees and bushes coming within 50 m on either side of the central line alignment the trees will be numbered and marked with quality paint serially from angle point 1 (I) onwards and the corresponding number will be painted on the stem of trees at-a height of 1 metre from ground level. The trees list should contain the following:

- i. Girth (circumstances) measured at a height of 1 metre from ground level.
- ii. Approximate height of the tree with an accuracy of +2 metres.

- iii. Name of the type of the species/tree.
 - iv. The bushy and under growth encountered in the 52 m belt should also be evaluated with its type, height, girth and area in square metres, clearly indicating the growth in the tree/bush statement.
- 2.6.4 Payment of compensation towards value of trees, crops, buildings etc. to be cleared as identified in clause 2.6.1 will be the responsibility of the Employer.

2.7.0 ENVIRONMENTAL CONDITIONS

2.7.1 Forest

The line route passing through forest stretches for various transmission lines covered under this specification shall be furnished to the successful Bidder.

2.7.2 General Climatic Conditions

Climatic conditions shall be of tropical nature having summer period for 8 months and winter period for 4 months in a year. Working season shall be approximately 7-8 months/year and balance 4-5 months shall be monsoon period. The maximum temperature during summer shall be of the order of 45 Degrees Centigrade and the minimum temperature in the winter shall be of the order of 4 Degrees Centigrade Normal everyday temperature is 32 Degrees Centigrade.

2.8.0 STATUTORY REGULATIONS AND STANDARDS

2.8.1 Statutory Regulations

The Contractor is required to follow local statutory regulations stipulated in Electricity (Supply) Act, Indian Electricity Rules as amended and other local rules and regulations referred in this Specification.

2.8.2 Reference Standard

The Codes and/or standards referred to in the specifications shall govern in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions, amendments/changes adopted and published by the relevant agencies unless otherwise specified. Other internationally accepted standards, which ensure equal or better performance than those specified shall also be accepted, subject to prior approval by the Employer.

SECTION-3

SPECIFICATION FOR DESIGN AND FABRICATION OF TRANSMISSIONLINE TOWERS (TECHNICAL SPECIFICATIONS)

3.1.0 SCOPE

3.1.1 This section covers the design, fabrication, galvanising, supply and delivery at site of galvanised steel structures, bolts & nuts, tower accessories etc. for transmission line towers covered under this Bid Document and as per Specification.

3.1.2 **Design of structures is not in the scope of Bidders for this package. The structures shall be supplied on the basis of drawings supplied by the Employer.** However, in case any special tower or structure is required but is not covered in the bidding document, the Employer may ask the Contractor to design and supply such structure.

3.2.0 GENERAL DESCRIPTION OF THE TOWER

3.2.1 General

3.2.1.1 The towers shall be of self-supporting hot dip galvanized lattice steel type designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions.

3.2.1.2 The tower shall be fully Galvanised using mild steel or / and high tensile steel sections. Bolts and nuts with spring washer are to be used for connections.

3.2.2 Type of Towers

3.2.2.1 Normal Towers

The towers for transmission lines are classified as given below. The bidder shall design and quote for the following four types of towers (Standard/Standard Towers):

Tower type D shall also be used as a Dead End tower.

Type of Tower	Deviation Limit	Typical Use
A	0 – 2 deg.	To be used as tangent tower with single or Double suspension Insulator String
B	2 - 15 deg.	a) Angle towers with Single / Double Tension insulator string.
C	15 - 30 deg.	a) Angle tower with single or /and double tension insulator string. b) Also to be used for locations where uplift exist. c) Section tower for anti-cascading condition.
D	30 - 60 deg/ Dead End.	a) Angle tower with Single or / and Double tension insulator string. b) Also to be used for locations where uplift exist. c) Dead end with 0 deg. to 15 deg. deviation both on line side and substation side (slack span)

The angles of line deviation specified are for the design span. The span may however be increased up to an optimum limit with reduced angle of line deviation if adequate ground and phase clearances are available. For this purpose the Contractor shall prepare a tower rating chart (weight/wind span as function of various angles of deviations).

3.2.2.2 Special Towers

In case a defined type of Towers cannot be used at certain location(s), the Contractor may be asked to submit design of such towers/structures for such locations and payments shall be made at unit rates of other type of towers.

3.3.0 SPANS AND CLEARANCES

3.3.1 Normal span, Wind Span & Weight Span

The normal ruling span, wind span and weight span to be adopted for lines covered under this Specification are specified in Clause 1.6.0, Section-1 of this Volume along with all other parameters.

3.3.2 Electrical Clearances

3.3.2.1 Ground Clearance

- a) The minimum ground clearance of conductors above ground shall not be less than the limits specified in Line Data at 1.6.0, Section-1 of this volume, at a conductor temperature of 85°C and in still air. However, to achieve the above clearance the standard tower heights include the following additional allowances:
- b) 150 mm to account for errors in stringing;
- c) Conductor creep as calculated by over tensioning the conductor at a temperature of 30°C lower than the stringing temperature or as determined from the sag-tension tables, which include the final sags including the effects of creep.

3.3.2.2 Clearances of live parts form cross arm & towers

The minimum clearances shall be adopted from the following Table.

SL. No	Item	Swinging in degrees	Minimum electrical clearances for line voltage 132 kV
1	SUSPENSION STRINGS (a) Single suspension string	Nil	1530 mm
		15°	1530 mm
		30°	1370 mm
		45°	1220 mm
		60°	1070 mm
	(b) Double suspension string	Nil	1530 mm
2	TENSION STRING Single / double	Nil	1530 mm
3	JUMPER	Nil	1530 mm
		10°	1530 mm
		20°	1070 mm
		30°	1070 mm
4	Min. Vertical distance between conductor or cross arms (Single or double circuit)		3900 mm
5	Min. Horizontal distance between conductors (Single or double circuit)		6800 mm

3.3.2.3 Railway Crossings, etc.

For railway crossing the clearances from the lowest conductor points to the rail level shall not be less than what is required to comply in all respects with the "Regulation governing the placing of transmission lines across railway tracks" issued by the railway board. In case of trunk road crossings, the clearance from the lowest conductor point to road level shall not contravene the provision of IE rules. Power and Tele-communication line crossings are to be constructed strictly in accordance with provision of IE Rules.

3.4.0 DESIGN DRAWINGS

3.4.1 The relevant drawings for all the towers and their extensions (if applicable) shall be furnished by the Contractor to the Employer which shall include structural/erection drawings, shop fabrication drawings, Bill of Materials, foundation working drawings.

3.4.2 The structural/erection drawings, Bill of materials and shop fabrication drawings for all the towers and their extensions shall be submitted as specified in this Bid document. Documents shall be submitted in four copies and will be finally approved by the Employer. The mass/fabrication shall be taken up from the approved shop drawings. The overall responsibility of fabricating tower members correctly lies with the Contractor only and the Contractor shall ensure that all the tower members can be fitted while erecting without any undue strain on them.

3.4.3 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, in three copies, along with one reproducible, for record. These drawings shall be prepared in **A4** size only.

3.4.4 All the drawings shall 'have a proper name plate clearly displaying the name of "Assam Electricity Grid Corporation Limited" on right hand bottom corner. The exact format of the nameplate shall be handed over to the successful bidder for incorporation of the same on all the drawings. Also all the drawings shall carry the following statement and shall be displayed conspicuously on the drawing: WARNING: THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH AEGCL. UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM THE EMPLOYER IN WRITING.

3.4.5 While submitting the structural drawings, bill of materials and any other drawings pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing Bid Reference No., Name of the transmission line and project, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies. The Contractor shall be required to submit 15 copies of all relevant drawings for necessary distribution.

3.5.0 SLENDERNESS RATIO

3.5.1 **Slenderness ratio for members shall be computed in accordance with Clause 10 of IS: 802. The limiting values of L/R shall be as follows:**

(a) Leg members, G.W. peak and cross arm lower member:	120
(b) Bracings:	200
(c) Redundant members and those carrying nominal stress:	250
(d) Tension member:	400

3.6.0 CONDUCTOR CONFIGURATION

- 3.6.1 In case of single circuit line the conductor shall be in triangular formation with one conductor on one side of the tower and the other two on the other side.
- 3.6.2 In case of the double circuit line (and also in case of single circuit line in double circuit towers with provision of stringing the line in future), the six power conductors shall be square type of formation at distances suiting to the specified clearance requirements. The lines will be placed on either side of the tower with the phase conductors of each line being placed vertically on above the other and as far as possible are equidistant from the centre line of the towers. One continuous earth wire shall be provided above the conductors at suitable distance to offer effective shielding and safe clearance.

3.7.0 HEIGHT AND LOCATION OF GROUND WIRES

- 3.7.1 Provision of single earth wire / ground wire shall be made in the design of the towers. The height and location of the ground wires will be such that the shield angle is not greater than 30 degrees.
- 3.7.2 The mid-span clearance between the earth wire and conductors shall be kept more than the clearance at the tower. The Contractor shall maintain the sag of the ground wire at least 10 percent less than that of the power conductor under all temperature conditions in still wind at the normal spans so as to give a mid-span separation greater than that at the supports.

3.8.0 LOADS ON TOWERS

- 3.8.1 The tower members shall be designed for three conditions of loadings. The conditions with their combinations of loadings are as follows:

A) **Reliability Condition (Normal Condition)**

- i) Transverse Loads as per Clause: 3.8.2.
- ii) Vertical Loads as per Clause: 3.8.5.
- iii) Longitudinal Loads as per Clause: 3.8.8.

B) **Security Condition (Broken wire condition)**

- i) Transverse Loads as per Clause: 3.8.3.
- ii) Vertical Loads as per Clause: 3.8.6.
- iii) Longitudinal Loads as per Clause: 3.8.9.

C) **Safety Condition (Construction and Maintenance)**

a) *Normal Condition*

- i) Transverse Loads as per Clause: 3.8.4 (a).
- ii) Vertical Loads as per Clause: 3.8.7.
- iii) Longitudinal Loads as per Clause: 3.8.10 (A).

b) *Broken Wire Condition*

- i) Transverse Loads as per Clause: 3.8.4 (b).
- ii) Vertical Loads as per Clause: 3.8.7.
- iii) Longitudinal Loads as per Clause: 3.8.10 (B).

- 3.8.2 *Transverse Loads: Reliability Condition (Normal Condition)*

Under this following loads shall be taken into account:

- a) **Wind Load on Conductor and Ground Wire:**
This shall be calculated by taking the basic wind pressure be acting normal to the line.
- b) **Wind Load on Insulator String:**
Wind load on insulator strings shall be determined from the attachment point to the centre line of the conductor in case of suspension towers and upto the end of clamp in case of tension towers. The Design wind pressure shall be considered acting on 50% area of insulator string projected on a plan, which is parallel to the longitudinal axis of the string.
- c) **Wind Load on Towers:**
This shall be calculated considering the wind to be acting normally on face of the tower.
- d) **Transverses Loads from Mechanical Tension of Conductors and Ground Wire (Due to line deviation):**
This is the component of conductor/ground wire tension at tower acting in the transverse direction of the line. In calculating this force; the conductor/ground wire tension is either the tension at every day temperature (32^o C) & 100% of full wind pressure or the tension at minimum temperature and 36% of full wind pressure whichever is more.

3.8.3 *Transverse Loads: security condition*

- a) **Suspension Towers**
 - i. Transverse loads due to wind acting on tower structure, conductors, ground wires and insulators shall be taken as nil.
 - ii. Transverse loads due to line deviation shall be based on component of mechanical tension of conductors and ground wires corresponding to everyday temperature and nil wind condition. For broken wire the component shall be corresponding to 75% of mechanical tension of conductor and 100% of mechanical tension of ground wire at every day temperature and nil wind.
- b) **Tension and Dead End Towers**
 - i. Transverse loads due to wind action on tower structure, conductors, ground wire and insulators shall be as per Clause: 3.8.2 (a) and (b) 60% wind span shall be considered for broken wire and 100% for intact wires.
 - ii. Transverse loads due to line deviation shall be the component of 100% mechanical tension of conductor and ground wire as defined in Clause: 3.8.2 (d).

3.8.4 *Transverse Loads: safety condition*

- a) **Normal Condition: -- Suspension, Tension and dead End Tower**
 - i) Transverse loads due to wind action on tower structure, conductors ground wires and insulators shall be taken as nil.
 - ii) Transverse loads due to mechanical tension of conductor or ground wire shall be calculated in same manner as in Clause: 3.8.2 (d) but with tension corresponding to everyday temperature and nil wind.
- b) **Broken Wire Condition: -- Suspension, Tension and dead End Tower**
 - i) Transverse loads due to wind action on tower structure, conductors, ground wire, insulators shall be taken as nil.
 - ii) Transverse load due to mechanical tension of conductor or ground wire on account of line deviation shall be taken as follows:

$$TM = TI \times \sin \phi/2, \text{ where,}$$

$$\text{Where, } TM = \text{Load}$$

- TI = 50% of tension of conductor and 100% of tension of ground wire at everyday temperature and nil wind for suspension tower and 100% for angle and dead end towers for both conductor and ground wire.]
- Φ = Angle of deviation of tower.

3.8.5 Vertical Loads: Reliability Condition (normal condition)

- i) Loads due to weight of each conductor and ground based on appropriate weight span, weight of insulator strings and accessories.
- ii) Self weight of structures up to tower panel under consideration.

3.8.6 Vertical Loads: Security Condition

- i) Loads due to weight of each conductor or ground wire based on appropriate weight span, weight of insulator strings and accessories taking broken wire condition where the load due to weight of broken conductor/ground wire shall be considered as 60% of weight span. For intact wire the vertical load shall be considered as given in Clause: 3.8.5.
- ii) Self weight of structures up to tower panel under consideration.

3.8.7 Vertical Loads: Safety Condition

- i) Same as Clause 3.8.6 (i) multiplied by overload factor of 2.0
- ii) Same as Clause 3.8.6 (ii).
- iii) A load of 1500 N shall be considered acting at each cross arm tip as a provision for weight of line man with tools.
- iv) An additional load of 3500 N at cross arm tip.
- v) All bracings and redundant members of the towers which are horizontal or inclined upto 15° from horizontal shall be designed to withstand as ultimate vertical load of 1500 N considered as acting at centre, independent of all other loads.

3.8.8 Longitudinal Loads: Reliability Condition

A) Suspension and Tension Towers

- i) Longitudinal loads for Suspension and Tension towers shall be taken as nil.
- ii) Longitudinal loads which might be caused on tension towers by adjacent spans of unequal length shall be neglected.

B) Dead End Tower

- i) Longitudinal loads for Dead End Towers shall be considered corresponding to mechanical tension of conductors and ground wires at every day temperature & design wind pressure or at minimum temperature with 36% of design wind pressure, whichever is more stringent.

3.8.9 Longitudinal Loads: Security Condition

A) Suspension Towers

The longitudinal loads corresponding to 50% of the mechanical tension of conductor and 100% of mechanical tension of ground wire shall be considered under everyday temperature and no wind pressure for broken wire only.

B) Tension Towers

Horizontal loads in longitudinal direction due to mechanical tension of conductors and ground wire shall be taken for loading criteria mentioned in Clause: 3.8.8 (B) for broken wires. For intact wires these loads shall be considered nil.

C) Dead End Towers

Horizontal loads in longitudinal direction due to mechanical tension of conductors and ground wire shall be taken for loading criteria mentioned in Clause: 3.8.8 (B) for intact wires; however for broken wires these loads shall be considered nil.

3.8.10 Longitudinal Loads: Safety Condition

A) Normal Condition

i) Suspension and Tension Towers

These shall be taken as nil.

ii) Dead End Towers

These loads for Dead End towers shall be considered as corresponding to mechanical tension of conductors/ground wire at every day temperature and nil wind. Longitudinal loads due to unequal spans may be neglected.

B) Broken wire Condition

i) Longitudinal loads during construction simulating broken wire condition will be based on stringing of one earth wire or one complete phase conductor at one time.

ii) Suspension Towers

Longitudinal loads during stringing on suspension towers should be normally imposed only by the passing restriction imposed during pushing of the running block through the sheave. It will apply only on one complete phase of sub-conductor or one earth wire. It will be taken as 10000 N per sub-conductor or 5000 N per earth wire.

iii) Tension and Dead End Tower

Angle Towers used as dead end during stringing simulating broken wire condition shall be capable of resisting longitudinal loads resulting from load equal to twice the sagging tension (sagging tension is 50% of the tension at every day temperature and nil wind) for one earth wire or one complete phase sub-conductors which is in process of stringing. At other earth wire or conductor attachment points for which stringing has been completed, loads equal to 1.5 times the sagging tension will be considered.

3.8.11 Anti Cascading Checks

i) All angle towers shall be checked for the following anti-cascading conditions with all conductors and G.W. intact only on one side of the tower.

ii) *Transverse Loads*:- These loads shall be taken under no wind condition.

iii) *Vertical Loads*:- These loads shall; be the weight of conductor/ground wire intact on one side of tower, weight of insulator strings and accessories.

iv) *Longitudinal Loads*:- These Loads shall be the pull of conductor/ground wire at every day temperature and no wind applied simultaneously at all points on one side with zero degree line deviation.

3.8.12 Broken Wire Conditions

A) **SINGLE CIRCUIT TOWERS**

Any one-phase conductor or earth wire broken, whichever is more stringent for a particular member.

B) **DOUBLECIRCUIT TOWERS**

i) **SUSPENSION TOWERS**

Any one phase conductor or earth wire broken, whichever is more stringent for a particular member.

ii) **ANGLE TOWERS, TYPE-B & C**

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

ii) **ANGLETOWERS, TYPE-D (Dead End Tower)**

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

3.9.0 DESIGN WIND PRESSURE

3.9.1 Design Wind Pressure for the purpose of this Specification shall be taken as **720 N/m²** which corresponds to wind velocity at 10 m height. For Design Wind Pressure at other heights reference shall be made to **IS: 802 or 'Transmission Line Manual'** published by Central Board of Irrigation and Power, *New Delhi*. The Design Wind Pressure mentioned above is corresponds to Wind Zone-5, Reliability Level-1 and Terrain Category-2 as per IS: 802.

3.10.0 OTHER DESIGN PARAMETERS

3.10.1 For other design parameters to be adopted for the design of towers reference shall be made to **Clause – 1.6, Section - 1** of this Specification.

3.11.0 MATERIALS

3.11.1 Tower Steel Sections

3.11.1.1 Steel Sections of tested quality of conformity with IS:2062 (Designated Y.S. 250 MPa) or/and IS:8500 (Designated Y.S. 350 Mpa) or equivalent international standards are to be used in towers, extensions 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/BS-4360-50B grade (355MPa) is not permissible.

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

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

3.11.2 Fasteners: Bolts, Nuts and Washers

3.11.2.1 All bolts and nuts shall conform to IS-12427 or equivalent international standards. All bolts and nuts shall be galvanized as per IS: 1367 (Part-13)/18:2629 or equivalent international standards and shall have hexagonal head and nuts, the heads being forged out of the solid truly concentric, and square with the shank, which must be perfectly straight.

3.11.2.2 The bolt shall be of 16/24 mm diameter and of property class 5.6 as specified in IS: 1367 (Part-III) or equivalent international standards and matching nut of property class 5.0 as specified in IS: 1367: (Part-VI) or equivalent international standards.

3.11.2.3 Bolts upto M 16 and having length upto 10 times the diameter if the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6

grade should be 310 MPa minimum as per IS: 12427 or equivalent international standards. Bolts should be provided with washer face in accordance with IS: 1363 (Part-I) or equivalent international standards to ensure proper bearing.

- 3.11.2.4 Nuts should be double chamfered as per the requirement of IS: 1363 Part-II'. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4MM oversize on effective diameter for size upto M 16.
- 3.11.2.5 Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.
- 3.11.2.6 All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.
- 3.11.2.7 Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro galvanised, positive lock type and 3.5mm in thickness for 16mm dia bolt and 4.5mm for 24mm bolt.
- 3.11.2.8 To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.
- 3.11.2.9 The bolt positions in assembled towers shall be as per structural drawing.
- 3.11.2.10 Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.
- 3.11.2.11 To ensure effective in-process Quality control it is essential that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this Specification and ISO: 14000 series Quality System Standard

3.12.0 TOWER ACCESSORIES

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

3.12.2 Step Bolts & Ladders

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

3.12.3 Insulator Strings and Earth wire Clamps Attachments

- 3.12.3.1 Single / Double suspension insulator string assemblies shall be used for 'A' type tower as required. For the attachment of Suspension Insulator string, a suitable strain plate of sufficient

thickness for transferring the load to the tower body shall be provided. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the 1nsulator string the insulator string the same shall be supplied by the Contractor.

3.12.3.2 At tension towers strain plates of suitable dimensions placed on the underside of each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details of the attachments shall be provided to the successful bidder. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor.

3.12.3.3 All important crossing like Railway Tracks, Important Roads, Rivers or any other Crossings of similar nature shall be done with Double Insulator String.

3.12.4 **GROUND WIRE Clamps Attachment**

3.12.4.1 Suspension Clamp

The detailed drawing shall be submitted by the Contractor for Employer's approval. The Contractor shall also supply U- bolts, D-shackles wherever required.

3.12.4.2 Tension Clamps

GROUND WIRE peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take Employer's approval for details of the attachments before the mass fabrication.

3.12.5 **Anti-climbing Device**

Barbed wire type anti climbing device, as per IS 5613 or equivalent International Standards shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS-278 (size designation A 1) or equivalent International Standards. The barbed wires shall be given chromatin dip as per procedure laid down in IS: 1340 or equivalent International Standards.

3.12.6 **Danger, Number and Phase plate**

Danger Plates, Number plates and phase plates shall be provided and installed by the Contractor.

- a) Each tower shall be fitted with a danger plate, number plate and a set of phase plates. The transposition tower should have the provision of fixing phase plates on both the transverse phases.
- b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS-2551 or equivalent International Standards and shall be in a signal red on the front of the plate.
- c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.
- d) The letters of number and circuit plates shall be red enamelled with white enamelled background.

3.12.7 **Aviation Requirements**

Aviation requirements, if indicated separately in Schedule of Requirements shall be in the scope of the Contractor and the same shall conform to IS: 5613 or equivalent International Standards.

3.13.0 **TOWER FABRICATION**

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

- 3.13.1.1 Except where hereinafter modified, details of fabrication shall conform to IS: 802 (Part-II) or the relevant international standards.
- 3.13.1.2 The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.
- 3.13.1.3 No angle member shall have the two leg flanges brought together by closing the angle.
- 3.13.1.4 The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.
- 3.13.1.5 The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.
- 3.13.1.6 All identical parts shall be made strictly inter-changeable. All steel sections before any work are done on them shall be carefully levelled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.
- 3.13.1.7 **Minimum Thickness of Tower Members:**
The minimum thickness of galvanised and painted tower members shall be as follows: -

ITEM	Minimum thickness in mm	
	Galvanised	Painted
Leg members & lower members of cross arms in compression	5	6
Other members	5	5

- 3.13.1.8 No tower angle member shall be less than 45x45x5 mm
- 3.13.2 **Drilling and Punching**
- 3.13.2.1 Before any cutting work is started, all steel sections shall be carefully strengthened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.
- 3.13.2.2 Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The punching may be adopted for thickness upto 16mm. Tolerances regarding punch holes are as follows:
- Holes must be perfectly circular and no tolerances in this respect are permissible.
 - The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8 mm on diameter.
 - Holes must be square with the plates or angles and have their walls parallel.
- 3.13.2.3 All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.
- 3.13.3 **Erection mark**
- 3.13.3.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing,
- 3.13.3.2 Erection Mark shall be A-BB-CC-DDD

A = Employer's code assigned to the Contractors -Alphabet
 BB= Contractor's Mark-Numerical
 CC = Tower Type Alphabet.
 DDD= Number mark tube assigned by Contractor -Numerical.

3.14.0 QUANTITIES AND WEIGHTS

- 3.14.1 The quantities of the following items have been envisaged in Metric Tonne (MT) in the relevant price Schedules for various types of towers:
- i) Basic Body.
 - ii) Body Extensions.
 - iii) Stubs & Cleats
 - iv) Bolts & Nuts including spring washers and step bolts etc.

During detail engineering, proto assembly of each of the above items shall be inspected, tested and approved by AEGCL and subsequently shall be released for fabrication and manufacturing as per the Technical Specification by the Contractor.

3.15.0 WEIGHTS OF TOWER

- 3.15.1 The weight of tower, stubs and stub template for payment purposes shall mean the weight, calculated by using the standard sectional weights (as per relevant IS) of all steel members of the sizes indicated in the approved fabrication drawings and bill of materials without taking into consideration the reduction in weight due to drilling of bolt holes, skew cuts, chamfering etc. or increase in weight due to galvanizing /painting. Similar method shall be used for nuts & bolts also.
- 3.15.2 The weight of various types structures indicated in the Bill of Materials (Annexure-I & II of Section-1) are provisional only and for bidding purpose. Payments shall be made on the basis of drawings released for construction.

3.16.1

3.17.0 GALVANIZING AND PAINTING

- 3.17.1 Galvanising and painting of the various members of the structures shall be done only after all works of sawing, shearing, drilling, filing, bending and matching are completed. Galvanising shall be done by the hot dip process as recommended in IS: 2629 or other such authoritative international standards and shall produce a smooth, clean and uniform coating of not less than 610 gm per square meter. The preparation for galvanising and the galvanising process itself must not affect adversely the mechanical properties of the treated materials.
- 3.17.2 All assembly bolts shall be thoroughly hot dip galvanized after threading. Threads shall be of a depth sufficient to allow for the galvanized coating, which must not be excessive at the root of the threads, so that the nut shall turn easily on the completed bolts without excessive looseness. The nut threads shall not be galvanized, but oiled only.
- 3.17.3 The outside surface shall be galvanised. Sample of galvanised materials shall be supplied to the galvanising test set out in IS 729 or other such authoritative international standards.
- 3.17.4 The portion of the stub angle from 150 mm below the plinth level shall be black and the remaining portion shall be galvanised.
- 3.17.5 The parts, which are to be painted, shall be thoroughly cleaned. Two coats of a good quality primer shall be applied to produce a smooth void less surface before applying one coat of approved quality aluminium paint at works. The final coating of aluminium paint shall be applied after erection at site.

3.18.0 EARTHING

- 3.18.1 To keep provision in the towers for earthing, two holes of 17.5 mm diameter and about 50 mm apart shall be drilled on each of the legs of the towers, such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earthing strip.

3.19.0 TEST AND TEST CERTIFICATE

- 3.19.1 Each consignment ready for transportation shall be offered to the Employer for inspection before dispatch. Samples of fabricated tower materials shall be subjected to following tests: -
- Tower steel: The structural steel shall conform to IS 226 and IS 8500 or other such authoritative international standards. Manufacturer's test certificate shall be submitted for all used steel.
 - Galvanising: The galvanising shall be as per IS 2633 or other such authoritative international standards. Zinc coating over the galvanised surfaces shall not be less than 610 gm per square meter.
 - Bolts and nuts: Manufacturer's test certificate as per standard practice shall be submitted.

3.19.2 *Test at Contractor's Premise:*

The contractor shall fabricate one specimen tower of each type as soon as possible after placement of order and before starting the bulk fabrication of the towers ordered. It shall be assembled on a foundation as nearly similar as practicable to site and tested with suitable test loads as per specified broken wire condition, multiplied by the corresponding factor of safety to ensure that the design and fabrication complies with the requirements. Each structure shall be capable of withstanding the above-mentioned tests without any injury or any permanent deflection at any part. If any member is found to be weak or damaged the design should be suitably modified and the tower re-tested.

After manufacture of first lot, finished members forming each type of towers shall be selected at random and tested for quality. The tower then shall be set on foundation as nearly similar as practicable to site and tested with equivalent test load for which the tower has been designed.

No tower or any member thereof, which failed under the test shall be supplied. No tests need to be carried out on the special towers and the 3 meter and 6 meter extensions. As such, they shall be very carefully designed on the basis of the results of the other types of towers.

If desired by the Employer, towers shall be tested to destruction at the expenses of the contractor/supplier. The Employer reserves the right to witness any and all of the tests carried out as above and so should be given 30 days advance notice of the dates on which such tests are scheduled to be carried out.

3.20.0 LIST OF STANDARDS AND GUIDES

- 3.20.1 List of Indian Standards and other related Publications:

Sl. No	Indian Standards	Title
1	IS: 209-1992	Specification for Zinc
2	IS 278-1991	Galvanised Steel Barbed wire
3	IS 800-1991	Code of Practice for Steel in General Building Construction.
4	IS: 802 (Part1, 2,3)	Code of Practice for use of Steel in Overhead Transmission Line
5	IS: 808-1991	Dimensions for Hot Rolled
6	IS: 875-1992	Coe of Practice for Design Loads

Sl. No	Indian Standards	Title
		(other than Earthquakes) for Buildings and Structures
7	IS: 1363-1990	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures
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
10	IS: 1573-199	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
13	IS: 2016-1992	Plain Washers ISO/R887
14	IS:2062-1992	Steel for general structural purposes
15	IS: 2074-1992	Ready Mixed Paint. Air Drying Red Oxide, Zinc Chrome, 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
19	IS: 3043-1991	Code of Practice for Earthing
20	IS: 3063-1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws
21	IS:3757-1992	High Strength Structural Bolts
22	IS: 4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products
23	IS: 5369-1991	General Requirements for Plain Washers
24	IS:5613-1993	Code of Practice for Design installation and Maintenance of overhead Power Lines
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
28	IS: 6745-1990	Method for Determination of weight of Zinc coated iron and Steel Articles
29	IS: 8500-1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)
29	IS: 10238-1989	Step Bolts for Steel Structures
30	IS: 12427-1988	Bolts for transmission Line Towers
31		Indian Electricity Rules
32	Publication No.19 (N)700	Regulation for Electrical Crossing of Railway Tracks
33	CBIP Publication No-	Transmission Line Manual

SECTION-4

TOWER FOUNDATIONS

(TECHNICAL SPECIFICATIONS)

4.1.0 SCOPE

- 4.1.1 This section covers the specifications for design of foundations for various types of towers and special structures under different soil condition described herein after.
- 4.1.2 Design of foundations is not in the scope of Bidders for this package. The foundations shall be constructed on the basis of drawings supplied by the Employer. However, in case any special type of foundation is required but is not covered in the bidding document, the Employer may ask the Contractor to design and construct such foundation.

4.2.0 STANDARDS

- 4.2.1 For design of foundations reference shall be made to **IS 4099**. Reference shall also be made to '**Transmission Line Manual**' issued by *Central Board of Irrigation and Power, New Delhi*.

4.3.0 TYPE OF FOUNDATION(To be provided by AEGCL)

- 4.3.1 Most of the paddy fields of Assam remain under water for about 3 months in a year. During the remaining period of the year sub-soil water is normally found about 1.5 meters below the ground level. The Contractor shall note this factor while designing the foundation of towers.
- 4.3.2 It is expected that the type of foundations defined in **Clause 4.3.4** below shall be suitable for use at various locations of all the Transmission Lines covered in this Bid Document. *The Contractor shall examine the suitability of foundation type assigned for each location depending on the soil investigation reports.*
- 4.3.3 In case a defined type of foundations cannot be used at certain location(s), the Contractor may be asked to design foundations for such locations and payments shall be made at unit rates of other type of foundations.
- 4.3.4 The Contractor shall design and quote for the following four types of foundations and all the foundations shall be RCC type.
- (i) **Dry type foundation:** Design of this type of foundation shall be normally for dry / rocky / hard soil for which, (a) weight of earth shall be assumed to be 1600 kg/cum. (b) The Limit Bearing Capacity of the soil shall be 22000 kg/square meter. (c) The angle of repose shall be 30°.
 - (ii) **Wet type foundation (Suitable for paddy field location):** Design of this type of foundation shall be for locations where sub-soil water level is found below 1.5 meters from the ground level. This design shall also be suitable for paddy fields in Assam, as described in the first Para 4.3.1 above. The weight, the limit bearing capacity, the angle of repose and the ultimate bearing capacity of soil up to depth of 1.5 meter shall be taken as mentioned in (i) above and same for earth beyond 1.5 meter depth shall be taken as per (iv) below.
 - (iii) **Semi sub-merged type foundation:** Design of this type of foundations shall be for locations where sub-soil water level is found below 0.75 meter from the ground level.

The weight, the limit bearing capacity, the angle of repose and the ultimate bearing capacity of soil up to depth of 0.75 meter shall be taken as mentioned in (i) above and same for earth beyond 0.75 meter depth shall be taken as per (iv) below.

- (iv) **Sub-merged type foundation:** Design of this type of foundations shall be for locations where sub-soil water level is found at less than 0.75 meter from the ground level including completely sub-merged locations. (a) The weight of earth shall be assumed to be 850 kg/cum. (b) The limit bearing capacity of the soil shall be 11000 kg/sq. meter. (c) The angle of repose shall be 15°.
- (v) **Special Foundation:** Short Pile/Caisson/Pile drawings to be provided by AEGCL.

4.4.0 SEISMIC CONDITION:

- 4.4.1 Each foundation shall be provided with the tie beam for each type of tower to take care of seismic conditions. Force due to earthquake shall be assumed to be vertical 0.1g and horizontal 0.2g.

4.5.0 OVER LOAD FACTOR

- 4.5.1 The magnitude of limit loads for foundation should be taken as 10% higher than those for the corresponding towers.

4.6.0 FOUNDATION DEPTH

- 4.6.1 The total depth of foundations below the ground level shall not be less than 1.5 meter. To maintain inter-changeability of stubs for all type foundations of each type of towers almost the same depths of foundations will be used. However, the maximum depth of foundations for all types of towers shall not be more than 3.0 meters below the ground level.

4.7.0 LOADS ON FOUNDATIONS

- 4.7.1 The foundation shall be designed to withstand the loads of the superstructure (as specified under Section -3) for the full footing reactions obtained from the structure as per analysis in conformity with the relevant factors of safety. The reactions on the footings shall be composed of the following types of loads for which they shall be required to be checked.
1. Maximum tension or uplift
 2. Maximum compression or down thrust
 3. Maximum horizontal shear or side thrust
- 4.7.2 The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and the embedded steel parts will also be taken into account adding to the down thrust.

4.8.0 CONCRETING

- 4.8.1 The concrete foundation for transmission line towers shall consists of two portions viz. (i) pyramid & (ii) chimney. In chimney portion, the thickness of the concrete cover should be such that it provides minimum cover of not less than 10 cm from any part of the stub angle to the nearest outer surface of the concrete in respect of all dry locations, limiting the minimum section of chimney to 30.5 cm. Sq. In respect of all wet locations, the section of chimney should be 45.72 cm. Sq. uniformly for all sizes of stub angle.
- 4.8.2 The chimney top or muffing must be 23 cm above ground level in dry locations, 38 cm in irrigated field and 15.24 cm above maximum water level in tank beds.

- 4.8.3 The size of the bottom portion of the foundation viz. Pyramid should be designed according to the nature of the sub soil met with at the design depth for the stub angles.
- 4.8.4 The maximum base thickness in the pyramid portion in case of sub-merged foundation may be taken as 200 mm.

4.9.0 VOLUME OF FOUNDATIONS

- 4.9.1 The volume of foundation of a tower shall mean the total volume of the foundation including chimney, tie beams and the PCC soling. The volumes indicated for various types of tower foundations in BOQ provided are provisional only and for bidding purpose. Measurements and payments shall be made only on the basis drawings released for construction.

SECTION- 5

ERECTION OF TRANSMISSION LINE

(TECHNICAL SPECIFICATIONS)

5.1.0 SCOPE

5.1.1 This section covers the construction of the foundation as per approved drawing of the Employer, erection of towers and stringing of conductors and ground wires i.e. the complete construction of the proposed line.

5.2.0 SCOPE OF THE CONTRACT

5.2.1 The contractor will be responsible for all materials on turnkey basis and complete erection to the satisfaction of the Employer till the time of taking over of the transmission lines by the Employer.

5.3.0 SURVEY

5.3.1 The contractor shall execute both the detailed and check survey of the entire route selected by the Employer as far as possible. For this, the contractor will be supplied with the data of the original reconnaissance survey.

5.3.2 During the survey the contractor shall check the original reconnaissance survey and make recommendations for change if found necessary according to the final design of towers and shall make fresh profile sheets and submit the same for approval of the Employer before commencement of construction works.

5.3.3 During the Check Survey the Contractor shall also conduct soil investigation to decide on the type of the foundation to be adopted at various locations.

5.4.0 RIGHT OF WAY

5.4.1 The Employer will arrange for the right of way but clearance of jungles etc if necessary will have to be done by the contractor.

5.5.0 FOUNDATION CONSTRUCTION

5.5.1 For normal concrete foundation and for any other special foundation, the tenderer shall obtain approval of complete design for each of the foundation proposed to be adopted in different types of soil conditions. He will be responsible for construction of the foundations in accordance with the approved design. The Contractor shall be responsible for each foundation and shall be responsible for any failure, which in the opinion of the Employer is due to insufficient care having been taken either in investigation of sub-soil conditions or defective erection.

5.5.2 The work shall include all necessary revetment, concreting and earth filling above ground level. The concrete on stubs shall be set with the tops above 380 mm above ground level. Where the ground surface is irregular, the foundation will be finished off in a suitable and permanent way by forming a plinth by side cutting, building a suitable revetment as desired by authorised representative of the Employer.

5.5.3 The back fill material should be clean and free of organic or other foreign materials. The back fill shall be compacted with special care. The back fill shall be deposited in layers having a

thickness of not more than 200 mm after compression. The back filling operation shall be such that the materials when compressed will be blended sufficiently to secure the best practicable degree of compaction. The back filling and grading shall be carried to an elevation of approximately 75 mm above the finished ground level to drain out water.

- 5.5.4 The detailed specifications of the concrete foundation and the method of concreting will be required to be submitted to the Employer and approval obtained prior to commencement of work.
- 5.5.5 All wet foundations must be kept completely de-watered both during the placing of the concrete and for two hours subsequent to completion.
- 5.5.6 The concrete shall be covered by gunny bags being kept wet for a period of 24 days after laying. The pits may be back filled with wetted earth and consolidated for a minimum of 24 hours and thereafter the exposed top and fill shall be kept for the prescribed time of 21 days.

5.6.0 ERECTION OF TOWERS

- 5.6.1 The method will be left to the Contractor subject to the responsibility for any damage done to the materials due to any cause.
- 5.6.2 The towers must be truly vertical after erection and no straining will be permitted to bring them to a vertical position. Tolerance limit for vertical shall be one in 360 of the tower height. All nuts shall be tightened properly. Before tightening it is ensured that filler washers and plates are placed in relevant gaps between members, bolts of proper size and length are inspected and one spring washer is inserted under each nut. The tightening shall be progressively carried on from the top downwards, care being taken that all bolts at every level are tightened simultaneously.
- 5.6.3 The threads of bolts projecting outside nuts shall be punched at three positions on the diameter to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.
- 5.6.4 The Contractor shall arrange for tack welding of all nuts and bolts up to the bottom cross arm level of the towers, if so desired by the Employer. So, the Contractor shall quote separately for such tack welding for each type of tower on per tower basis. The quoted rates for erection of towers shall, therefore, be exclusive of the cost of above tack welding.

5.7.0 STRINGING OF CONDUCTOR AND GROUND WIRE

- 5.7.1 The stringing of the conductors and earth-wires shall be done in a most standard method used for such lines, which shall be indicated in the tender. The Contractor shall give complete details of the stringing method they propose to follow and indicate its adaptability and advantages. They shall also indicate the tools and equipment required for stringing by the method proposed by them. The contractor shall use his own stringing and erection tools and other equipment.
- 5.7.2 The contractor shall be entirely responsible for any damage to the towers or the conductors during stringing.

5.8.0 HANDLING OF CONDUCTOR

- 5.8.1 The contractor shall be entirely responsible for proper handling of the conductor, earth wire and accessories in the field. Care shall be taken to ensure that the conductor is not damaged; the section affected shall be replaced or repaired by putting joint or using repair sleeves or polishing with emery cloth, so as to give satisfactory performance.

5.9.0 PULLING ON OPERATION

5.9.1 The GROUND WIRE shall be strung and securely clamped to the towers before the conductors are drawn up in order of the top conductor first.

5.9.2 The pulling of the conductor into the travellers (comprising of aerial and ground rollers) shall be carried out in such a manner that the conductor is not damaged or contaminated with any foreign substance and that it may not be rubbed with rough ground surface. The traveller surface in contact with aluminium surface of conductor is not damaged. These shall be equipped with high quality ball and roller bearings for minimum friction.

During pulling out operation the tension in each conductor and GROUND WIRE shall not exceed the design working tension of the conductor at the actual prevailing temperature. After being pulled the conductor and the earth wire shall not be allowed to hang in the stringing blocks for more than 96 hours, before being pulled to the specified sag. It shall be ensured that the conductors and earth wire are not damaged due to wind, vibration or other cause.

5.10.0 SAGGING IN OPERATION

5.10.1 The conductors shall be pulled up to desired sag and left in travellers for at least one hour after which the sag shall be rechecked and adjusted. The conductors shall be clamped within 36 hours for sagging in. The sags shall also be checked when the conductors have been drawn up and transferred to the insulator clamps.

5.10.2 At sharp vertical angles the sags and tensions shall be checked on both sides of the angle. Sagging operations shall not be carried out under wind, extremely low temperature or other adverse weather conditions, which prevent satisfactory sagging.

5.11.0 JOINTING

5.11.1 All the joints of the conductor or the earth wire shall be compression type in accordance with the recommendations of the manufacturers, for which the necessary tools and equipment like compressors and dies, grease guns, presses shall have to be arranged by the contractor.

5.11.2 All joints and splices shall be made at least 30 meters away from the structures. No joint or splices shall be made in span crossing over main roads, railways, small rivers or in tension spans. Not more than one joint shall be allowed in one span.

5.11.3 After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

5.12.0 INSULATOR HOISTING

5.12.1 Suspension insulators shall be used up to deviation of 2 degrees on all 'A' type towers in the line and strain insulators on all 'B', 'C' and 'D' type towers. Except on approaching towers, all suspension strings will consist of the specified number of insulator discs per string with arching horns on line side only and tension string of specified number of insulator discs per string with arching horns on both line and tower sides.

5.12.2 Insulator strings shall be assembled on the ground. These shall be cleaned and examined before hoisting. Insulators with hair cracks or clips or those having glazing defects exceeding half centimetre square will not be used. No separate rates shall be quoted for insulator hoisting. The charges shall be included in the rates of string of conductors.

5.13.0 ACCESSORIES

5.13.1 Accessories like vibration dampers; armour rods etc. for the conductor shall also be fitted on the line. Armour rods shall be provided at all suspension support of the conductors and vibration dampers shall be provided at both ends of each span at suitable distances from the supporting points for each phase conductor. All accessories shall be clean, smooth and in perfect condition before fitting.

5.14.0 STRINGING RATE

5.14.1 The rate of stringing of the conductors and earth wire per kilometre route length of line will include laying, stringing, tensioning, clamping and jointing of these power conductors, one earth wire and fitting of all necessary accessories above or otherwise, which are normally required or are usual with such lines.

5.15.0 GROUNDING

5.15.1 The Contractor shall measure the tower footing resistance of each tower after it has been erected and before the stringing of the GROUND WIRE during dry weather. Each tower shall be earthed and the tower footing resistance shall not exceed 10 ohms. Generally pipe type earthing shall be done in accordance with the latest additions and revisions of:

IS: 3043 : Code of practice for Earthing or equivalent International Standards.

IS:5613 :Code of practice for Design, Installation and maintenance(Part-II/Section-2) of overhead power linesor equivalent International Standards.

No extra charges shall be admissible for these tests.

5.15.2 The earthing will be effected by burying 3 meters long GI pipe in a 300 mm diameter and 3750 mm deep pit at a distance of not less than 3650 mm diagonally away from the stubs and filling in the pit with finely broken coke having the granule sizes not less than 25 mm and salt in such a way that a minimum cover of 125 mm thick salt mixed coke shall be maintained from the pipe on all sides and that the top edge of the pipe shall be at least 600 mm below the ground level. A 45 X 6 mm-galvanised steel flat shall be used to connect the tower with the pipe. The galvanising steel strip shall be buried not less than 600 mm deep from the ground level. The tenderer will quote the erection charges for each earthing inclusive of the cost of coke and salt, excavation and back filling etc.

5.16.0 FINAL CHECKING, TESTING & COMMISSIONING

5.16.1 After completion of the works, final checking of the line shall be done by the contractor to ensure that all the foundation work; tower erection and stringing have been done strictly according to the specifications and as approved by the Employer. All the works shall be thoroughly inspected keeping in view the following main points:

1. Sufficient back filled earth is layed over each foundation pit and it is adequately compacted.
2. Concrete chimneys and their copings are in good and finally shaped condition.
3. All the tower members are correctly used strictly according to final approved drawings are free of any defect or damage whatsoever.
4. All the bolts are fully tightened and they are properly punched.
5. The stringing of the conductors and earth wire done to maintain proper sag.

The contractor shall submit a report to the above effect. After final checking the line shall be tested for insulation and any defect found as a result of such test, the contractor shall rectify.

In addition to the above, the contractor shall arrange for testing of the total and relative sags of the conductors and earth wire and shall be responsible to maintain the values within specified tolerances.

The contractor shall make all arrangements for such tests and the contractor shall provide necessary labour, transport and equipment.

After satisfactory tests on the line and on approval by the Employer the line shall be energised at full operating voltage before handing over.

SECTION -6

TECHNICAL SPECIFICATIONS INSULATORS & HARDWARE

6.3.0 SCOPE

6.3.1 This Section of the specification covers design, manufacture, testing at works of suspension and tension string insulator assemblies for 132 kV transmission lines.

6.4.0 STANDARDS

6.4.1 The suspension and tension string assemblies, insulator discs and hardware offered, material and processes adopted in the manufacture of insulator discs and hardware shall conform to the provision of the following Indian Standards or equivalent other international standards:

- (1) IS: 731 Specification of porcelain insulators for overhead power lines.
- (2) IS: 2486 Specification of insulator fittings for overhead power lines.
- (3) IS: 2026 Specification for recommended practice for hot dip galvanising of steel
- (4) IS: 2633 Specification for method for testing uniformity of coating on zinc coated articles.
- (5) IS: 2107 Specification for white hearth malleable iron castings.
- (6) IS: 2108 Specification for black hearth malleable iron castings.

6.5.0 INSULATOR AND STRINGS

The insulators of the strings shall consist of disc insulators with normal sheds for a three phase, 50 Hz, effectively earthed 132 kV transmission system in a lightly polluted atmosphere. Insulators shall be long rod type with Ball and socket connections.

6.3.1 Insulators shall have normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-815.

6.3.2 Supplier quoting for long rod insulators made of electro porcelain shall also supply intermediate ball pins and intermediate arcing horns along with long rod insulators.

The price of these items shall be considered as including in the price of long rod insulators.

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

Ball and Socket Designation

The dimensions of the balls and socket shall be of following designation for different for disc insulators in accordance with the standard dimensions stated in IS 2486-(Part-II)/IEC:120:-

Sl. No.	Rating of Insulators	Designation of Ball & socket as per IEC: 120
i)	70 KN	16 mm, AltB

ii)	90 KN	16 mm, AltB
iii)	120 KN	20 mm
iv)	160 KN	20 mm

2.4 Dimensional Tolerance

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

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

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

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

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

2.5 Intermediate Ball Pin Designation

The dimensions of the intermediate ball pin shall be in accordance with the standard dimension stated in IEC:471.

2.6 Intermediate Arcing Horn

2.6.1 For Insulator strings with long rod insulators besides the arcing horn on tower side of hardware fittings, intermediate arcing horns along with fixtures and fasteners as shown in the specification shall also be provided.

The total effective arcing distance shall be 3050 mm for 400 kV line, 1800 mm for 220 kV line and 1200 for 132 kV line under nominal dimensions of insulator.

2.6.2 The spark gap shall be so adjusted to ensure effective operation under actual field coordination.

2.7 Inter Changeability

The long rod insulators with ball and socket connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC standards.

2.8 Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localised pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

2.9 Maintenance

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

2.9.2 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.

2.10 Materials

2.10.1 Porcelain

The porcelain used in the manufacture of long rods shall be alumina type. It shall be sound, free from defects and thoroughly vitrified and smoothly glazed.

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

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

6.6.0 INSULATOR DISCS AND STRINGS

6.6.1 TYPE OF INSULATORS:

All suspension and tension strings shall consist of standard 255 x 145 mm centre ball and socket type porcelain insulators with all the exposed porcelain parts fully glazed, unless otherwise specified.

6.6.2 QUALITY AND STRENGTH OF THE INSULATORS:

The insulators and their hard wares used in the lines shall comply with requirement of relevant IS or other equivalent international standards. The pin-ball shackle diameter of suspension string will be 16 mm and tension string will be 20 / 16 mm. Minimum failing load shall be as per Clause-1.6, Section-1 of this Volume.

6.6.3 MATERIALS USED

The porcelain used in the manufacture of the insulators shall be of the best quality and shall be manufactured by the wet process. It shall be homogeneous, free from lamination; flaws etc. and well finished making it impervious to moisture. The glaze shall be brown colour and shall cover all the porcelain parts of the insulator except these areas necessarily left unglazed for the purpose of assembly. The cement used in the construction of the insulators shall not cause fracture by expansion or loosening and shall not give rise to any chemical reaction with the metal fittings.

6.7.0 INSULATOR STRING HARDWARE

6.7.1 HARDWARE

Each insulator string assembly shall generally include the following hardware:

Anchor shackle for attachment of suspension string assembly to the tower hanger and tension string assembly to the tower strain plate. Suitable top and bottom yoke assemblies with the arrangement of fixing a set of arcing horns.

- Set of arcing horns
- Suspension or tension clamp
- Bolts, nuts, washers, split pins etc.
- Other fittings necessary to make the strings complete such as ball clevis, socket clevis, chain links etc.

The tenderer shall be responsible and satisfy himself that all the hardware included in strings are entirely suitable for the conductor offered.

6.7.2 *SUSPENSION CLAMP*

The suspension clamps shall be made of malleable iron or aluminium alloy, hot dip galvanised and shall be suitable to accommodate the conductor together with one set of preformed armour rods. Suitable sheet aluminium liners shall be provided. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor. The lips shall be rounded off and the seating and the bell mouths shall be smooth to avoid corona and radio interference noises. The suspension clamps shall be suitable to carry the bottom part of the arcing horn and to receive the fittings of the insulator string.

The suspension clamps shall be such that the conductor should not slip at a load of 25% of the breaking load of the conductor. The ultimate strength of the clamp for vertical load shall not be less than the failing load of the Disc Insulators.

6.7.3 *STRAIN CLAMP*

The bolted strain clamps shall also be made of malleable iron or aluminium alloy; hot dip galvanised, lined with sheet aluminium liners and shall be suitable to accommodate the conductor with necessary binding tapes etc. The lips shall be rounded off carefully and conductor seating and the ball mouth shall be smooth to avoid corona and radio interference noises. Suitable attachment for receiving one side of arcing horns and for connecting to the insulator strings shall be provided.

The strain clamps shall be such that the conductor should not slip at a load of 90% of the breaking load of the conductor. The ultimate strength of the clamp for horizontal load shall not be less than the ultimate strength of the conductor

6.7.4 *ARCING HORNS:*

Arcing horns of approved size and dimensions shall be provided for every string of insulators. The performance data for arcing horns to be supplied shall be made available to the Employer.

6.7.5 *OTHER INSULATOR STRING HARDWARE:*

The strength of other string hardware namely anchor shackle, yoke plates, socket-clevis etc. shall be co-ordinated with insulator disc strength.

Interchangability

The hardware together with ball and socket fittings shall be of standard design, so that this hardware are interchangeable with each other and suitable for use with disc insulators of any make conforming to relevant Indian/International Standard

Ball and Socket Designation

The dimensions of the ball and socket shall be of 16mm designation up to 90 KN discs and 20 mm designation for 165KN discs, in accordance with the standard dimensions stated in IS : 2486-(Part-II) or equivalent International Standards. The dimensions shall be checked by the appropriate gauge after galvanising only.

6.7.6 Security Clips and Split Pins

- 6.7.6.1. Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking of the coupling as per IS: 2486-(Part-III) or equivalent International Standards. The legs of the security clips shall be spread after assembly in the works 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 the locking devices allow separation of fittings.
- 6.7.6.2. The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall neither be than 50 N (5 kg) nor more than 500 N (50 kg).

Split pins shall be used with bolts & nuts.

6.7.7 Arcing Horn for EHV Strings

- 6.7.7.1. The arcing horn shall be provided on tower side of the hardware fittings. The same shall be either ball ended rod type or tubular type.
- 6.7.7.2. The spark gap shall be so adjusted to ensure effective operation under actual field conditions.

6.7.8 Turnbuckle

- 6.7.8.1. The turn buckle is to be provided with single tension hardware fitting. The threads shall be of sufficient strength to remain unaffected under The specified tensile load.
- 6.7.8.2. The maximum length of the turn buckle from the connecting part of the rest of the hardware fittings shall be 380 mm. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing submitted with the bid. An adjustment of 135 mm minimum shall be possible with turnbuckle.

6.7.9 Suspension Assembly

- 6.7.9.1. The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth and without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.
- 6.7.9.2. The suspension assembly/clamp shall be so designed so that it minimises the static and dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs and have required level of Corona/AIV performance.

6.7.10 Standard Preformed Armour Rod Set

- 6.7.10.1. The Preformed Armour Rod Set suitable for Conductor shall be used to minimise the stress developed in the conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localised heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.
- 6.7.10.2. The preformed armour rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor in order to gently but permanently grip the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions, etc.
- 6.7.10.3. The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

6.7.10.4. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

6.7.11 **Dead End Assembly**

6.7.11.1. The dead end assembly shall be suitable for Conductor as detailed in the document.

6.7.11.2. The dead end assembly shall be compression type with provision for comprising the jumper terminal at one end. The angle of the jumper terminal to be mounted should be 300 with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

6.7.11.3. The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

6.7.12 **Fasteners: Bolts, Nuts and Washers**

6.7.12.1. All bolts and nuts shall conform to IS: 6639 or equivalent International Standards. All bolts and nuts shall be galvanised as per IS-1367 -(Part 13)/IS-2629 or equivalent International Standards. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

6.7.12.2. Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS-12427 or equivalent International Standards. Bolts should be provided with washer face in accordance with IS: 1363 Part-1 or equivalent International Standards to ensure proper bearing.

6.7.12.3. Nuts should be double chamfered as per the requirement of IS: 1363 Part-III or equivalent International Standards. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size upto M16

6.7.12.4. Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

6.7.12.5. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

6.7.12.6. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanised. The thickness of washers shall conform to IS: 2016.

6.7.12.7. The Bidder shall furnish bolt schedules giving thickness of components connected. the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

6.7.12.8. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.

6.7.12.9. Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

6.7.12.10. Fasteners of grade higher than 8.8 are not to be used.

6.7.13 **Materials**

The materials of the various components shall be as specified hereunder. The Bidders shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

6.7.14 Workmanship

- 6.7.14.1. All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for rated voltage of transmission lines and will give continued good performance.
- 6.7.14.2. The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio- interference, best resistance to corrosion and a good finish.
- 6.7.14.3. All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS: 2629 / IS-1367 (Part 13) or equivalent International Standards and shall satisfy the tests mentioned in IS: 2633-1986 or equivalent International Standards. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalent to 610 gm / sq.m shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard price test for galvanizing.
- 6.7.14.4. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.
- 6.7.14.5. The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright. Continuous and free from imperfections such as flux, ash, rust, stains, bulky white deposits and blisters. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209 or equivalent International Standards.
- 6.7.14.6. Socket ends, before galvanizing, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions, of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS: 2486 or equivalent International Standards.
The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.
- 6.7.14.7. In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm
- 6.7.14.8. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.
- 6.7.14.9. No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the inductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.
- 6.7.14.10. All the holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.
- 6.7.14.11. All fasteners shall have suitable corona free locking arrangement to guard against Vibration loosening.

6.7.15 Bid Drawings

- 6.7.15.1. The Bidder shall furnish full description and illustrations of materials offered.
- 6.7.15.2. Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished in five (5) copies along

with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

- (i) Suspension or dead end assembly.
 - (ii) Arcing horn attachment to the string
 - (iii) Hardware fittings of ball and socket type for inter connecting units.
 - (iv) Corona control rings/grading ring attachment to conductor and other small accessories.
- 6.7.15.3. All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

- (i) Dimensions and dimensional tolerance.
 - (ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
 - (iii) Catalogue No.
 - (iv) Marking
 - (v) Weight of assembly
 - (vi) Installation instructions
 - (vii) Design installation torque for the bolt or cap screw.
 - (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.
 - (ix) The compression die number with recommended compression pressure.
 - (x) All other relevant terminal details.
- 6.7.15.4. After placement of award, the Contractor shall submit fully dimensioned drawings including all the components in four (4) copies to the Employer for approval. After getting approval from the Employer and successful completion of all the type tests, the Contractor shall submit thirty (10) more copies of the same drawings to the Employer for further distribution and field use at Employer's end.

6.7.16 **Completeness of works**

Bidder shall assess the complete requirement of line hardware, hardware accessories and assemblies in complete for the erection of the lines as per the recommended erection practices.

The hardware assemblies shall be supplied complete with components, sub-components, nuts, bolts, washer etc. fittings and accessories for conductor & earth wire like Mid Span Joints, Repair Sleeves, and Stockbridge Vibration Dampers.

The Contractor shall also supply all line and tower accessories.

6.7.17 **Standards**

- 6.7.17.1. The Hardware Fittings, conductor and GROUND WIRE accessories shall conform to the following Indian Standards or equivalent International Standards, which shall mean latest revisions, amendments/changes adopted and published unless specifically stated otherwise in the specification.

- | | | |
|----|----------|---|
| 1. | IS: 209 | Specification for Zinc. |
| 2. | IS: 398 | Specification for Aluminum Conductors.
for Overhead Transmission Purposes, |
| 3. | IS: 1327 | Method of Determination of Weight of
Zinc Coating on Tin Plate. |
| 4. | IS: 1573 | Electroplated Coating of Zinc on Iron and Steel |

- | | | |
|-----|---|--|
| 5. | IS: 2121

(Part-1)

(Part-2) | Specification for Conductors
Accessories for Overhead Power Lines
Armour Rods, Binding Wires and Tapes for
Conductors
Mid-span joints and Repair Sleeves for
Conductors |
| 6. | IS : 2486

(Part 1) | Specification for Insulator Fittings for Overhead Power Lines
With a Nominal Voltage Greater than 1 000 V
General Requirements and Tests |
| 7. | IS:2629 | Recommended Practice for Hot Dip
Galvanizing of Iron and Steel |
| 8. | IS:2633 | Method of Testing Uniformity of Coating
on Zinc Coated Articles |
| 9. | IS:4826 | Galvanized Coating on Round Steel Wires |
| 10. | IS : 6639 | Hexagonal Bolts for Steel Structures |
| 11. | IS: 6745 | Methods for Determination of Weight of Zinc Coating on
Zinc Coated Iron and Steel Articles |
| 12. | IS : 8263 | Method for Radio Interference Tests on High Voltage Insulators |
| 13. | IS : 9708 | Specification for Stock Bridge vibration Dampers for Overhead
Power Lines |

6.7.18 TESTS

The insulator discs and hardware fittings shall be subjected to the tests before despatch, in accordance with the relevant standards. The successful contractor shall submit the test results in quadruplicate to the Employer.

6.7.19 MARKING

Each insulator disc shall be legibly and indelibly marked with the following:

- Name or trade mark of the manufacturer.
- Month and year of manufacture.
- Minimum failing load in Newton.
- Country of manufacture
- Standard certification mark, if any.

The marking of the porcelain shall be printed and shall be applied before firing

SECTION - 7

TECHNICAL SPECIFICATION CONDUCTORS, GROUND WIRES AND ACCESSORIES FOR CONDUCTORS AND GROUND WIRES

7.1.0 SCOPE

7.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor, G.I. Earth Continuity wires (Ground Wires) and accessories for Power Conductors and Earth Wire.

7.2.0 POWER CONDUCTOR

7.2.1 TYPE OF CONDUCTOR

The Power Conductor shall be stranded, 37/4.00 mm size all aluminium alloy conductor (AAAC) conforming to IS: 398, Part-IV (latest version) or equivalent International Standards.

7.2.2 TECHNICAL PARTICULARS

All Aluminium Alloy Conductor shall satisfy all the parameters as furnished in Technical Data Sheet.

7.2.3 MATERIAL

All Aluminium Alloy Conductor shall be stranded consisting of heat treated aluminium magnesium silicon alloy wires (Strands) containing approximately 0.5% magnesium and approximately 0.5% silicon.

7.2.4 JOINTS IN WIRE

In conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the brass rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor, such joint shall be made by resistance or cold pressure butt welding. They are not required to fulfil the mechanical requirement of un-jointed wires. Joints made by resistance butt welding shall, subsequent to welding, be annealed over a distance of at least 200 mm on each side of the joint.

7.2.5 STRANDING

The wires used in construction of a stranded All Aluminium Alloy Conductor (AAAC) shall, before and after stranding, satisfy all requirements of IS 398 (Part-IV) with latest amendments there for equivalent International Standards.

The lay ratio of the different layers shall be within the limits as per the said Standard.

In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right handed. The wires in each layer shall be evenly and closely stranded.

In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

7.2.6 ROUTINE/ACCEPTANCE TESTS

The samples of individual wires for the test shall normally be taken before stranding. The manufacture shall carry out test on samples taken out at least from 10 % of the aluminium wire spools. However, when desired by the Employer, the test sample may be taken from the stranded wires. The wires used for alloy conductors shall comply with the following tests as per latest edition of IS: 398 (Part - IV) (amended upto date):

- i) Breaking load test
- ii) Elongation test
- iii) Resistance test.

7.2.7 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

7.2.8 PACKING

All conductor reels shall conform to latest edition of IS : 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable that is next to the lagging.

The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

The wooden drums shall preferably be given protective coating of are liable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.

7.2.9 TECHNICAL DATA SHEET FOR CONDUCTOR

Sl. No	DESCRIPTION	PARTICULARS
1	Type of Conductor	All Aluminium Alloy Conductor (AAAC), Stranded
2	No of Strand x size	37 x 3.15 mm
3	Conductor over all diameter	22.05 mm
4	Total sectional area	288 mm ²
5	Approx. weight	794.05 kg/km
6	Minimum UTS	84.71 kN
7	Modulus of Elasticity (Final)	0.5814 kg/cm ²
8	Coefficient of linear expansion	23.0 x 10 ⁻⁶ /°C
9	Calculated maximum resistance/Km of Conductor at 20°C	0.1182 ohms/km
10	Particulars of Aluminium Alloy Wires (strands)	
	(a) Wire Diameter	
	(i) Standard:	3.15mm
	(ii) Maximum:	3.18 mm
	(iii) Minimum:	3.12 mm
	(b) Resistivity of wire	0.0328 ohms.mm ² /m
	(c) Density	2.70 kg/dm ²

Sl. No	DESCRIPTION	PARTICULARS
	(d) Co-efficient of Linear expansion	23.0 x 10 ⁻⁶ /°C
	(e) Cross Sectional area of Aluminium wire	7.793 mm ²
	(f) Approximate Total weight of each strand	21.04 kg/km
	(g) Calculated resistance at 20°C (D.C.)	4.290 ohm/km
	(h) Minimum Breaking Load of each strand	2.41 kN – before stranding 2.29 kN – after stranding

7.3.0 GROUND WIRES

7.3.1 TYPE OF GROUND WIRES

The ground wires shall be stranded, 7/3.15 mm size galvanised steel wires having tensile stress of 110 Kg/mm² and minimum breaking load of 5710 Kg conforming to IS: 2142 (latest version).

The materials should comply in all respect with the requirements of the latest editions of Indian Standard Specifications or other equivalent authoritative standards.

7.3.2 GALVANISING

All strands of the ground wires shall be of galvanised steel, galvanising being done on each strand individually before stranding. The galvanising on the wire shall comply in all respect with the requirements of the latest editions of IS: 4826.

7.3.3 JOINTS

The individual strands shall preferably be continuous in each length. No joints, if at all, in any wire shall occur within 15 meters of another joint in the same wire or any other wire in the finished ground wire.

7.3.4 TESTS

Individual wires and finished ground wires shall be subjected to the tests before despatch, in accordance with the relevant standards.

7.4.0 FITTINGS AND ACCESSORIES FOR CONDUCTORS

7.4.1 The accessories for conductors shall conform to IS: 2121 and 2486 (Latest version) in all respects.

7.4.2 The tension joints and repaired sleeves in the conductors shall be of compression type. The joints shall be such that in electrical resistance of the joints measured between two points just beyond the fittings shall not exceed 75% of that of an equivalent length of the conductor without joint and shall be capable to withstand a load of 95% of the breaking load of the conductor itself.

7.4.3 The non-tension joints such as the parallel groove clamps shall conform to IS 2121 and should be able to withstand a load of 10% of the breaking load of conductor without any slip.

7.4.4 Preformed type armoured rods shall be provided for the conductors at all suspension points. Vibration dampers of stock bridge type shall be used for power conductors.

7.5.0 FITTINGS AND ACCESSORIES FOR GROUND WIRES

7.5.1 The accessories for conductors shall conform to IS: 2121 and 2486 (Latest version) in all respects.

7.5.2 The tension joints and repaired sleeves in the conductors shall be of compression type. The joints shall be capable to withstand a load of 95% of the breaking load of the ground wire itself.

7.5.3 The non-tension joints such as the parallel groove clamps shall conform to IS 2121 and should be able to withstand a load of 10% of the breaking load of conductor without any slip.

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- 7.5.4 Suspension clamps used with ground wires shall be capable of holding the ground wire without slipping under tension of 25% of the breaking load of the ground wire. Each clamp will be capable of supporting a weight not less than 70 kN.
- 7.5.5 Bolted type dead end connector assemblies for use with ground wires shall be provided at the tension points and shall be capable of carrying a load up to 90% of the ultimate breaking load of the ground wire before slipping. Minimum failing of the complete fittings shall not be less than 90 kN. Both the suspension clamps and the dead end connectors shall be provided with an elongated bolt with a washer and a nut to take care of the flexible copper earth bonds.



SECTION- 8

SCHEDULES

SCHEDULE - I

GUARANTEED PARTICULARS FOR POWER CONDUCTOR

(To be filled in by the bidder and submitted as part of Bidding Schedules)

Sl. No	DESCRIPTION	PARTICULARS
1.0	Name of manufacturer and address for: (a) Aluminium Alloy rods: (b) Aluminium Alloy Conductor:	
2.0	Applicable Standard for: (a) Aluminium Alloy rods: (b) Aluminium Alloy Conductor:	
3.0	No of Strand x Size, (No. x mm)	
4.0	Conductor over all diameter, (mm)	
5.0	Total sectional area, (mm ²)	
6.0	Approx. weight, (kg/kM)	
7.0	Minimum UTS, (kN)	
8.0	Modulus of Elasticity (Final), (kg/cm ²)	
9.0	Coefficient of linear expansion, (per°C)	
10.0	Calculated maximum resistance of Conductor at 20°C, (ohm/Km)	
11.0	Lay Ratio: (i) 6 wire layer (max/min) (ii) 12 wire layer (max/min) (iii) 18 wire layer (max/min)	
12.0	Particulars of Aluminium Alloy Wires (strands)	
	(a) Wire Diameter, (mm) (i) Standard: (ii) Maximum: (iii) Minimum:	
	(b) Resistivity of wire, (ohms.mm ² /m)	
	(c) Density	
	(d) Co-efficient of Linear expansion (per°C)	
	(e) Cross Sectional area of Aluminium wire	
	(f) Approximate Total weight of each strand, (kg/km)	
	(g) Calculated resistance at 20°C (D.C.), (ohms/km)	
	(h) Minimum Breaking Load of each strand, (kN)	
	(i) Minimum elongation on a gauge length of 200 mm	

SCHEDULE – II

GUARANTEED PARTICULARS AND MANUFACTURING DATA

(FOR INSULATORS, AND HARDWARE EFC.)

(To be filled in by the Bidder)

Sl. No.	Description	Particulars
1.	INSULATORS AND ACCESSORIES	
	(i) Name of manufacturer, Country of Origin for: a) Insulator Disc b) Insulator Hard ware c) Accessories	
	(ii) Size of the Insulator Disc a) Outside diameter of the disc, mm b) Height of the Disc, mm c) Pin ball shank diameter, mm d) Size of ball and socket and the Standard to which it conform.	
	(iii) Particulars of single Disc:- a) Electromechanical Strength, KN b) Minimum failing load, KN c) Dry flashover voltage, KV d) Wet flashover voltage, KV. e) Puncture Voltage, KV f) Weight, Kg.	

Sl. No.	Description	Particulars
	<p>(iv) Particulars of Insulators String:</p> <p>a) Breaking Strength, KN</p> <p>b) Low frequency flashover voltage without arching horn</p> <ul style="list-style-type: none"> > Dry, KV > wet, KV <p>c) Low frequency flashover voltage without horn</p> <ul style="list-style-type: none"> > Dry, KV > Wet, KV <p>d) Dry impulse flashover voltage using standard 1.2/50 micro second impulse:</p> <ul style="list-style-type: none"> > without arching horn, KV > with arching horn on line side only, KV > with arching horn on both line and tower sides, KV <p>e) Low frequency test voltage with arching horn</p> <ul style="list-style-type: none"> > on line side only, KV > on both line and tower sides, KV <p>f) Dry impulse test voltage using standard 1.2/50 micro second impulse:</p> <ul style="list-style-type: none"> > without arching horn, KV > with arching horn on line side only, KV > with arching horn on both line and tower sides, KV <p>g) Corona formation voltage with normal fittings, KV</p> <p>h) Breaking Strength of</p> <ul style="list-style-type: none"> > Suspension Clamps, KN > Tension Clamps, KN <p>h) Slipping Strength of</p> <ul style="list-style-type: none"> > Suspension Clamps, KN > Tension Clamps, KN 	