

SECTION - 1

SCOPE SPECIFIC TECHNICAL REQUIREMENTS BILL OF MATERIALS

1.1 Introduction

BHEL is participating in tender for design, engineering, supply, construction, erection, testing & commissioning of 100 MW (AC) Solar PV Project (200MWp DC capacity) alongwith 50MW/150MWh Battery storage system having 10 years of plant Operation & Maintenance at district Rajnandgaon, Chhattisgarh, India for M/s SECI.

The purpose of this specification is to enter a pre-bid tie-up for construction of 132kV DCDS transmission line for evacuation of power from PV power plant.

The transmission line is required for following project:

Name of customer	Solar Energy Corporation of India Limited (SECI), New Delhi
Name of the project	100 MW (AC) Solar PV Project (200MWp DC capacity)

1.2 Scope of work :-

Work of **construction of** 132 KV DCDS transmission line, with single **ACSR panther conductor**, from take-off gantry from SECI PV Power plant to 132KV sub-station at Thelkadi Dist. is to be carried out on turnkey basis including operation & maintenance transmission line for ten years. The scope covers design, drawings, customer approvals, route survey at all stages, ROW, construction, supply, erection, testing, commissioning, successful handing over, Maintenance etc.

Scope of supply and services shall be broadly as follows:

1. Supply of fabricated galvanised towers materials along with its accessories. The work involves fabrication, galvanising and delivery of towers and complete construction of 132 KV DCDS transmission line from SECI PV Power plant to Thelkadi s/s on turnkey basis including all materials
2. Supply of Conductor/ 24 fibre OPGW, supply of all line materials i.e. G.I. Bolts & Nuts, spring washer, galvanized earthing rods with clamps, danger board, number plate, phase plate, Anti-climbing Devices (Including fixing arrangements and barbed wires), conductor and ground wire accessories, insulators, stringing hardware etc.
3. Reconnaissance survey, preliminary survey, route alignment, detailed survey, checks survey. Multiple route surveys are possible. BHEL is not liable to pay for repeated surveys.
4. Right of way (contractor's scope) includes but not limited to

- Coordination with local administration / authorities for collection of all records pertaining to ROW.
- Adequate compensation for loss of land under tower footings and restrictive use of land under ROW,
- Compensation for damages including crop damages wherever applicable, caused by tower and Right of Way for transmission lines. Crop compensation may be required multiple times.
- Obtaining clearances from concerned authorities like CEA, corporation, local administrative bodies, power ministry, Highway authority, railways, forest department, airport authority, telecom etc. and other relevant authorities as per provision of relevant acts.

All expenditure for arrangement of ROW is in contractor's scope.

5. Stub- setting, erection of towers, stringing of the line, etc. required for turnkey project. Cement and reinforcement steel, metal, sand for foundation of towers shall also be provided by the bidder. The details of work and technical specifications are given in various sections of this specification.
6. Bidder shall provide structural drawings and Bill of Materials of 132 KV towers and extensions along with foundation drawings after placement of award in sequence, suiting the project requirement. The bidder shall prepare Workshop drawings for fabrication of towers promptly. Before taking up the mass fabrication, the contractor will fabricate proto tower and offer the proto assembly for inspection. Proto assembly of tower shall be inspected by BHEL/SECI authorized representative.
7. The technical requirements for supply of G.I. Towers & other line materials and erection of the transmission line have been specified in section-2.
8. Bidder shall submit his offer taking into consideration the complete transmission system design.
9. Bidder to follow the environmental impact assessment of the project and follow the guidelines given for construction works.
10. Maintenance of lines shall be as per **Annexure-Maintenance transmission line**. Tentative specification is attached for tender purpose. However, final specification and conditions shall be informed after receiving firm order from SECI.

1.3 Specification Technical Requirements

The works shall general include, ***but not limited to***, following:

Design - General

- (i) Submission of drawings, route survey reports, test reports & quality plans of supply items
- (ii) Getting approval from customer/BHEL for all design drawings and documents required for the successful completion of job prior to the execution of work.
- (iii) Submission of drawings / documents, Quality Plans, inspection reports in soft copies and hard copies at each stage for customer / BHEL use.

Design For 132 -

- (i) Design basis report of 132 kV line is to be prepared by the bidder
- (ii) Submission of design and drawings of type tested 132kV transmission line lattice type towers supplied to reputed utilities like POWERGRID / state utilities etc as acceptable to SECI/ BHEL. Type test (destructive test etc) reports shall be submitted for approval.
 If type tested tower design drawings meeting the customer/project requirement are not available, then bidder has to design the towers, do type test on proto type tower under customer/BHEL witness at certified labs.
- (iii) Type tested tower design shall include Structural drawings of tower along with extensions, Shop drawings, Bill of material (BOM), Drawing of foundation including extensions for all soil types, Foundation loads, Stub setting templates, Sag tension calculation, Sag template drawing, Tower spotting data.
- (iv) Preparation of fabrication drawings (structure assembly drawing) and detailed BOQ for 132kV tower structures.

Suppl

- (v) Make of items should have SECI/BHEL approval before supply. In case, the offered make is not in approved list of BHEL/ SECI, bidder has to submit required documents for getting the sub-vendor approval of alternate make components without any commercial/ time of delivery implication to BHEL/ SECI.
- (vi) The materials shall conform to all the type tests as per relevant standards and contract specification. The acceptance, routine tests and tests during manufacture shall be carried out on the line material as per relevant standards & customer technical specification.
- (vii) Source of structure material shall be from **SAIL/Tata/Jin al/RINL**/(SECI or BHEL approved sources).
- (viii) BHEL / customer / third party shall inspect equipment / material before despatch. Stage inspection during manufacturing may also be carried out. Material shall be dispatched only after getting dispatch Clearance from BHEL. Supplier shall send inspection call on prescribed format (web site) only, with an advance notice of 15 days.
- (ix) Fabrication of 132kV towers, stub, stub setting template as per approved drawings and proto type testing.
- (x) Supply of 132kV Transmission Line towers including extensions, bolts and nuts, stub setting template including all tower accessories (phase plate, caution plate, number plate, circuit plate, anti-climbing device, bird guard, aviation signal etc.
- (xi) Earthing materials includes electrodes and counterpoise type earthing for all type of towers.

Ser i es Ci il or s Ere tion

- (i) Route survey for 132kV DCDS line
- (ii) Check survey for 132kV DCDS line
- (iii) Right of way from land owners
- (iv) Providing FQP for erection and other details as required for civil works, erection including stringing of all lines.
- (v) Technical support and revision of documents including **re he sur e** as and when required during the execution of the transmission line contract till completion of work.
- (vi) Soil investigation & Earth Resistivity Test for tower locations as per relevant standard

- (vii) Civil work for 132kV transmission line tower foundation including excavation including dewatering, shoring, strutting, and filling under and around structures, backfilling with suitable available excavated earth around completed structures, disposal of surplus soil, backfilling, formwork, providing necessary steel embedment and other setting of template, stub fixing including supply of all material, labor etc. complete as per approved drawing.
- (viii) Erection of 132kV Transmission Line towers including extensions, bolts and nuts, stub setting template including all tower accessories (phase plate, caution plate, number plate, circuit plate, anti-climbing device, bird guard, aviation signal etc).
- (ix) Complete erection of 132kV double circuit transmission line, including erection of tower, stringing of conductor, ground wire and their accessories, earthing of tower, insulator hoisting, String hardware, OPGW etc. for successful commissioning of line.
- (x) Tack welding of bolts & nuts along with supply & subsequent application of zinc coating on the welded portion as required.
- (xi) Tree cutting (if any) is in the scope of bidder.
- (xii) Bidder may note that (SECI /BHEL) shall not pay any compensation for any damage or loss of material including the free issue items during storage, transportation & erection work. Further, any other loss or damage to the properties during work of execution of transmission line job or for tree cutting due to bidder's work shall not be compensated by SECI/BHEL.
- (xiii) All equipment, tools-tackles shall be organized by contractor.
- (xiv) Obtaining clearance from electrical inspector & submitting any relevant drawing/document shall be responsibility of bidder.
- (xv) Obtaining right of way shall be responsibility of contractor.
- (xii) Accessories of conductor includes Vibration dampers, Clamps (tension, suspension, cleat), Preformed armour rod, mid span compression joint, Repair sleeves, etc to complete.
- (xiii) Accessories of earthwire includes Vibrations dampers, Clamps (Tension Clamps, suspension clamp, cleat clamp, PG clamp etc), flexible copper bond, mid span compression joint, Repair sleeves etc to complete.

1.3. E lusion – Nil

Technical requirement or P R - As per Annexure -PQR

1. MAINTENANCE: -

a) For a period of 10 (Ten) years commencing immediately upon the satisfactory completion of the final tests at site and taking over of the line, the contractors' liability shall be limited to the replacement (supply and re-erection) of any defective parts that may develop in transmission line of his own manufacture or those of his sub-contractors approved under the conditions provided for by the contract under proper use and arising solely from faulty design, materials, or workmanship.

b) If it becomes necessary for the contractor to replace or renew any defective portions of the material under this clause, the provisions of this clause shall apply to the portions of the material so replaced or renewed until the expiration of six months from the date of such replacement or renewal or until the end of the above mentioned period of ten years which

ever may be later. If any defects be not remedied within a reasonable time, the purchaser may proceed to do the work at the contractor's risk and expense, but without prejudice to any other rights which the purchaser may have against the contractor in respect of such defects.

c) The contractor shall bear reasonable cost of minor repairs carried out on his behalf at site and shall consider sufficient spares whose price is deemed to be included in quoted price.

d) At the end of the maintenance period, the contractor's liability cease. In respect of goods not covered by this clause, the purchaser shall be entitled to the benefit of any guarantee given to the contractor by the original supplier or manufacturer of such goods.

Scope of maintenance or as per specification in case as per Annexure-Maintenance transmission line or ten other purpose.

1. BILL OF MATERIAL

As per Annexure-BOQ.

The **SUPPLY OF MATERIAL** shall include GI Lattice Structure including Hardware, Stub, Template etc. String Insulators with all hardware accessories and tension/ suspension clamps suitable for conductor, vibration dampers, danger plates, name plates, phase plates, circuit plates, anti-climbing device, pipe electrodes, bird guard, mid-span compression joint, repair sleeve, ACSR conductor, 90/70kN Insulators, OPGW and its accessories etc as required as per detailed technical specification.

The **COST** shall inclusive of all material and Labour etc.

Any item(s)/ work(s) not covered specifically in the BOQ but is (are) required for successful completion of transmission line shall be deemed to be included in the package.

1. STORES FOR SUPPLY OF MATERIALS INCLUDING MATERIALS TO BE SUPPLIED BY THE CONTRACTOR)

- I. The Contractor shall be required to set up Store along the route of the transmission line.
- II. The cement, reinforcement steel and other line materials (to be supplied by the contractor) shall also be arranged in above stores as per the sequence of the work.
- III. The Contractor shall make arrangements to take delivery of all the materials and stock them properly.
- IV. Yards and stores for stocking provided by the Contractor shall be opened for inspection by the Purchaser's representative as and when desired.
- V. The cost of handling and storage shall be deemed to be included in the quoted erection prices and no extra charges towards, loading, transportation, unloading, stacking and storage etc. shall be payable.
- VI. In case of materials to be supplied by the Contractor himself, all the above provisions shall also apply. However, shortage and/or damage of the materials shall be made good within a reasonable time and without any extra charge to the Purchaser and without delaying the construction of transmission line.

- 1. CONSTRUCTION POWER AND WATER:** -Water supply and Electricity for construction work is to be arranged by the contractor at his own cost. Also, storage space for equipment and contractor's site office will be arranged by contractor.

**Bill of quantities for executing TRANSMISSION LINE WORK
for 132 kV Double Circuit Double Strung (DCDS) overhead Transmission
line from Plant substation to CSPTCL 220/132kV Thelkadi substation**

SN		Unit	Quantity
1	Design & Consultancy	Lot	1
2	Detailed Route Survey	Lot	1
3	Right of Way (ROW)	Lot	1
4	Supply of Material	km	33
5	Erection, Testing & Commissioning	km	33
6	Civil Work	km	33
7	Maintenance charges - 1st year	year	1
8	Maintenance charges - 2nd year	year	1
9	Maintenance charges - 3rd year	year	1
10	Maintenance charges - 4th year	year	1
11	Maintenance charges - 5th year	year	1
12	Maintenance charges - 6th year	year	1
13	Maintenance charges - 7th year	year	1
14	Maintenance charges - 8th year	year	1
15	Maintenance charges - 9th year	year	1
16	Maintenance charges - 10th year	year	1

SECTION – 2

(PART-A)

TECHNICAL REQUIREMENT FOR FABRICATION AND SUPPLY OF LINE MATERIALS FOR CONSTRUCTION OF LINE

2.01 SCOPE:-

The successful bidder will supply various types of G.I. towers as per approved tower schedule, their extensions and accessories as envisaged for 132 **KV** DCDS Line.

2.02 TYPE OF TOWERS :

(i) The towers for 132 KV line are classified as below: -

Type of tower	Deviation limit	Typical Use
DN-2 / MD-2	0 deg. – 2 deg.	To be used as Tangent tower
DN-30 / MD-30	Up to 30 deg.	a) Angle tower with double/single tension insulator string. b) To be used for uplift forces resulting from an uplift span. c) To be used for anti-cascading condition. d) To be used as section towers
DN-60 / MD-60	30 deg-60 deg.	a) Angle tower with double/single tension insulator string. b) To be used for uplift forces resulting from an uplift span. c) Dead end with 0 deg. Deviation both on line side and substation side (slack span)

Note:- The above towers can also be used for longer span with smaller angle of deviations.

(ii) EXTENSIONS:-

- (a) The double circuit towers are designed so as to be suitable for adding 3M, 6M and 9M body extensions / leg extensions for maintaining adequate ground

clearances without reducing the specified factor of safety in any manner.

- (b) The provision for additional + 18M body extension for tower type of DN-60 is also to be kept. For power line crossing or any other obstacle the DN-60 tower can be used with 18M extension depending upon the merit of prevailing site conditions. The maximum reduced span for DN-60 type towers shall be mentioned in tower spotting data. However, this shall in no case be less than 200M.
- (c) **Truncated Gantry** -Wherever necessary will also be required for crossing 132KV/220KV/400 KV transmission lines.

2.03 SPAN AND CLEARANCES :-

- (a) **NORMAL SPAN**:-The Normal ruling span for 132 KV line is 335 M for DN-2, DN-30 & DN-60 type towers.
- (b) **WIND SPAN**:- The wind span is sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.
- (c) **Weight Span** :- The weight span is the horizontal distance between the lowest point of the conductor on the two spans adjacent to the tower. For spotting of structures, the following span limits should be considered :-

Type of tower	Reliability condition		Security condition	
	Maximum	Minimum	Maximum	Minimum
DN-2 /MD-2	503	134	252	67
DN-30 / MD-30	503	0	252	(-) 200
DN-60 / MD-60	503	0	252	(-) 200

- (d) In case of certain locations where actual spotting spans exceed the design spans, cross-arms and certain members of towers are required to be modified / reinforced. In such cases, design & drawings of the modified/reinforced tower and its foundation shall be supplied by the Contractor as per site requirement without any extra cost to the Owner.
- (e) **Ground Clearance**: -
 - (i) The minimum ground clearance from the bottom conductor shall not be less than 6100 mm for 132KV line at the maximum sag condition and still air.
 - (ii) Conductor creep shall be compensated by over tensioning the conductor at a

temperature of 26 deg C lower than the stringing temperature for ACSR Panther for 132 V line.

- (f) Other than the items indicated above, some other Tower and Foundation Designs, Structural drawings, BOM, Shop drawings, if required for proper and effective execution of project may also be required to be developed by the Contractor without any extra cost to the owner.

2.04 GALVANISING PASSIVATION AND PAINTING:

The tower parts, stubs and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 or equivalent International Standard after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 or equivalent International Standard while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

Unless otherwise specified the fabricated tower parts and stubs shall have a minimum overall zinc coating of 610 gms per sq.m. of surface except for plates below 5mm which shall have Zinc coating of 460 gms per sq.m of surface. The average zinc coating for sections 5mm & above shall be maintained as 87 microns and that for sections below 5mm shall be maintained as 65 microns.

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

The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out as indicated herein below:-

- 2.04.1 Degreasing & Cleaning of Surface:** Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629-1985 or equivalent International Standard. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.
- 2.04.2 Pickling:** pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629-1985 or equivalent International Standard. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.
- 2.04.3 Rinsing:** After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residue from the tank.

- 2.04.4 Fluxing:** The rinsed article shall be dipped in a solution of zinc ammonium chloride, The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.
- 2.04.5 Drying:** When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.
- 2.04.6 Quality of Zinc:** Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or equivalent International Standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminium alloy shall be added as per IS 2629 or equivalent International Standard.
- 2.04.7 Dipping Process:** The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 300+/- 10 degree C. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.
- 2.04.8 Post Treatment:** The article shall be quenched in water. The quench water is to be changed / drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard while rust attack. The temperature of the chromate solution shall not exceed 65 degree C. The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.

- 2.04.9 Storing, Picking and Handling:** In order to prevent while rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to SECI for approvals as part of Quality Assurance Plan.

2.05 MATERIAL: -

The tower members including cross-arms shall be of structural steel quality conforming to I.S. 2062 latest revision thereof (section as per IEEMA circular). Only structural steel angles sections manufactured according to latest revisions of I.S 808 - 1976 (Part V & VI - The Dimensional and Section Properties) shall be taken into consideration in design of towers. Only tested steel sections having its yield strength not less than 2550kg/cm² shall be used.

2.06 FASTENERS: BOLTS AND NUTS AND WASHERS:

- 2.06.1** The design of the towers and extensions are based on use of HRH mild steel hot dip galvanized bolts (5.6 quality) and nuts (5.0 quality). The connections are designed on the basis of use of 16mm dia bolts. The spring washers shall be provided for insertion under all nuts. These washers shall be of steel, electro galvanized, positive lock type and of 3.5mm thickness.
- 2.06.2** All bolts and nuts shall conform to IS:12427. All bolts and nuts shall be galvanised as per IS:1367 (Part 13)/IS:2629. All bolts and nuts have hexagonal heads and nuts, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.
- 2.06.3** Bolts upto M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363, Part-1 to ensure proper bearing.
- 2.06.4** Nuts should be double chamfered as per the requirement of IS:1363, Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size upto M16.
- 2.06.5** 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.
- 2.06.6** 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 8mm when fully tightened. All nuts shall fir and tight to the point where shank of the bolt connects to the head.

- 2.06.7** 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.
- 2.06.8** 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..
- 2.06.9** The bolts of 16mm size shall be manufactured by cold/hot forging process and the threads shall be rolled.
- 2.06.10** The bolts and nuts shall be free from forging and threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.
- 2.06.11** The bolts shall be threaded up to standard length only as per relevant Indian Standard and not to full length.
- 2.06.12** The bolts and nuts shall confirm to IS 1967-1971 Part-III and Part-IV, IS 12427, IS 1363-92, IS 1367Part-XIII with latest amendment.
- 2.06.13** The spring washers designated as M 16-B suitable for 16mm dia galvanized bolt shall be manufactured out of rectangular section with tolerances as per IS 3063-1994 with latest amendments. The spring steel shall conform to IS- 4072- 1975 with latest amendments "Specification for steel for spring washers".
- 2.06.14** The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS 1586- 1968.
- 2.06.15** The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall not abut when the washers are compressed. The ends shall be so served as to prevent tangling.
- 2.06.16** The approximate weight of 1000 pieces of spring washers suitable for 16mm dia bolt shall be 8.91 kg. in natural black finish as shown in IS 3063-1972 with latest amendments.
- 2.06.17** The spring washer shall be electro galvanized with chromate passivation. The electro galvanizing of washers should conform to 'severe' grading service conditions incorporated in IS 1573-1986 as "Service Grade No.4", classification Fe Zn 25. The local thickness of zinc coating should be minimum 25 microns and average thickness 38 microns. It should be further suitably heat treated to avoid any danger of hydrogen embitterment.

2.07 STEP - BOLTS:

Each tower will be provided on one of the legs, with step bolts conforming to IS:1363- 1992, IS:10238 and IS:1367 (Part-XIII):1983 of not less than 16 m.m. diameter and 175m.m. long, spaced not more than 300 mm apart and extending from 2.5 metres above the ground level to the top of the tower. For double circuit tower the step bolts shall be fixed on two diagonally opposite legs 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 withstanding vertical load not less than 1.5KN.

2.08 DANGER BOARD, NUMBER PLATE AND PHASE PLATES:-

Danger plates, Number plates, Circuit plates and phase plates shall be provided and installed by the Contractor:

- i. Each tower shall be fitted with a danger plate, number plate, circuit plate and two sets of phase plates for double circuit tower.
- ii. The letters, figures and the conventional skull and bones of danger plates shall conform to IS:2551 and shall be in a signal red on the front of the plate.
- iii. The corners of the danger and number plate shall be rounded off to remove sharp edges.
- iv. The letters of number plate shall be red enamelled with white enamelled background and should be centrally spaced.

The drawings for number plate, danger board, and phase plates are **enclosed in the tender**. Necessary provision for fixing of these items has been made.

2.09 ANTI-CLIMBING DEVICE WITH BARBED WIRE ON TOWER/GANTRY:-

The barbed wire type anti-climbing device shall be used at a height of approximately 3 meters as an anti-climbing deterrent measure, as per the details given in IS:5613(Part-2/Sec-I)1985. The towers to be supplied by the bidder shall have provision to fix the barbed wire as indicated above. The drawing of **Anti-climbing device is attached in tender**.

Thus the angle pieces with notches for accommodating barbed wire shall be supplied with the towers along with provision for suitable bolt holes on leg members for fitting the angles. The scheme of the anti-climbing device shall be provided along with the tower drawing. It should have the facility of the locking arrangement. The Barbed wire shall confirm to IS:278/1978 with latest amendment and shall be type 'A-3'.

The Barbed wire shall be made of Hot dip Galvanised MS solid wire of size 2.5mm dia (for line wire) and 2.0 mm dia (for point wire). The barbs shall have four points and shall be formed by twisting 2 point wires, each two turns, tightly around both line wires making altogether four complete turns. The wire shall be galvanised by Hot dip process as per IS:2629/1966 (with latest amendment). The galvanised wire shall confirm to the requirement as per IS:4826/1971 with latest amendment in all respect. IS:2633/1972 and IS 6730/1972 for testing of uniformity & mass of zinc coating. The zinc coating shall be medium type on line wire and light type on point wire i.e. having zinc coating minimum 110 gm/m² on line wire and 70 gm/m² on point wire.

2.10 GALVANISED EARTHING ON TOWER/ GANTRY: -

2.10.1 The provision shall be made in the stub for fixing Galvanised Earthing materials. The stub will be provided with a hole at a distance of 250 m.m. from bottom and at a distance of 500 mm below ground level for connection with Galvanised Earthing materials. The hole will be of 17.5 m.m. diameter.

2.10.2 The contractor shall also supply and fix properly the following materials for Galvanised Earthing towers (Two sets per tower) as per approved tower drawing:-

- (i) Hot dip galvanized earthing M.S. rod (2 metre long and 25 m.m. diameter).
- (ii) Hot dip galvanised connecting clamps.
- (iii) Hot dip galvanised stranded steel wire of size 7/ 3.66 m.m. to be used as connecting wire and counterpoise wire (wherever necessary) confirming to IS:2141-1968 and 2121 - 1979, with latest revisions thereof.

The details of Galvanised Earthing rod and clamps and earthing arrangements for towers are enclosed in the tender.

2.10.3 The Galvanised Earthing rod shall be of mild steel solid rod of 2 metres in length and 25 m.m. diameter with one end pointed. The rods shall be galvanised as per relevant I.S.S. The Zinc coating on the rod shall not be less than 610 gm./ sq. metre of surface area.

2.10.4 The tower end connecting clamp shall be of flat type and rod end shall be of “U” type. The clamps shall be of forged steel, cast iron / malleable iron. The clamps should be hot dip galvanised as per relevant I.S. 2621 - 1969, with latest revision thereof. The Zinc coating on the clamps shall not be less than 610 gm./ sq. metre of surface area.

2.10.5 The hot dip galvanised stranded steel wire of size 7 /3.66 m.m. shall be used as counterpoise wire. The steel wire shall conform to I.S. 2141 -1968 and IS:2141-1979 & latest revisions thereof, and shall consist of 7 strands, each strand having a diameter of 3.66 m.m. The galvanising shall be done as per Indian Standards Specifications 4826 - 1968 and 4826-1971 & latest revision thereof, for „heavy“ Zinc coating. The coating of Zinc shall not be less than 260 gm. / sq. metre.

2.11 INSULATOR STRINGS ATTACHMENTS: -

- a) For the attachment of suspension Insulator string, a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-Shackles etc. as required and considered in the design of the tower shall have minimum ultimate tensile strength of 70 KN for single suspension string. The supply of hanger, D-Shackles, strain plate etc are also in the scope of Contractor. The drawing of tower accessories will be provided as per approved drawing.
- b) At tension towers strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. 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.

2.12 FLEXIBLE COPPER BOND: -

The flexible copper bond shall be circular in cross-section of minimum 34 sq.mm equivalent copper area and not less than 500 mm in length. It shall consist of 259 wires of 0.417 mm dia. tinned copper conductor. It shall be laid up as 7 stranded ropes, each of 37 bunched wires. The tinning shall be as per relevant Indian Standard. Two tinned copper connecting lugs shall be press jointed to either ends of the flexible copper cable. One lug shall be suitable for 12mm dia bolt and the other for 16mm dia bolt. The complete assembly shall also include one 16mm dia, 40mm long HRH MS Bolt hot dip galvanised with nut and lock washer.

2.13 EARTHWIRE CLAMPS ATTACHMENT: -

- a) **Suspension Clamp:** Earthwire suspension clamps will be supplied by the Contractor. The drawing shall be supplied by the Contractor for Employer's approval. The Contractor shall also supply U bolts / D-shackles, wherever required.
- b) **Tension Clamp:** Earthwire 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.

2.14 FABRICATION WORKMANSHIP: -

- a. Except where here-in-after modified, details of fabrication shall conform to I.S. 802 (Part - II) – or relevant International Standards.
- b. The fabrication of towers shall be done strictly in accordance with the proto corrected approved drawing.
- c. The tower shall be of bolted construction.
- d. Normally lap splice shall be used for connecting the members of un-equal size and the inside angles of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. Butt-joints as well as lap joint splices shall be made as above and as close to the main panel as possible.
- e. Joints shall be designed and detailed to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gusset plates and spacer plates may be used in conformity with modern practice.
- f. The tower structures shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.
- g. No angle member shall have two leg flanges brought together by closing the angle.
- h. The diameter of the hole shall be equal to the diameter of the bolt plus 1.5 mm.

- i. The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all point where pockets of depressions are likely to hold water.
- j. The identical parts shall be made strictly interchangeable. All steel section before any work is 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 surface are in close contact throughout. No rough edges shall be permitted in the entire structures. Hammering is not permitted for straightening.
- k. Cutting may be done by shearing, cropping, flame cutting or sawing. The surface so cut shall be cleaned smooth, reasonably square and free from deformation and distortion.

2.15 DRILLING AND PUNCHING:-

4.10.2 Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

4.10.3 The holes in the member shall either be drilled or punched with a jig, the former process will be preferred:-

- (i) Punching may be adopted for sections up to 12 mm thickness. For thicker sections drilling shall be done.
- (ii) The holes shall be punched/drilled after bending and related position of these holes shall be maintained with the use of proper templates/jigs and fixtures .
- (iii) The holes shall be perfectly circular and no tolerance in this respect is permissible. The holes shall be perpendicular to the plate and angle flanges.
- (iv) Holes must be square with the plates or angles and have their walls parallel.
- (v) All burrs left by drills or punch shall be removed completely. When the tower members are in positions, the holes shall be truly opposite to each other. Drilling or ramming to enlarge defective holes shall not be permitted.
- (vi) The minimum spacings of bolt and edge distance shall be as under :-
 - (a) For 16 mm dia bolt edge distance of 20 mm from hole centre to rolled or swaged edge and 23mm from hole centre to sheared or flame cut edge, hole centre to hole centre distance minimum 40mm (the hole size being 17.5mm).
 - (b) The gap between the edges of the connected members in butt joint shall not be more than 6mm and less than 4mm.
- (vii) The bolt gauge distance in flanges of angle sections shall generally be in accordance with Table XXXI of SF6(1)-1961-ISI “ Hand Book for structural Engineers-Structural Steel Sections (Revised).”

2.16 TOLERANCES:-

- (i) The maximum allowable difference in the diameter of the hole on the two sides of the

plate or angle shall not exceed 0.8 m.m. in diameter. The allowable taper in drilled / punched hole shall not exceed 0.8 m.m. on diameter.

- ii) The tolerance cumulative or between consecutive holes shall be within +/- 0.5 mm.
- iii) The tolerance on the overall length of member shall be within +/- 1.6 mm.
- iv) The tolerance on gauge distance shall be within +/- 0.5 mm.

2.17 MARKING:-

- (i) All members shall be distinctly given punch mark similar to the given in structural drawings. The mark shall be given with marking dies of minimum 18 mm size and this mark shall be legible. Letter DN-2, DN-30, DN-60 which indicate the transmission line and the type of tower shall precede erection mark.

2.18 CLASSIFICATION OF FOUNDATIONS:

The foundation shall depend upon the type of soil, sub-soil water level and the presence of surface water which have been classified as follows and as per CBIP Manual publication No.268 :-

1	Normal dry Soil.	To be used for locations where normal dry, cohesive or non-cohesive soils are met.
2	Wet	To be used for locations:- (a) Where sub-soil water is met at 1.5 Meter or more below the ground level. (b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields..
3	Partially submerged	When water table is at a depth between 1.5m and 0.75m below ground level and when the soil is normal and cohesive.

4	Black cotton (Dry/Wet)	<p>When soil is cohesive having inorganic clay exceeding 15% and characterised by high shrinkage and swelling property.</p> <p>Where top layer of black cotton soil exceeds 50% and extends upto full depth or is followed by good soil and where top layer is good soil up to 50% of the depth but the lower layer is a black cotton soil. For designing purpose the soil is to be considered as Submerged.</p> <p>To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5meter below ground level.</p>
5	Fully submerged	When water table is within 0.75m below ground and soil is normal and cohesive.
6	Soft rock (Dry Fissured Rock)	To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used at these locations.
7	Submerged Fissured Rock	Where fissure rock is encountered with subsoil water within 0.75m or below 0.75 m from G.L. (Top layer may be either a good soil or black cotton soil)
8	Hard rock	In locations where chiselling, drilling and blasting is required for excavation, hard rock type foundations are to be used where hard rock encountered at 1.5 m or less below ground level.
9	Sandy soil	Sandy soil with clay content up to 5%

In addition to the above, depending of the site conditions, other types of foundations may be introduced suitably for following type of soils for which the design will be submitted by the contractor without any extra cost to the BHEL/SECI :-

- (i) Intermediate conditions under the above classifications to effect more economy, or
- (ii) For locations in hilly and special rocky areas.
- (iii) For locations where special foundation (well type, pile type or any other type) are necessitated, the proposal for this shall be submitted by the contractor based on the detailed soil investigations and approval for the same shall be obtained from the

SECI.

2.19 PROPERTIES OF CONCRETE:-

2.19.1 Wherever specified the cement concrete use for the foundations shall be as per approved drawing of foundations. However in general the concreting shall be as under :-

- (a) Grade of concrete mix M-35 for pile foundation and cap work.
- (b) The cement concrete used for tower and belt foundations shall be Nominal Mix Concrete of Grade M-20 having 1:1.5:3 nominal mix ratio with 20 mm coarse aggregate. The quantity of cement to be used per cubic meter shall be as per CPWD specification /IS codes. All the properties of concrete regarding its strength under compression, tension, shears, punching and bending etc. as well as workmanship, will conform to IS: 306.

2.19.2 The cement concrete used for lean pad of Grade M-10 having 1:3:6 nominal mix ratio with 40 mm metal aggregate in bottom portion.

2.19.3 a) The Portland Cement used in concrete shall conform to **43 grade (IS:8112) or 53 grade (IS:12269).**

- b) The Pozzolena used in concrete shall confirm to IS:1489. The curing time of pozzolena cement will be decided at the time of execution of the work under the contract based on the certificate form a reputed laboratory which will be obtained and submitted by the Contractor.

2.19.4 Concrete aggregates shall confirm to IS:383.

2.19.5 The water used for mixing concrete shall be fresh, clean and free from oil, acids &alkalise, organic materials or other deleterious substances. Potable water is generally preferred.

2.20 REINFORCEMENT:-

2.20.1 Reinforcement shall confirm to Gr.I of IS:432 from MS bars and hard drawn steel wires and to IS:1139 and IS:1786 (Grade Fe 415) for deform and cold twisted bars respectively. Thermo mechanically treated (TMT) bars (equivalent grade) in place of cold twisted bars are also acceptable. All reinforcement shall be clean and free from loose mill scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and Specifications. For fixing the steel reinforcement bars in position arid binding with 0.9 mm annealed binding wire confirming to IS:280, 1978 should be used.

2.20.2 Grade of Steel Fe-500/500D as per IS 1786 or Thermo mechanically treated (TMT) bars of minimum yield strength 500 N/sq,mm slum 150 mm to 500 mm as per MORTH & IRC specification.

2.21 CONTRACTOR'S LIABILITY:-

The contractor shall ensure that the specification of materials and workmanship of all towers actually supplied & constructed conform strictly to the towers which have successfully undergone the tests. In case, any deviation is detected the Contractor shall replace such defective towers free of cost to BHEL/ SECI. All expenditure incurred in erection to and fro transportation; any other expenditure or losses incurred by the SECI on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.

2.22 STANDARDS: The manufacturing, fabrication, Galvanising, erection procedure and materials used for manufacture, erection of towers and construction of foundations shall conform to the Indian Standards (IS) which shall mean latest revisions, with amendments / changes adopted and published unless specifically stated otherwise in the specification.

The material and services covered under these specifications shall be performed as per requirements of the relevant IS standards against each set of equipment and services.

2.23 GUARANTEED PARTICULARS: The guaranteed technical and other particulars shall be furnished. The bids which are incomplete in this respect or do not give clear information shall be ignored out rightly.

2.24 DEPARTURE FROM SPECIFICATIONS TECHNICAL CONDITIONS: In case of deviation from any of the requirements of the specifications, the same may be brought out clearly in separate Annexure, Otherwise it will be presumed that all the technical conditions of our specifications are acceptable to the bidder.

2.25 TECHNICAL CONDITION FOR ERECTION (SCOPE): -The contractor is required to carry out complete construction with supply of all the materials. It involves all construction activities viz. Survey, soil investigation, excavation, stub- setting, erection of structures, stringing and final testing and charging of the transmission line.

2.26 LINE MATERIALS:

2.26.1 TOWER & EXTENSIONS: As detailed in, clause 2.02 of this specification.

2.26.2 CONDUCTOR: The conductor used in the line will be ISI marked (IS:398(P-II) 1996 with latest amendment) which will be supplied by the Contractor. The conductor size of ACSR Zebra and Panther is furnished as below: -

S. No.	CONDUCTOR DETAILS	ZEBRA	PANTHER
i.	Conductor	ACSR	ACSR
ii.	Code name	Zebra	Panther
iii.	Size	260 mm ² Cu. Eq.	130 mm ² Cu. Eq.
iv.	Nominal Aluminium area	419 mm ²	207 mm ² .
v.	Sectional area of aluminium	428.90 mm ²	212.10 mm ²

vi.	Weight per kilometre of 41 Conductor	1621 Kg.	974 Kg.
vii.	Area of cross section of Conductor	484.5 mm ²	261.5 mm ²
viii.	Coefficient of linear expansion of Conductor	19.3 x 10 ⁻⁶ Kg/mm ²	17.80 x 10 ⁻⁶ Kg/mm ²
ix.	Modulus of elasticity is to be designed.	7034 kg/ mm ²	8155 kg/mm ²
x.	Temp. Variation	0 Deg. / 80 Deg. C	
xi.	Calculated DC resistance at 20 deg. Centigrade	0.0691 Ohm per km	0.139 Ohm per km
viii	Material	Aluminium conductor steel reinforced	Aluminium conductor steel reinforced
ix	Conductor Size	54(24+18+12) /3.18 mm Aluminium + 7 /3.18 mm Steel	30(18+12) /3.00 mm Aluminium + 7 /3 mm Steel
x	Stranding	Yes	Yes
xi	Overall diameter	28.62 mm	21.00 mm
xii	Ultimate Strength	130.32 KN	89.67 KN
xiii	Current carrying capacity	740 Amp. at 45 deg. Cent. Ambient and 30 deg. Rise	430 Amp. at 45 deg. Cent. Ambient and 30 deg. rise
xiv	DC Resistance of Aluminium wire (Maximum at 20 Deg. Cent.)	3.627 Ohm per Km.	4.07 Ohm per Km.
xv	Standard length	1500 Mtr. \pm 5%	1500 Mtr. \pm 5%
xvi	Net weight of conductor (Approximate)	2432 Kg.	1461 Kg.
xvii	Breaking load: Aluminium Wire(Min.) Steel Wire(Min.)	1.23 KN 9.91 KN	1.11 KN 8.83 KN
xvii i	Galvanisation test of steel wire: Uniformity : Weight :	260 gm per m ²	237.5 gm per m ²

2.26.3 GROUNDWIRE: The ground wire will be ISI marked (IS:12776 –2002 with latest amendments) 7/3.66 mm, 95 kg/mm² quality galvanised steel stranded wire which will be supplied by the Contractor. The standard Technical Particulars of the ground wire shall be as follows:-

S.No	PARTICULARS	PARAMETERS
1.	Materials	Steel
2.	Stranding	7 / 3.66 m.m.

3.	Weight per K.M.	583 Kg.
Single wire before stranding		
4.	Diameter of Wire :- (a) Nominal (b) Maximum (c) Minimum	3.66 m.m. 3.75 m.m. 3.58 m.m.
5.	Tolerance	+ / (-) 2%
6.	Minimum elongation in 100 m.m. length	5 m.m.
7.	Minimum breaking load of strand	10.58 KN
8.	Minimum Tensile Strength	95 Kg / mm ²
9.	D.C. Resistance at 20 ° Celsius	17.15 Ohms / KM
Stranded wire : Length of Lay :-		
10.	Nominal	181mm
11.	Maximum	198 m.m.
12.	Minimum	165 m.m.
13.	Minimum breaking Load	6972 Kg.
14.	Overall diameter	10.98 m.m.
15.	Modulus of elasticity	1.933 x 10 ⁶ kg/ cm ²
16.	Coefficient of linear expansion	11.50 x 10 ⁻⁶ per °C
17.	D.C. resistance at 20° C	2.5 Ohms / KM
Zinc coating		
18.	Minimum Weight of Zinc coating on wire	260 gms./sq. Meter of uncoated wire surface.
19.	No. of one minute dip and half minute dip respectively	3 & 1 respectively
20.	Minimum purity of zinc	99.95%
21.	Standard length	3000 Mtrs. ± 5%

2.26.4 GUARANTEED TECHNICAL PARTICULARS FOR GALVANISED SPRING WASHER FOR TRANSMISSION LINE

S.No	Particulars	
1.	ISS number to which spring washer will conform.	IS:3063
2.	ISS to which electro galvanised washer will conform	IS:1573
3.	ISS for tests regarding dimensions and strength etc.	IS:3063
4.	ISS for test for electro galvanising of washer.	IS:1573
5.	ISS for raw material of washers.	IS:4072
6.	Ultimate tensile strength.	0 N/m ²
7.	Hardness of finished washers in HRC after heat treatment as per Rock well hardness test.	43 – 50 HRC

8.	The free height of washers:- i) After having compressed flat for compression of 52,200N for 16mm size. ii) After compression and removal of pressure and repeated 20 times in quick succession.	5.95 mm 5.95 mm
9.	Method of testing for electro galvanising.	As per IS:1573
10.	Thickness of zinc coating in microns.	38 average, 25 min
11.	Result of twist test.	Passes
12.	Dimension, indicating tolerance of single coil Rectangular section spring washers with flat ends: i) Inside diameter basic tolerance. ii) Maximum outside diameter. iii) Breadth of washers basic tolerance. iv) Thickness of washers basic tolerance. v) Weight of spring washers (kg/1000 Nos. pieces)	16.2 ± 0.8mm 27.4 mm 5 ± 0.2 mm 3.5 ± 0.2 8.91 kg. approx. as per IS:3063

NOTE: Spring washer should be suitable for use with 16 mm bolts and nuts conforming to IS:1363 and electro galvanising should be as per IS:1573 service condition “3” i.e. minimum thickness of 25 microns and average thickness of 38 microns.

2.26.5 GUARANTEED IS SPECIFICATION TO BE ADOPTED FOR G.I. NUT BOLTS :-

No	Particulars	Relevant IS No.
1	IS Specification of BIS for all GI Nut Bolts	IS:12427-2001
2	Minimum sharing strength of bolts (kg per mm sq.)	IS:12427-2001
3	Minimum ultimate tensile strength of Bolts	IS:1367
4	Value of Hardness test: a. Rock well hardness test b. Brinell hardness test	IS:1367
5	Indian standard for bolts & nuts dimensions	IS:12427-2001, IS:6639-1972 and any latest revision thereof for property class 5.6/5

6	Indian standard for threading dimension of bolts & nuts	IS:1367-1967 including IS-1367 (Part-XIII) 1983 & any latest revision thereof and IS:4218 (Part-V) 1978.
7	Indian Standard for hot dip galvanising	IS:1367 Part-XIII, 1983
8	Indian Standard for test of bolts & nuts	IS:1367-1967 and any latest amendment thereof.
9	Designation of standard for raw material for bolts & nuts.	IS:2062 Gr.A with latest amendment

2.26.6 GUARANTEED TECHNICAL PARTICULARS FOR GI NUTS AND BOLTS

S. No	Description	Dimensions (in mm) 16 mm bolts, Property class 5.6
1	Nominal diameter	16.00
1)	1) Maximum diameter of Unthreaded shank	16.7
	ii) Minimum diameter of unthreaded shank.	15.3
3.	Width Across flats Nom/Max./Min.	24.00/24.00/23.16
4.	Width Across corner	26.17
5.	Thickness of bolt head (Max. / Min.)	10.75/9.25
6.	Pitch	2.00
7.	Length of thread	23.00
8.	Zinc coating thickness	Minimum 54 microns.
9.	Mass of coating	Minimum 375g/m ²
10.	Minor diameter. A) Before plating Max/ Min. B) After plating Max.	13.508 /13.204
11.	Nut Thickness Max. / Min.	15.9 / 14.1
12.	Across flat width of nut Max./ Min.	24.00 / 23.16
13.	Across corner width of nut Min.	26.17

NOTE:- The bolts of above specification with different lengths of 35, 40, 45, 50, 55, 60, 65 mm with 50% thread / as per relevant ISS.

2.26.7 GUARANTEED TECHNICAL PARTICULARS OF ISI Mark G.I. STEP BOLTS

S.No	Particulars	Relevant IS No.
1	IS Specification of BIS for GI Step Bolts	IS:10238(2001) and Nuts IS:1363, Pt.III (1992)
2	Minimum ultimate tensile strength of Bolts	IS:1367
3	Value of Hardness test: (i) Rock well hardness test (ii) Brinell hardness test	IS:1367
4	Proof load test	IS:1367-2001
5	Indian standard for bolts & nuts dimensions	IS:10238-1982 and any latest revision thereof
6	Indian standard for threading dimension of step bolts & nuts	IS:4218 (Part-V) - 1978 & any latest revision thereof
7	Indian Standard for hot dip galvanising step bolts & nuts	IS:1367 Part-XIII, 1983 & IS:2629
8	Indian Standard for test of step bolts & nuts	IS:1367-1967 and any latest amendment thereof.
9	Designation of standard for raw material for step bolts & nuts.	IS:2062 Gr.A with latest amendment

2.26.8 DISC INSULATORS:-

S.No	Particulars	70 KN	90 KN	160 KN
1.	Type of Insulator (Pin & Cap)	Ball & Socket	Ball & Socket	Ball & Socket
2.	Size and designation of ball and socket with standard to which it will confirm	16 mmB mmB Conforming to IS: 2486 (part-II) 1974	16mmB	20
3.	Dimension a) Porcelain disc diameter mm b) Unit spacing mm c) Creepage distance of single disc (min.) mm	255 +/-10 145 +/-4 320	255 +/-10 145 +/-4 320	280 +/-13 170 +/-5 330

4..	Colour of glaze of the finished porcelain insulator	Brown	Brown	Brown
5	Mechanical values. 2. Combined mechanical & electrical strength in KN 3. Materials used for ball pins. 4. Grade of material	70 KN Forged steel Class 3A or 4 of IS 2004	90 KN Forged steel Class 3A or 4 of IS 2004	160 KN Forged steel Class 3A or 4 of IS 2004
6	Ultimate tensile stress Kg. Per mm ²	63	63	71
7	Yield stress Kg. Per mm ²	32.5	32.5	47
8	Hardness test value BHN	175	175	201-255
9	Percentage elongation	(min. 15%)	(min. 15%)	(min. 14%)
10	Whether machine forced	Yes	Yes	Yes
11	Normalising particulars (Temp in C 0)	30-880	30-880	30-880
12	Withstand voltage of single disc a) Dry KV (RMS) b) Wet KV (RMS)	70 40	70 40	75 45
13	Impulse voltage 1.2 x 50 Micro sec. a) Positive KV (Peak) b) Negative KV (Peak)	110 110	110 100	130 130
14	Flesh over voltage for the disc. Power frequency: a) Dry KV (RMS) b) Wet KV (RMS)	78 45	78 45	80 50
15	Flesh over Impulse voltage 1.2 x 50 Micro sec. a) Positive KV (Peak) b) Negative KV (Peak)	120 120	120 120	140 140
16	P.F. Puncher voltage KV (RMS)	120	125	130
17	Min. Corona extinction voltage KV (RMS)	09	09	18
18	Max. RIV at 10 KV (RMS) Micro volts	50	50	50

9	Security clip/ locking device a) Type and dimension b) Material c) Standard to which security clip confirmed d) Test values	R TYPE and dimensions as per 2486 Part-IV Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	R TYPE and dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	R TYPE and dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--
20	Standard specification to which insulator will confirm	IS- 731 & IS- 3188	IS- 731 & IS- 3188	IS- 731 & IEC-383
21	Test required	As per IS 731 & IS 3188	As per IS 731 & IS 3188	As per IS 731 & IS 3188
22	Inter changeability of disc insulator	Required	Required	Required
23	Net weight of Insulator unit (Approx.)	5.8	5.8	8.5
24	Packing details i) Type of packing ii) No. of disc in each packing iii) Gross weight of each packing	Wooden crates 6 42	Wooden crates 6 42	Wooden crates 5 54

2.26.9 INSULATOR STRINGS WITH HARDWARE FITTINGS:

The complete insulator string including Hardware fittings shall have the following characteristics: -

S. No.	Characteristics	Single/Double Suspension		Single/Double Tension	
		220 kV	132 kV	220 kV	132 kV
1	No. of Standard Discs	1x13 2x13	1x9 2x9	1x14 2x14	1x10 2x10
2	Nominal diameter of discs	255	255	280	255
3	Power frequency Withstand voltage (wet) kV (rms)	460	280	490	300
4	Lighting impulse withstand voltage (dry)(kVp)	1200	800	1200	800

5	Switching surge Withstand voltage (Dry & wet) (kVp)	900	350	900	350
6	Mechanical failing Load (kgf)	7000/ 14000	7000/ 14000	16500/ 33000	9000/ 18000
7	Pollution	Moderately polluted		Moderately polluted	
8	No deformation load (kgf)	4690/ 9380	4690/ 9380	11055/ 25610	6030/ 12060
9	Corona Extinction voltage (KV rms)	176	-	176	-

The Insulator string Hardware fittings and Ground wire assemblies shall comply and conform to the above requirement.

BALL & SOCKET DIMENSIONS: - The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimensions of the Hardware sets to be used with 7000 kg and 9100 kg Electro Mechanical strength Disc Insulators shall conform to designation 16mm/16mm-B in accordance with IS:2486(Part-II) or equivalent International Standard. The Ball and Socket dimension of Hardware to be used with 16,500 kg Electro Mechanical strength disc insulator shall conform to designation 20mm in accordance with IS-2486:(Part-II) or equivalent International Standard. The Bidder shall offer full detail of locking device in accordance with IS 2486:(Part-III) or equivalent International Standard along with test reports, gauges and adherence to Standards for Tests on Locking Devices in line with IS:2486 (Part-IV) or equivalent International Standard.

REQUIRED GUARANTEED STRENGTH OF HARDWARE: -.

- i. The Hardwares fittings and accessories of 132 KV/220 KV single suspension and double suspension strings suitable for Panther ACSR and Zebra ACSR for transmission line and also all types of suspension and tension strings suitable for sub-station shall have the ultimate breaking strength of not less than 7,000 kgs.
- ii. The slipping strength of the suspension clamp shall not be less than 15% and more than 20% of the Conductor strength with which it is to be used.
- iii. The Hardware fittings and accessories of single and double tension strings suitable for Panther ACSR shall have ultimate breaking strength of not less than 9,100 Kgs.
- iv. The Hardware fittings and accessories of single & double tension strings suitable for Panther ACSR for 132 kV transmission line shall have ultimate breaking strength of not less than 9100 kgs.

- v. Each individual Hardware component of double suspension and double tension strings such as ball-clevis, socket clevis etc. shall have minimum breaking strength as specified for respective single suspension and tension string respectively.

2.26.10 SINGLE SUSPENSION HARDWARE FOR PANTHER, ZEBRA ACSR CONDUCTOR WITH PREFORMED ARMOUR RODS

S.No.	ITEM	PANTHER	ZEBRA
1.	Type of clamp	AGS type	AGS type
2.	Ball & socket dimension	16mm	16mm
3.	Suitable for conductor size	ACSR Panther with amour rods	ACSR Zebra with amour rods
4.	Breaking strength	7000 kg.	7000 kg.
5	Tension clamp & keeper	Alu.alloy GDC	Alu.alloy GDC
6.	Anchor. Shackle. Ball Link & socket Eye	Forged steel HDG	Forged steel HDG
7.	Bolts, nuts & washers	Galvanised MS	Galvanised MS
8.	Security clip	R type made of SS/PB	R type made of SS/PB
9,	Spring Washer	Electro galvanised spring steel	Electro galvanised spring steel
10.	Galvanising standard	IS:2633	IS:2633
11.	Standard reference	2486 part-I,II & III	2486 part-I,II & III
12.	Arcing Horn	MS Flat 25x6	Steel tube type
13.	Preformed Armour rods	As per standard in No. & size.	As per standard in No. & size.

The 132 / 220 KV double suspension hardware set suitable for Panther / Zebra

conductor shall consist of following items:-

S.No	ITEM	Qty / Set	Material
1	Ball Hook	1	Forged Steel
2	Socket Clevis	3	Forged Steel
3	Yoke Plate	2	Mild Steel
4	Ball Clevis	2	Forged Steel
5	Arcing Horn	1	M.S. Flat / Steel tube
6	Clevis eye	1	Forged Steel
7	Suspension clamp AGS type	1	Aluminium Alloy
8	Pre formed armour rod	1 Set	Aluminium Alloy

2.26.11 SINGLE TENSION HARDWARE COMPRESSION TYPE SUITABLE FOR PANTHER, ZEBRA & EARTHWIRE :-

Single tension string Hardware shall comprise of one `D` Shackle, one Ball Link, one Forged Steel Socket, Socket Clevis Horn holder, one line side Arcing Horn and one Tension Clamp of compression type having before and after compression dimensions strictly as mentioned below:-

S.NO	ITEM	PANTHER	ZEBRA	EARTHWIRE
1.	Type of clamp	Compression type	Compression type	Compression type
2.	Suitable for conductor size	ACSR Panther	ACSR Zebra	7/3.66mm Groundwire
3.	Breaking strength	9100 kg.	16500 kg.	7000 kg,
4.	Tension clamp jumper	Ex-Alu.alloy	Ex-Alu.alloy	Forged steel
5.	Steel sleeve, anchor shackle, ball link socket eye	Forged steel HDG	Forged steel HDG	Forged steel HDG

6.	Bolts, nuts and washers	Galvanised MS	Galvanised MS	Galvanised MS
7.	Security clip	'R' type made of SS/PB	'R' type made of SS/PB	--
8.	Spring washer	Electro galvanised spring wheel	Electro galvanised spring wheel	Electro galvanised spring wheel
9.	Galvanised Standard	IS:2633	IS:2633	IS:2633
10.	Standard reference	2486, part – I,II & III	2486, part – I,II & III	2486, part – I,II & III
11.	Arcing Horn	MS FLAT 25 X 6	Steel tube type	--
12.	Standard Length of hardware set without pin and D shackle arrangement	457 m.m.	539 mm	285 mm
13.	Diameter of aluminium tube before compression:			
	a) Inner dimension	23 mm	31mm	--
	b) Outer dimension	38 mm	48 mm	
14.	Diameter of aluminium tube after compression :-			
	a) Across Flat	32 mm	40 mm	
	b) Across Corner	37 mm	46 mm	
15.	Diameter of steel tube before compression:-			
	a) Inner dimension	9.35 mm	9.95 mm	11.5 mm
	b) Outer dimension	18 mm	20.8 mm	21.2 mm

16.	Diameter of steel tube after compression.			
	a) Across Flat	15.1 mm	17.5 mm	17.5 mm
	b) Across Corner	17.4 mm	20.2 mm	20.2 mm
17.	Length of sleeve (Steel/Al.)	203/610	241/711	230
	a) Before compression	233/660	2763	262
	b) After compression			
18.	Conductivity	Equal to ACSR Panther	Equal to ACSR Zebra	Equal to groundwire
19.	Weight of hardware	As per ISS	As per ISS	As per ISS

In the case of railway / road / river / other transmission line crossing, double suspension / double tension insulators strings will be used with their hardwares and fittings.

2.26.12 DOUBLE TENSION HARDWARE FOR PANTHER & ZEBRA ACSR CONDUCTOR COMPRESSION TYPE:-

BALL & SOCKET dimensions:- The ball and socket dimensions of double tension hardware for Panther ACSR Conductor which will be used with 90KN disc insulator & for Zebra ACSR Conductor with 160 KN disc insulator shall conform to dimension 16mm B& 20 mm B.

The double tension string of 132 KV and 220 KV line shall have ultimate breaking strength of not less than **9100 kg** and 16500 kg respectively. Individual items of the fittings which will be subjected to tension shall also have ultimate breaking strength of not less than **9100 kg** and 16500 kg. The compression clamp shall have a minimum slipping strength of not less than 95% of breaking strength of conductor with which it is used.

CONDUCTIVITY:- The entire fitting or part thereof shall have the conductivity equivalent to length of conductor.

All the ferrous parts should be hot dip galvanised as per IS 2633 and nut bolt should be galvanised as per IS 5358.

132 KV / 220 KV DOUBLE TENSION HARDWARE for ACSR Panther and Zebra shall comprise of following items:-

S.No	ITEM	Qty / Set	Material
1	“U” clevis	2	Forged Steel
2	Chain Link	1	Forged Steel
3	Yoke Plate	2	M.S. Plate
4	Ball Clevis	2	Forged Steel
5	Socket Clevis	2	Forged Steel
6	Clevis eye	1	Forged Steel
7	Arcing Horn	1	M.S. Flat / Steel tube
8	Compression tension clamp assembly complete	1	Extruded Al. & Forged Steel.

2.26.13 CONDUCTOR ACCESSORIES:

(A) Armour Grip Suspension Clamp (AGS):

AGS fitting shall consist of 2 Neoprene Halves, a set of Helical rods made of Aluminium alloy, two Aluminium halves casting having inner profile matching with the profile of the Armour rod cage and jointed by supporting strap made of Aluminium alloy.

The Bidder should give complete data on the reduction of the dynamic stresses of the Conductor at the point of AGS support compared to that of bare clamp used with preformed types of Armour rods.

The Bidder will be required to prove the comparative performance in regard to the dynamic flexural stress pattern on the vibrating Conductor on the tensioned span with actual tests on the AGS unit compared to the normal bare clamp with Armour rods. Suitable curves should be furnished along with the bid for the same and also actual reports on the stress/ strain determinations. The Bidder should give the guaranteed value of the power loss of the AGS units offered by them supported by a test certificate of any reputed laboratory of the country. Suitable curves should be furnished along with the bid for the power loss due to AGS unit as well as with the conventional envelope type of Suspension Clamps.

The housing supports and housing straps should provide positive stop closure. AGS unit should have low rotational inertia, strut action of the Armour Cage, resilient cushioning of the neoprene insert, immunity from high compressive and flexural stress and wide area support. Manufacturer is required to guarantee minimum fatigue life of the AGS units and this would be established under actual tests on tensioned Conductor span. The manufacturer is required to guarantee minimum 40 years life of the complete AGS units including Neoprene cushioning and this should be established under actual test on a tensioned Conductor span.

The rubber used with AGS unit must be capable of withstanding desired long out-door performance including the variation of temperature from 0°C to 75°C. The Bidder will have to provide certificate from reputed manufacturers that the rubber being supplied by them is

suitable for AGS fitting and must have tensile strength of 2000 PSI and minimum ultimate elongation 300%.

The helical retaining rods required for AGS assembly shall be made of Aluminium alloy of HE 20 grade as per IS-6051/19 or equivalent International Standard duly heat treated and shall be suitable to wrap a desired size of Conductor. The tensile strength of the retaining rod material should not be less than 50,000 PSI and the electrical conductivity should not be less than 40% (IACS). The minimum slipping strength of the complete fitting shall not be less than 15% and more than 20% of the UTS of the cable on which it is to be used. The Clamp shall be in 2 parts made of Aluminium and will have inner profile matching with the profile of Armour rod. This Clamp should be made by drop forging process. AGS assembly should be provided with the forged steel socket eye to match with the suspension string and should have UTS not less than 7,000 Kgs.

IT IS ESSENTIAL FOR THE MANUFACTURER TO HAVE SUITABLE HEAT TREATMENT FACILITIES FOR ALUMINIUM ALLOY WIRES IN THE ARMOUR GRIP SUSPENSION UNITS. FORMED ROD BASED ITEMS WILL NOT BE ACCEPTABLE FROM MANUFACTURERS WHO DO NOT HAVE NECESSARY TECHNOLOGY FOR DEVELOPMENT OF ADEQUATE RESILIENCE, ELONGATION UTS AND TWIST TEST FACILITIES BACKED WITH PROPER HEAT TREATMENT SYSTEMS. SUCH OFFERS MAY BE TREATED AS NON-RESPONSIVE.

(B) The AGS Preformed Armour rods set suitable for ACSR Zebra/Panther conductor (as the case may be) shall be used to minimize the stress developed in a conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from suspension clamp as a result of unbalance conductor tension in adjacent span and broken wire condition. It shall be made of Aluminium alloy of HE 20 grade as per IS-6051/19 duly heat-treated. The aluminium alloy wires (pre heat treated) for manufacturing of Armour rods can also be used, however bidder should submit the test certificates in support of their claim for using pre heat-treated wires. It shall also withstand power arcs; chafing and abrasion from suspension clamp and localized heating effects due to resistance losses of the conductor.

The pitch length of the rods shall be determined by the supplier but shall be less than that of the outer layer of ACSR conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristics wholly independent of the skill of lineman.

The preformed armour rod sets shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to grip the same tightly. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

The length of each rod shall be as per drawing enclosed. The tolerance in length of each rod shall be +/- 25mm. The tolerance in length of the rods in completed sets should be within 13 mm between the longest and shortest rod. The ends of the armour rod shall be parrot billed.

The number of armour rods in each set shall be 11/12. The each rod shall be marked in the middle with paint for easy applications on the line.

The armour rod shall not loose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of International Annealed Copper Standard (IACS). The minimum tensile strength of armour rod should be 35 Kg per sq.mm.

Mid span joints, Repair Sleeves, Flexible Copper Bond etc. should be used as per transmission line practice & latest revision of I.S.S.

(C) STANDARD PARTICULARS FOR MID SPAN JOINTS:-

S. No	Description	Panther ACSR	Zebra ACSR	Earthwire
1	Type of hardware	Compression	Compression	Compression
2	Breaking strength	100% of UTS of conductor	100% of UTS of conductor	100% of UTS of earthwire
3	Conductivity	Equal to ACSR Panther	Equal to ACSR zebra	Equal to earthwire
4	Dimensions before & after compression			
	Aluminium Joint :-			
	a) Overall Dia before compression			
	(i) Inner dimension	23	31	
	(ii) Outer dimension	38	48	
	b) Dimension after compression:-			
	(i) Across Flat	32	40	
	(ii) Across corner	37	46	
	Steel Joint :-			
	a) Overall Dia before compression	9.35	9.95	11.5
	(i) Inner dimension	18	20.8	21
	(ii) Outer dimension			
	b) Dimension after compression:-			
	(i) Across Flat	15.1	17.5	17.5
	(ii) Across corner	17.4	20.2	20.2
5	The material from which following is made of			
	Al. Sleeve	Extruded 99.5% pure Aluminium	Extruded 99.5% pure Aluminium	-
	Steel Sleeve	HDG Steel	HDG Steel	HDG Steel
6	Standard weight	As per IS with tolerance	As per IS with tolerance	As per IS with tolerance

7	Length of aluminium sleeves before and after compression m.m. Length of steel sleeves before and after compression m.m.	610 / 660 mm 203 / 233 mm	711 / 775 mm 241 / 280	-
8	Reference	IS 2121	IS 2121	-

(D) STANDARD PARTICULARS OF REPAIR SLEEVES OF PANTHER ZEBRA AND EARTHWIRE

S. No	Description	Panther ACSR	Zebra ACSR	Earthwire
1	Breaking strength of cable with sleeve compressed	100% of UTS	100% of UTS	100% of UTS
2	Conductivity of cable with sleeve compressed	Equal to conductor	Equal to conductor	Equal to earthwire
3	Dimensions before and after compression (flat to flat).	38 / 32 mm	48 / 40 mm	20.8 / 17.5 mm
4	Length of sleeve before & after compression	241/270	279/310	254/280
5	The material from which sleeve is made	Extruded Aluminium	Extruded Aluminium	HDG Steel
6	Weight of repair sleeve	0.42 kg	0.60 kg	

(E) VIBRATION DAMPER FOR PANTHER, ZEBRA & EARTHWIRE :-

Vibration dampers (4-R type) shall be used for Conductors & Groundwires.

S.No	Item	Panther	Zebra	Earthwire
1	Type	4 – R type	4 – R type	4 – R type

2	Suitable for conductor size	21 mm	28.62 mm	10.98 mm
3	Material used for clamp	Alu. Alloy GDC as per IS 617	Alu. Alloy GDC as per IS 617	Alu. Alloy GDC as per IS 617
4	Messenger cable	High tensile steel stranded galvanised wire	High tensile steel stranded galvanised wire	High tensile steel stranded galvanised wire
5	Damper weights	3.2 Kg	5.0 kg	1.8 kg.
6	Slipping strength	500 Kg	500 Kg	500 Kg
7	Natural frequency of damper	7.14, 11.36, 25.64, 38.5 Hz.	9.2, 15.8, 26.6, 36.8 Hz.	14.3, 20.4, 27, 33.9, 42.6 Hz.
8	No. Of clamps required per span length of 250M, 300M, 350M, 400M, 300 M & 500 M	Upto 400 M, 2 dampers per span; and upto 500 M, 4 dampers per span	Upto 400 M, 2 dampers per span; and upto 500 M, 4 dampers per span	Upto 400 M, 2 dampers per span; and upto 500 M, 4 dampers per span
9	Minimum fatigue strength of damper in cycle	10 million cycle	10 million cycle	10 million cycle
10	Amplitude of fatigue test at the highest resonant frequency	+ 1 m.m.	+ 1 m.m.	+ 1 m.m.
11	Slip strength of clamp	300 kg	500 kg	250 kg
12	Clamping torque	5 kg-mtr	8 kg-mtr	4 kg-mtr

13	Maximum dynamic strain on the conductor with the damper at clamping points	Less than 150 micro strains	Less than 150 micro strains	Less than 150 micro strains
14	Standard to which material will be manufactured and tested	IS 98 / 1980	IS 98 / 1980	IS 98 / 1980
15	Magnetic power loss in watts	Below 1 watt per damper	Below 1 watt per damper	Below 1 watt per damper

2.26.14 MISCELLANEOUS ITEMS: Enamelled number plates, phase plates and danger board, bolts and nuts, spring washers, pack washers and other tower accessories like „D” shackle, hanger and fasteners shall be provided with the tower gantry. Drawing of Anti-climbing devices (including barbed wire) for Gantry shall be submitted by contractor for approval of SECI. No extra payment will be made for this.

2.26.15 VENDOR LIST:

All the materials required for construction of the line shall be supplied strictly as per the approved makes of BHEL/SECI. Before Purchase of any material, prior vendor approval is to be obtained from BHEL/SECI.

2.27 SURVEY & ROUTE OF THE TRANSMISSION LINE:-

- (i) Three alternate tentative route alignment of this 132 KV transmission line wherever required, shall be submitted by bidder. The preliminary survey of the line should be made and plotted on the latest 1: 50000 topo sheet of survey of India map, using the shortest route technically feasible. In respect of forest involvement two or more alternate routes should be submitted for approval. These alternate routes are to be fixed in consultation with the Forest Authorities and the concerned Engineer-in-charge of SECI. The route is subjected to modification / alterations depending on exigencies during the currency of the contract.
- (ii) **ROUTE MARKING:** - At the starting point of the commencement of route survey an angle iron spike of 65x65x6mm section and 1000mm long shall be driven firmly into the ground to project only 150mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50x50x650mm six shall be driven at prominent position at intervals of not more than 750 metre along the transmission line to be surveyed upto the next angle point. Nails of 100mm wire length should be fixed on the top of

these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100mm only above ground level. At angle position stone/concrete pillar with SECI marked on them shall be put firmly on the ground for easy identification.

- (iii) While carrying out survey work, the Soil Resistivity values will have to be measured at convenient points along the route, not exceeding 2.50 Km between adjacent points. The Soil Resistivity will be measured using 4 electrode method with an inter electrode spacing of 50 M. The following formula shall be used:

$$P = 2\pi aR$$

Where a = Inter electrode spacing = 50M
R = Earth resistance measured in Ohms
P = Soil Resistivity in Ohm- m

The soil resistivity values shall be submitted duly marked on the route map and also in the form of statement. The quoted rates for detailed survey/ check survey work shall be inclusive of cost of measuring soil resistivity values along the proposed route and the contractor will not be paid separately for this work.

The contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of SECI and final approval shall be taken before execution of work. The requirement of tower site levelling and revetment work if required, will be marked by the contractor in the profiles while carrying out the survey work.

2.28 PROFILE PLOTTING AND TOWER SPOTTING:-

The Survey is to be conducted by the bidder and the profiles will be handed over to BHEL/SECL progressively marking of towers on the profiles on the basis of sag template curve. The profile will be prepared on cm. Graph paper on scale 1: 2000 horizontal and 1: 200 vertical on 1.0, 10 mm squared paper as per approved 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 10 mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be 594mm wide in accordance with the IS standard. For „as built“ profile these shall be in A1 size. The profile should be submitted to OIC of the work along with the tower schedule indicating the minimum and maximum weight spans.

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.

The minimum ground clearance of **6.1metres for 132KV line** shall be available corresponding to the maximum working temperature and normal span of **355metres for 132kV line** or as per IS:5613. The clearance from building, trees, power line crossings should be made in accordance with the Indian Electricity Rules, 1956 as amended up-to-date and as per IS:5613.

All topographical details, permanent features, such as trees, building etc. **13.5 m for 132 KV line** on either side of the alignment shall be detailed on the profile plan.

2.29 CHECK SURVEY:-

- After approval of profile from SECI, the check survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the 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.
- Changes in the preliminary tower schedule after detailed survey, if required, shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each towers and the deviation at all angles as set out with other details.
- If due to site conditions any change in the tower location/ provision of extn. is considered necessary compared to approved profiles, the contractor shall bring the same to the knowledge of the SECI well in time and get revised approval of the profile before setting the stubs of the work.
- The contractor will be responsible for the correct setting of tower as shown in approved profiles. If tower after erection are found to be out of the approved alignment / position in the profile, the contractor will dismantle and re-erect them correctly fully at his own cost and without extn. of time.
- The following tolerances shall be applicable in case of position of foundations erected with reference to the tower positions spotted on Survey Charts:

Type of tower	Out of Alignment	From centre line of route	From Transverse centre line
Suspension or Intermediate	0.5 degree	25mm	± 250 mm
Section or Tension (Set at bi-section of deviation angel)	0.5 degree	25mm	± 25 mm

2.30 SOIL INVESTIGATION /GEOTECHNICAL INVESTIGATIONS:-

General

SECI requires that a detailed Geotechnical investigation be carried out at tower locations as per requirement of SECI to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally.

These specifications provide general guidelines for geotechnical investigation of normal soils. Cases of marshy locations and locations affected by salt water or saltpetre shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by Contractor and furnished to SECI.

2.30.1 Scope

- 2.30.1.1 The scope of work includes detail soil investigations and furnishing bore log data at various tower locations as per requirement of SECI. However, during actual execution of work, the location shall be decided by the site engineer in charge, depending upon the soil strata and terrain. Based on the bore log data / soil parameter /soil investigation results, the Contractor/soil investigation agency shall submit the test result for the locations and the approval for soil classification shall be taken from SECI. The decision of SECI is full and final.
- 2.30.1.2 These specifications cover the technical requirements for a detailed soil investigation work shall include mobilization of all necessary tools and equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis and interpretation of data and results, preparation of detailed soil report including specific recommendations for the type of foundations. The aforementioned work shall be done or supervised by any independent educational/research institutions or any govt. department laboratory or any govt./board approved agency having work experience of least 5 years in geotechnical investigation work as per technical specification. The approval for the same shall be obtained from SECI.
- 2.30.1.3 Contractor shall make his own arrangements to establish the co-ordinate system required to position boreholes, tests pits and other field test locations .Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details including maximum velocity discharge, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and nalas (canals).
- 2.30.1.4 The field and laboratory data shall be recorded on the Performa recommended in relevant Indian Standards. Contractor shall submit to SECI after the completion of each boreholes/test.
- 2.30.1.5 After reviewing Contractor's geotechnical investigation report, Owner will call for discussions, at Owner's site Office, in order to comment on the report in the presence of Contractor's Geotechnical Engineer. Any expenditure associated with the redrafting and finalizing the report, traveling etc. shall be deemed included in the rates quoted for the

geotechnical investigations.

- 2.30.1.6 Contractor shall carry out all work expressed and implied in these specifications in accordance with requirements of the specification.
- 2.30.1.7 The contractor shall prepare and submit soil profile along the transmission line route indicating salient soil characteristics / features, water table etc based on detailed soil investigations and other details / information collected during detailed survey.
- 2.30.1.8 It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the SECI so desires, contractor shall arrange for having the instruments tested at an approved laboratory at its cost and shall submit the test reports to the Owner. If the Owner desires to witness such tests, Contractor shall arrange for the same.

2.30.2 Field Investigation for Soils

Tentative numbers of detailed soil investigation to be done is given in PBS

2.30.2.1 Boring

Boreholes are required for detailed soil investigations.

General Requirements

- a) Boreholes shall be made to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter of the borehole shall be 150mm and boring shall be carried out in accordance with the provisions of IS:1892 and the present specification.
- b) All boreholes shall be 4mtr deep for normal soil conditions. The depth of boreholes at river crossings and special locations shall be 40m. If a strata is encountered where the Standard Penetration Test Records N values greater than 100, with characteristics of rock, the borehole shall be advanced by coring atleast 3 mtr further in normal locations and at least 7 mtr further for the case of river crossing locations with prior approval of the Owner. When the boreholes are to be termination in soil strata an additional Standard Penetration Test shall be carried out at the termination depth. No extra payment shall be made for carrying out Standard Penetration Tests.
- c) Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15cm above the borehole bottom. In case of cohesion less soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.
- d) In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported following IS:6935. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.
- e) The borehole shall be cleaned using suitable tools to the depth of testing or sampling,

- ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.
- f) On completion of the drilling, Contractor shall backfill all boreholes as directed by the Owner.

2.30.2.2 Auger Boring

Auger boring may be employed in soft to stiff cohesive soils above the water table. Augers shall be of helical or post hole type and the cuttings brought up by the auger shall be carefully examined in the field and the description of all strata shall be duly recorded in the field bore log as per IS:1498. No water shall be introduced from the top while conducting auger boring.

2.30.2.3 Shell and Auger Boring

Shell and auger boring may be used in all types of soil which are free from boulders. For cohesion less soil below ground water table, the water level in the borehole shall always be maintained at or above ground water level. The use of chisel bits shall be permitted in hard strata having SPT-N value greater than 100 Chisel bits may also be used to extend the bore hole through local obstructions such as old construction. Boulders rocky formations etc. The requirements in Clause 4.5.1.2 shall apply for this type of boring also.

Rotary method may be used in all types of soil below water table. In this method the boring is carried out by rotating the bit fixed at the lower end of the drill rod. Proper care shall be taken to maintain firm contact between the bit and the bottom of the borehole. Bentonite or drilling mud shall be used as drilling fluid to stabilise and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard clays and in dense sandy deposits.

2.30.2.4 Standard Penetration Test (SPT)

a. This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure sensitive engineering properties of cohesive soils and sifts such as strength and compressibility shall not be inferred based on SPT values.

2.30.2.5 The test shall be conducted at depths as follows:

Location	Depths (m)
Normal Soils	1.0, 2.0, 3.0, 4.0
River crossings and special Locations.	2.0, 3.0, 5.0, 7.0, 10.0 and thereafter at the rate of 3m intervals upto 40 m or refusal whichever occur earlier.

- a. The spacing between the levels of standard penetration test and next undisturbed sampling shall not be less than 1.0m. Equipments, accessories and procedures for conducting the test and for the collection of the disturbed soil samples shall conform to IS:2131 and IS:9640 respectively. The test shall be conducted immediately after reaching to the test depth and cleaning of bore hole.
- b. The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of a 650N hammer having a free fall of 0.75 m. The sample shall be driven using the hammer for 450mm recording the bumper of blows for every 150mm. The number of blow for the last 300mm drive shall be reported as N value.
- c. This test shall be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labeled.

2.30.2.6 Sampling

General

- a) Sufficient number of soil samples shall be collected. Disturbed soil samples shall be collected for soil identification and for conducting tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate the physical bearing capacity and settlement properties of the soil.
- b) All samples shall be identified with date, borehole or test pit number, depth of sampling, etc. The top surface of the sample in-situ shall also be marked. Care shall be taken to keep the core and box samples vertical, with the mark directing upwards. The tube samples shall be properly trimmed at one end and suitably capped and sealed with molten paraffin wax. The Contractor shall be responsible for packing, storing in a cool place and transporting all the samples from site to the laboratory within seven days after sampling with probe, protection against loss and damage.

2.30.2.7 Disturbed Samples

- a) Disturbed soil samples shall be collected in boreholes at regular intervals. Jar samples weighing approximately 1 kg shall be collected at 0.5m intervals starting from a depth of 0.5m below ground level and at every identifiable change of strata to supplement the boring records. Samples shall be stored immediately in air tight jars which shall be filled to capacity as much as possible.
- b) In designated borrow areas, bulk samples, from a depth of about 0.5m below ground level shall be collected to establish the required properties for use as a fill material. Disturbed samples weighing about 25kg (250N) shall be collected at shallow depths and immediately stored in polythene bags as per IS:1892. The bags shall be sealed

properly to preserve the natural moisture content of the sample and placed in wooden boxes for transportation.

2.30.2.8 Undisturbed Samples

In each borehole undisturbed samples shall be collected at every change of strata and at depths as follows:

Location	Depths (m)
Normal Soils	1.0,2.0, 4.0
Special Locations	1.0, 4.0, 6.0, 8.0,10.0 and thereafter at the rate of 3 m
	intervals up to 33m or refusal whichever occur earlier.

2.30.2.9 The spacing between the top levels of undisturbed sampling and standard penetration testing shall not be less than 1.0m. Undisturbed samples shall be of 100mm diameter and 450mm in length. Samples shall be collected in a manner to preserve the structure and moisture content of the soil Accessories and sampling procedures shall conform to IS:1892 and IS:2132

- a) Undisturbed sampling in cohesive soil :
 Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce the wall friction, suitable precautions, such as oiling the surfaces shall be taken. The sampling tube shall have a smooth finish on both surfaces and a minimum effective length of 450mm. The area ratio of sampling tubes shall be less than 12.5%. However, in case of very stiff soils area ratio up to 20% shall be permitted.
- b) Undisturbed sampling in very loose, saturated, sandy and silty soils and very soft clays :
 Samples shall be obtained using a piston sampler consisting of a cylinder and piston system. In soft clays and silty clays, with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples in the presence of expert supervision.
 Accurate measurements of the sampling depth, dimensions of sampler, stroke and length of sample recovery shall be recorded. After the sampler is pushed to the required depth, the cylinder and piston system shall be drawn up together, preventing disturbance and changes in moisture content of the sample;
- c) Undisturbed sampling in cohesion less soils
 Undisturbed samples in cohesion less soils shall be obtained in accordance with IS:8763. Sampler operated by compressed air shall be used to sample cohesion less soils below ground water table.

2.30.2.10 Ground Water

One of the following methods shall be adopted for determining the elevation of ground water table in boreholes as per IS:6935 and the instructions of the Owner:

- a) In permeable soils, the water level in the borehole shall be allowed to stabilize after

depressing it adequately by bailing before recording its level. Stability of sides and bottom of the boreholes shall be ensured at all times.

- b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observations on the rise or fall of water level shall be made at each depth. The level at which neither fall nor rise is observed shall be considered the water table elevation and confirmed by three successive readings of water level taken at two hours interval.

2.30.2.11 If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the filed investigation. Levels in nearby wells, streams, etc., if any, shall also be noted in parallel.

2.30.2.12 Subsoil water samples

- a) Subsoil water samples shall be collected for performing chemical analysis. Representative ground water samples shall be collected when first encountered in boreholes and before the addition of water to aid boring or drilling.
- b) Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate, carbonate, nitrate and chloride contents, presence of organic matter and suspended solids. Chemical preservatives may be added to the sample for cases as specified in the test methods or in applicable Indian Standards. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written permission and approval of the Owner.

2.30.3 Laboratory Testing

2.30.3.1 Essential Requirements

- c) Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant IS codes. One copy of all laboratory test data records shall be submitted to Owner progressively every week. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory test results could be useful in planning the later stages of field work. A schedule of laboratory tests shall be established by Contractor to the satisfaction of the Owner within one week of completion of the first borehole;
- d) Laboratory tests shall be conducted using approved apparatus complying with the requirements and specification of Indian Standards or other approved standards for this type of work. It shall be checked that the apparatus are in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory.

2.30.3.2 Tests

Tests as indicated in these specifications and as may be requested by the Owner, shall be conducted. These tests shall include but may not be limited to the

following:

- a) Tests of undisturbed and disturbed samples
 Visual and engineering classification, Sieve analysis and hydrometric analysis, Liquid, plastic and shrinkage limits, Specific gravity, Chemical analysis, Swell pressure and free swell index determination, Proctor compaction test.
- b) Tests of undisturbed samples:
 Bulk density and moisture content, Relative density(for sand), Unconfined compression test; Box shear test (for sand), Triaxial shear tests (depending on the type of soil and field conditions on undisturbed or remolded samples Unconsolidated undrained, Consolidated drained test),
- c) Chemical analysis of sub soil water.

2.30.3.3 Salient Test Requirement

- a) Tri-axial shear tests shall be conducted on undisturbed soil samples, saturated by the application of back pressure. Only if the water table is at sufficient depth so that chances of its rising to the base of the footing are small or nil, the tri-axial tests shall be performed on specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300 KPa respectively or as required depending on the soil conditions;
- b) Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 KPa or as required for the soil conditions;
- c) Consolidation test shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 800 KPa. Rebound curve shall be recorded for all samples by unloading the specimen at its in-situ stress. Additional rebound curves shall also be recorded wherever desired by the Owner;
- d) Chemical analyses of subsoil shall include determination of PH value, carbonate, sulphate (both SO_3 and SO_4), chloride and nitrate contents, organic matter, salinity and any other chemicals which may be harmful to the foundation material. Their contents in the soil shall be indicated as percentage (%);
- e) Chemical analysis of subsoil water samples shall include the determination of properties such as colour, odour, turbidity, PH value and specific conductivity, the last two chlorides, nitrates, organic matter and any other chemical harmful to the foundation material. The chemical contents shall be indicated as parts per million (PPM) based on weight.

SUMMARY OF RESULTS OF LABORATORY TESTS ON SOIL AND WATER SAMPLES

- 1. Bore hole test pit. no
- 2. Depth (m)
- 3. Type of sample
- 4. Density(kg/m^3)
 - a) Bulk (b) Dry.
- 5. Water content (%)
- 6. Particle Size (%)
 - a) Gravel (b) Sand (c) Silt (d) Clay

7. Consistency properties
 - a) LL (b) PL (c) PI (d) LI
8. Soil
 - a) Classification –IS, (b) Description, (c) Specific gravity
3. Strength Test
 - a. Type (b) C (Cohesion) (c) ϕ (angle of internal friction)
 - d) Angle of repose
 - e) Consolidation Test
 - e_0 , P_c , C_c , DP , M_v , C_v
 - f) Shrinkage limit(%)
 - g) Swell Test
 - S_{Pr} , FS
 - h) Relative Density (%)
 - i) Remarks

Notations:

I. For type of Sample:

DB - Disturbed bulk soil sample. DP - Disturbed SPT soil sample
 DS - Disturbed samples from cutting edge of undisturbed soil sample.
 RM - Remoulded soil sample, UB - Undisturbed block soil sample
 US - Undisturbed soil sample by sampler, W - Water sample

II. For Strength Test :

SCPT - Static Cone Penetration Test, UCC - Unconfined Compression Test
 VST - Vane Shear Test, Tuu - Unconsolidated Undrained Triaxial Test
 Note: Replace T by D for Direct Shear Test
 Tod - Consolidation Drained Triaxial Test

III. For Others :

LL - Liquid Limit (%), PL - Plastic Limit, PI - Plasticity Index
 LI - Liquidity Index, C - Cohesion (kPa), ϕ - Angle of Internal Friction (degrees)
 S_{Pr} - Swelling Pressure (kPa), e_0 - Initial Void Ratio
 P_c - Reconsolidation Pressure (kPa), C_c - Compression Index
 DP - Change in Pressure (kPa),
 m_v - Coefficient of Volume Compressibility (m^2/KN)
 C_v - Coefficient of Consolidation (m^2/hr)

IV. For Chemical Test

As per Specifications - Clause 2.4.D

2.30.3.4 Recommendations

- a) Recommendations shall be provided for tower location duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and considerations required for proper selection, dimensioning and future performance of tower foundations considers such investigations necessary.

2.30.3.5 Hydro geological Conditions

The maximum elevation of ground water table, amplitudes of its fluctuations and data on

water aggressivity with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each aquifer:

- a) bicarbonate alkalinity mg-eq/(deg),
- b) pH value
- c) content of aggressive carbon dioxide, mg/l;
- d) Content of magnesia salts. mg/l, recalculated in terms of ions Mg^{+2} ;
- e) content of ammonia salts, mg/l, recalculated in terms of ions NH_4^+
- f) content of caustic alkalis, mg/l, recalculated in terms of ions Na^+ & K^+
- g) contents of chlorides, mg/l recalculated in terms of ions Cl^-
- h) contents of sulphates, mg/l, recalculated in terms of ions SO_4^{2-}
- i) Aggregate content of chlorides, sulphates, nitrates, carbonates and other salts. mg/l.

2.30.3.6 Codes and Standards for Geotechnical Investigations

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail.

Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

All work shall be carried out in accordance with the following Indian Standards and Codes:

Indian Standards (IS)	Title	International Standard/Code
IS:1080-1990	Codes of Practice for Design and Construction of Simple Spread Foundations.	
IS:1498-1992	Classification and Identification of Soils for General Engineering purposes.	ASTM D 2487 ASTM D2488
IS:1892-1992	Code of Practice for Subsurface Investigation for Foundation	
IS:1892-1992	Code of Practice for Subsurface Investigation for Foundation	
IS:1904-1986	Code of Practice for Design and Construction of foundation in Soils: General Requirements.	
IS:2131-1992	Method of Standard Penetration Test for Soils	ASTM D 1586
IS:2132-1992	Code of Practice for Thin Walled Tube Sampling of Soils	ASTM D 1587
IS:2720-1992	Method of Test for Soils(Relevant Parts)	ASTM D 420
IS:3025	Methods of Sampling and Testing(Physical and Chemical) for water used in Industry	

IS:4091-1987	Code of Practice for Design and Construction of Foundations for TransmissionLineTowers and Poles.	
IS:4434-1992	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D 2573 ASTM D 4648
IS:4453-1992	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts.	
IS:4464-1990	Code of Practice for Presentation of Drilling information and core description in Foundation investigation	
IS:4968(Part-II)1992	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry.	
IS:5313-1989	Guide for Core Drilling observations.	
IS:6403-1990	Code of Practice for Determination of Allowable Bearing Pressure on Shallow Foundation.	ASTM D 194
IS:6935-1989	Method of Determination of Water level in a Bore Hole.	
IS:7422-1990	Symbols and Abbreviations for use in Geological Maps Sections and subsurface Exploratory Logs (Relevant parts).	
Indian Standards (IS)	Title	International Standard/Code
IS:9259-1992	Specification for Liquid Limit Apparatus.	ASTM D 4318

2.31 EXCAVATION:-

2.31.1 Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation walls shall be vertical and the pit dimensions shall be such as to allow a clearance of 150 mm on all sides from the foundation pit, where form boxes are used. In undercut/stepped (slab type) foundations where form box is not required to be used at the base, the pit dimensions should be as per the standard drawings. All excavation shall be protected so as to maintain a clean sub- grade, until the footing is placed, using timbering, shoring or casing, if necessary. Any sand, mud, silt or other undesirable materials which may have accumulated in the excavation, shall be removed by the contractor before placing concrete.

2.31.2 The soil to be excavated for tower foundations shall be classified as under for the purpose of payment for excavation for tower site levelling and building stone revetment:

- Dry soil : Soil removable by means of ordinary pick axes and shovels (Normal soil, intermediate soil, sandy soil and black cotton soil fall under this category).
- Wet soil : Soil as per (a) above, where the subsoil water table is encountered within the range of foundation depth, the soil below the water table and that at

locations where pumping or bailing out of water is required due to presence of surface water, will be treated as wet soil.

- (c) Soft Rocks: This will mean fissured rock i.e. decomposed rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature which can be easily excavated with pick axe or spade. (DFR & SFR will fall under this category.)
- (d) Hard Rocks: Hard rock will be that which requires chiselling or drilling and blasting.

2.31.3 No extra charges shall be admissible for the removal the fallen earth in the pits when once excavated.

2.31.4 If water is encountered in the foundation pit, de-watering will have to be done. The cost of dewatering shall be deemed to be included in the unit rates of foundations indicated by the bidder in his offer.

2.31.5 For foundation in rock, where blasting is unavoidable, care should be taken to minimize the amount of concrete necessary for filling up the blasted area. The blasted area shall be reduced to the minimum possible so that the specified form for the foundation could be obtained. No extra payment for excavation in hard rock shall be allowed if the excavated area exceeds the designed excavation volumes. Similarly, no extra payment shall be made if concrete volume exceeds the designed volume due to excessive blasting.

2.31.6 The contractor shall arrange requisite blasting material, excavation and drilling equipment at his own cost and the quoted rates shall be deemed to be inclusive of such costs.

2.32 BENCHING :-

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

2.33 SETTING OF STUBS:-

- a. The stubs shall be set correctly in accordance with approved method at the exact locations and alignment and in precisely correct levels. The stub setting templates shall be used for proper setting of stubs. Stubs shall be set in the presence of SECI's representative available at site whenever required and for which adequate advance intimation shall be given to the site Engineer by the contractor.
- b. The foundations are to be made as per designs and drawings approved by the SECI. The extent of work as defined by such drawings shall not be exceeded except in very special cases where the prior approval of the SECI has been obtained.
- c. Each tower shall be provided with suitable foundation based on the approved designs after classification of soil. The soil classification shall be done after digging a small

section of a pit up to full depth (excluding hard rock locations). The soil should be classified strictly as per details encountered in the foundation pit. For example, dry soil foundations should be adopted at the locations where dry soil is encountered in the full depth of foundation. Similarly the wet type foundation should be adopted at the locations where water level is met at level of 1.5 metre or more below the ground level or in paddy fields or other places, which remain in surface water for long periods with water penetration not exceeding one meter below the ground level. Deviation, if any, from the approved / specified conditions shall be brought to the notice of Engineer-in-charge through site Engineer before taking up the work and his decision shall be final and communicated through site Engineer. If at a later date, it is found that the contractor has carried out some work, not according to the specification and without taking specific approval, then in that case, entire payments made to the contractor for carrying out such works shall be recovered and the contractor will have to rectify the same at the rates indicated in the order for carrying out such work and without extension of time.

- d. The setting of stubs in hard rock foundation may require cutting of stubs depending on depth at which hard rock is encountered. The cutting of stubs and drilling of new holes for fixing cleats etc. shall be considered inclusive in the rate of foundation of towers in hard rock.
- e. Setting of stub at each location shall be approved by the SECI's site Engineer. This approval shall not however, absolve the contractor of his responsibility of correct setting of stubs and casting of foundations, who will be required to rectify the faulty work at his own expense.

2.34 PLACEMENT OF REINFORCEMENT:

- (i) Some of the tower foundation may be designed with steel reinforcement so as to achieve better foundation strength with lesser space. The contractor will indicate in relevant schedules, the details of reinforcement to be provided along with the weight and size of steel rods. The cost of placing of reinforcement steel, binding etc. in the foundation pit shall be deemed to be included in the quoted rates of foundation of towers.
- (ii) The reinforcement steel shall be arranged by the contractor at his own cost. The reinforcement bars will have to be properly cut, bent in required shape and placed in the foundation in approved manner after due cleaning of soil grease or organic matter. The reinforcement shall be properly tied by binding wire.

2.35 CONCRETE:

- i. The cement concrete used for the foundation shall be of M 20 1:1.5:3 with 20 mm nominal size stone metal. For RCC, the aggregates shall preferably be of 20 mm nominal size.
- ii. The cement concrete used for lean pad shall be of M-10 1:3:6 ratio with 40mm nominal stone metal for bottom portion with minimum 75 mm thickness.
- iii. The cement required for the purpose of foundations, building revetment walls etc. shall be arranged by the contractor at his own cost.
- iv. The sand used for the concrete shall be composed of hard silicate materials. It shall be

- clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts.
- v. The aggregate shall be of clean broken hard granite or other stone specified or approved by the SECI. It shall be of hard, coarse-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matter. 40 mm aggregate shall be of size as will pass through a mesh of 40 mm measured in the clear and 20 mm aggregate through 20 mm square mesh measured in clear.
 - vi. The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali, organic materials or other deleterious substances, Salty / Saline or brackish water should not be used. Potable water is generally satisfactory.
 - vii. The concrete shall be mixed in a mechanical mixer. However in case of locations not accessible for concrete mixers, hand mixing may be permitted at the discretion of our site Engineer.
 - viii. Mixing shall be continued until there is uniform distribution of materials and the mixing is uniform in colour and consistency but in no case the mixing be done for less than two minutes, Normally mixing shall be done close to the foundation but in case it is not possible, the concrete may be mixed at nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.
 - ix. The concrete shall be mixed as stiff as the requirements of placing the concrete in the form boxes, with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.
 - x. Proper form boxes, adequately braced to retain proper shape while concreting should be used for chimney or pyramid and slab portions. The form boxes should be made water tight so that the cement cream should not come out leaving only sand and jelly consequently forming of honey combing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.
 - xi. The concrete shall be laid in 150 mm layers and consolidated well so that the cement cream works up to the top and no honey combing is left in the concrete. The concreting is to be done continuously so that the subsequent layers are laid before the initial setting of the bottom layer begins. The consolidation of concrete shall normally be done by using vibrators.
 - xii. After concreting the chimney portion to the required height, the top surface should be finished smooth, with slight slope towards the outer edge to drain off the rain water falling on the coping.
 - xiii. In wet locations, the site must be kept completely de-watered both during placing of the concrete and for 24 hours after completion. There should be no spilling to concrete during this period.
 - xiv. The form boxes shall not be removed at least 24 hours after the completion of concreting after removal of the forms, the concrete surface, wherever required shall be repaired with a mixture of rich cement and sand mortar in the shortest possible time.
 - xv. The cost of carrying out concreting of foundations shall be deemed to be included in the rates quoted by the tenderer.

2.36 BACKFILLING AND REMOVAL OF STUB TEMPLATES:

- i. Following opening of the form work and removal of shoring and shuttering, if required, backfilling shall be started after 24 hours of casting repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless, it is a clay type or it consists of large boulders/stones which shall be broken to a maximum size of 80 mm. At locations where borrowed earth is required for backfilling, Contractor shall bear the cost irrespective of lead and lift.
- ii. The backfill materials should be clean and free from organic or other foreign materials. A clay type soil with a grain size distribution of 50% or more passing the 200 sieve as well as a black cotton soil are unacceptable for backfilling. The earth shall be deposited in maximum 200 mm layers, levelled, wetted if necessary and compacted properly before another layer is deposited.
- iii. The back filling and grading shall be carried out to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling, 50 mm high earthen embankment (bund) will be made along the sides of excavation pits and sufficient water will be poured in the back filled earth for at least 24 hours. After the pits have been backfilled to full depth the stub template can be removed.
- iv. The stub setting templates shall be opened only after the completion of back filling.
- v. After completing the stringing work, if level of back filling of some of the location gets settled and it is required to back fill the locations again, the same would be done by the contractor at no extra cost.
- vi. No extra charge is admissible for carrying out the back filling of foundation pit (including backfilling from borrowed earth if required) and the cost of backfilling is included in the cost of foundations of towers.

2.37 CURING:-

The concrete after it is 24 hours old shall be cured by keeping the concrete wet continuously for a period of 14 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the back filled earth and exposed chimney top shall be kept wet for remaining period of the prescribed time of 14 days. The uncovered concrete chimney above the back filled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing ensuring that the bags are kept wet by frequent pouring of water on them. The contractor may use anti-curing paint. However, no extra payment shall be made on this account.

2.38 SHORING OF PITS:-

Shoring of the pits with shuttering on the internal wall surrounding the vertical facing of approved dimensions of the pit shall be done when the soil condition is so bad that there is likelihood of accidents due to falling of surrounding earth in foundation pit. The cost of carrying out shoring and shuttering shall be deemed to be included in the unit rate of foundation of tower and no extra payment shall be made on this account.

2.39 BUILDING STONE REVETMENT:

Stone revetment in 1:5 cement mortars shall be constructed by the Contractor at specified locations. The detailed proposal in consultation with the site Engineer, for carrying out revetment work shall be submitted to the Engineer-in-charge through concerned Superintending Engineer, EHT Construction and approval shall be obtained before carrying out revetment work. The top seal cover of revetment work shall be done with 1:2:4 normal mixes. All materials including cement shall be provided by the contractor and cost of building revetment shall be deemed to include cost of such materials also i.e. Cement, sand, metal and stone. Curing of revetment shall be done as specified for tower foundation. The back filling of the inside of the revetment wall with Soil/borrowed earth will be paid for extra on per m³ basis and shall include its compacting and watering. The excavation for revetment foundation shall be paid at the rates as indicated by the bidder in Price Schedule. The revetment work, wherever necessary, shall have to be completed before taking up final tensioning work in the Section.

2.40 TOWER EARTHING:-

- (i) For the purpose of earthing, 2 No. Galvanised Earthing rods (25 mm diameter and 2 metres long) connecting clamps and connecting wire will be provided by the contractor. The Galvanised Earthing rods are to be hammered preferably in the foundation pits and connected to stub by 7/3.66 mm earth wire and with necessary connecting clamps before concreting the foundation. If it is not possible to tie the rods in the foundation pit i.e. rocky location, they shall be buried near the foundations pit and connected to the stubs. The Galvanised Earthing rods are to be provided on two legs diagonally of the tower. Each tower shall be earthed before the foundation is casted.
- (ii) The tower footing resistance of all towers shall be measured in dry weather after the erection and before stringing of earth wire the counter poise earthing shall be resorted to, in accordance with the instructions of the site Engineer, in case the resistance exceeds the specified value. It shall be ensured that the tower footing resistance is less than 10 Ω (ohms). Each tower footing resistance shall be intimated (along with tower location number) while submitting the progress report of the foundation.

2.41 COUNTER POISE EARTHING:-

- i) In case of high resistivity, counter poise earthing shall be provided which consists of four lengths of galvanised steel stranded wire, each fitted with a leg / clamp for connection to the tower leg at one end. The counter poise will be laid radially away from the tower and will normally be 15 metres in length, buried to the depth of 300 mm below ground level. The length of counter poise wire may be increased if the resistance requirements are not met. Connecting clamps shall be buried in the chimney portion of the foundation. The scope of work of connecting counter poise to the tower leg shall be deemed to be included in the cost of laying of counter poise. The counter

poise connecting wire and clamps will be arranged by the contractor. The counter poise shall preferably be laid through soft areas if available. The planning of laying counter poise shall be done as per approval of site Engineer. The cost of laying of counter poise shall be inclusive of excavation and back filling work.

- i. The contractor shall have to provide Galvanised Earthing rods at the end of each counter poise wire and this may lead to getting required soil resistivity values.
- ii. The earthing of towers to be done as per I.S.S. 5613 Part II & latest revision of I.S.S.

2.42 TOWER ERECTION / ASSEMBLY :-

- i. The contractor shall be responsible for transportation to site of all the materials to be provided by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the SECI
- ii. Tower shall be erected after the concrete is at least 14 days old, but a gap of 24 days shall be preferred. The method followed for the erection of towers, shall ensure the points mentioned below:-
 - i. Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than **450 mm** long may be used.
 - ii. Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.
 - iii. All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.
 - iv. The bolt positions in assembled towers shall be as per I.S:5613(Part-II/ section 2, 1976).
 - v. All blank holes, if any left, after complete erection of tower, are to be filled up by nuts and bolts of correct size.
 - vi. Tower shall be fitted with number, phase and danger plate which shall be arranged by the contractor.
 - vii. **Anti-climbing Devices**: Barbed wire will be used at a height of approx. 3 meters as an anti-climbing measure, which shall be arranged by the contractor. At every location three layers of barbed wires will be provided each inside and outside the tower in horizontal plane. Spacing between the layers with fixing arrangements shall be provided as per the provisions of IS-5613 (Part-II/Sec.1) 1976 with latest modifications. The angle pieces with notches for accommodating barbed wire shall be supplied with the tower members. After the barbed wire is placed in position in the notches, the notch opening shall be welded to avoid the theft of barbed wire and anti-corrosive treatment with cold galvanizing paint shall be given, as also in the case of bolts to be welded below bottom cross arm level. Suitable locking arrangement (pad-lock) shall also be provided.

2.43 TREATMENT OF MINOR GALVANISATION DAMAGE:-

Minor defects in hot-dip galvanised members shall be repaired by applying atleast two coats of zinc rich primer (having approx.90% zinc content) and two coats of enamel paint to the satisfaction of the SECI before erection.

2.44 TIGHTENING, PUNCHING AND WELDING OF BOLTS AND NUTS

- i. All nuts shall be tightened properly using correct sizes of spanners and torque wrench. Before tightening, it will be verified that filler (packing & spring), washers and plates are placed in relevant gaps between members; bolts of proper diameter size and length are provided and one spring washer used under each nut and in case of step bolts, spring washers shall be placed under the outer nut.
- ii. The tightening shall progressively be carried out from the top downwards, care being taken that all the bolts at every level are tightened simultaneously. The threads of bolts projecting outside. The nuts shall be punched at three positions at the periphery 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.
- iii. The threads of all the bolts projected outside the nuts shall be welded on entire circular length of the Bolt. The welding of Bolts, projections as indicated above shall be provided from ground level to top cross arm level in all towers. However, for towers with +18 meter, +25 meter extn. and river crossing towers, the welding shall be provided from ground level to 35m height from stub level.
- iv. After welding zinc-rich primer having approximately 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high built enamel of the grade recommended by the manufacturer of the zinc rich primer. The coat of welding and paint including application of paint shall be deemed to be included in the erection price.

2.45 INSULATOR HOISTING:-

Suspension insulator strings shall be used for suspension towers and tension insulator strings on Angle & Dead end towers. They shall be fixed on all the towers just prior to stringing. Damaged insulators and fittings, if any, shall not be used in the assemblies. Before hoisting all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for the purpose. Security clips shall be fitted in position for the insulator before hoisting. For checking and soundness of insulator, IR measurement using 5 kV (DC) Megger shall be carried out on 100% insulators. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earth wire, etc., whenever recommended by the manufacturer of the same.

2.46 HANDLING OF CONDUCTOR AND EARTH WIRE:-

- 2.46.1** The contractor shall be entirely responsible for any damage caused to the towers or conductors during stringing. While running out the conductors, proper care shall be taken ensuring that the conductors do not touch and rub against the ground or objects which could cause scratches or damage to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. The drum stand shall be provided with a suitable braking device to avoid damage, loose running out and kinking of conductor. The conductor will be pulled by pull cable and consequently pass over the running out blocks. The groove of the running out blocks will be of such a design that the seat is semi-circular and larger than the diameter of the conductor

and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

- 2.46.2** The running blocks shall be suspended in a manner to suit the design of the cross arm. All running blocks especially those at the tensioning end, will be fitted on the cross arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. The conductor shall be continuously observed for loose or broken strands or any other kind of damage. When approaching towards end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully if another length is required to be run out, new length may be joined to the length already run out by the compression joint in approved manner.
- 2.46.3** The conductor joints and clamps shall be erected in such a manner that no bird caging, over tensioning of individual wires or layers or other deformities or damage to the conductor shall occur. Clamps or bracing devices shall under erection conditions allow no relative movement of strands or layers of the conductors. Repairs of conductors, in the event of damage being caused to isolated strands of a conductor during the course of erection, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface with repair sleeve shall be done only in case of minor damage, scuff marks etc., keeping in view both electrical and mechanical safety requirements. The final conductor surface shall be clean, smooth and shall be without any projections, sharp points, cuts, abrasions etc. Repair sleeves may be used when the damage is limited to the outermost layer of the conductor and is equivalent to the severance of not more than one third of the strands of the outermost layer. No repair sleeve shall be fitted within 30m of tension or suspension clamp or fittings not shall more than one repair sleeve per conductor be normally used in any single span.
- 2.46.4** Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.
- 2.46.5** The sequence of running out shall be from top to downwards, i.e. the earth wire shall be run out first followed by the conductors in succession. Imbalances of loads on towers shall be avoided as far as possible.
- 2.46.6** The proposed transmission line may run parallel for certain distance with the existing 400/220/132KV lines which will remain energized during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling cables, conductors and earth wire, which although comparatively small in magnitude during normal operations, can be severe during switching and ground fault conditions on the energised lines. It shall be the contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.
- 2.46.7** Towers no designed for one sided stringing shall be well guyed and steps taken by the Contractor to avoid damage. Guying proposal along with necessary calculations shall be submitted by the Contractor to Owner for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

2.46.8 When these 132 KV transmission lines runs parallel to existing energised power lines, the Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wire during stringing operations.

2.46.9 After being pulled, the conductor / earth wire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

2.47 REPAIRS TO CONDUCTORS:

2.47.1 The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

2.47.2 Repairs to conductor if necessary, shall be carried out with repair sleeve.

2.47.3 Repairing of the conductor surface shall be carried out only in case of minor damage scuff marks, etc. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

2.47.4 The Contractor shall be entirely responsible for any damage to the towers during stringing.

2.48 CROSSINGS: Derricks or other equivalent methods ensuring that normal services need not be interrupted nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication liens, power lines and railway lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth wire and accessories in the field.

2.49 STRINGING OF CONDUCTOR AND EARTH WIRE:-

2.49.1 The stringing of the conductor for 132 KV shall be done by the control tension method. The equipment shall be capable for maintaining a continuous tension per bundle such that the sag for each conductor is about twenty percent greater than the sag specified in then stringing sag table.

2.49.2 The Contractor shall give to site Engineer in Charge complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the conductor and earthwire showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines for the approval of the Owner at least one month in advance. The stringing shall be carried out as per the stringing chart approved by the purchaser in accordance with the relevant IS. All the tolerances for the line shall be confirm to IS 5613(Part-2/Sec-2) 1995.

2.49.3 A controlled stringing method suitable for simultaneous stringing of the stub conductors shall be used. The two conductors making up one phase bundle shall be pulled in and paid out simultaneously. These conductors shall be of matched length. Conductors or earthwires shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

2.49.4 Conductor creep are to be compensated by over tensioning the conductor at a temperature of 26⁰C lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

2.49.5 Suitable guying arrangement shall be made by the Contractor to ensure safety during stringing & final sagging operation.

2.50 JOINTING :

2.50.1 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the accessories manufacturer.

2.50.2 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

2.50.3 All the joints on the conductor and earth wire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc., and be properly greased with anti-corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.

2.50.4 All the joints of splices shall be made of at least 30 metres away from the structures. No joints shall be made in span crossing over main roads, Railway, small rivers and tension spans. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

2.50.5 During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks/aerial rollers. The pulley groove size shall be such that the joint along with protection can be passed over it smoothly.

2.51 TENSIONING & SAGGING OPERATIONS:

2.51.1 The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earth wire are finally attached to the towers through the earth-wire clamps for the earth wire and insulator strings for the conductor. Dynamometers shall be employed for measuring tension in the conductor and earth wire.

2.51.2 The conductors shall be pulled up to the desired sag and left in running block for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging.

2.51.3 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps. The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

2.51.4 At sharp vertical angles, conductor and earth wire sags and tensions shall be checked for equality on both sides of the angle and running block. The suspension insulator assemblies will normally assume vertically when the conductor is clamped.

2.51.5 4.52.5 Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

2.52 CLIPPING:-

- i Clipping of the conductors in position shall be done in accordance with manufacturer's recommendation and approved by our Engineer. At suspension location free centre type suspension clamp with armour rod set or A.G.S. type suspension clamps shall be used.
- ii The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator string shall be used, if found necessary, to restrict the jumper swing to the design values.
- iii Fasteners in all fittings and accessories shall be secured in position. The necessary clip shall be properly opened and sprung into position.

2.53 FIXING OF CONDUCTORS AND EARTH WIRE ACCESSORIES: -

Vibration dampers (4R-type) and other conductor and earth wire accessories supplied by the contractor shall be installed by the contractor as per the design requirement and as per instruction of the Engineer. While installing the conductor and earth wire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Dampers, suspension clamps etc. and torque recommended by the manufacturer of the same shall be applied.

2.54 REPLACEMENT: -

If any replacement is to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arm becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

2.55 ELECTRICAL INSPECTOR'S INSPECTION FEES: -

Electrical inspector's inspection fees to be deposited by the contractor and he has to obtain the clearance from Electrical Inspector before charging the line.

2.56 FINAL CHECKING, TESTING & COMMISSIONING: -

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

- i. Sufficient back filled earth is lying over each foundation pit and it is adequately compacted.
- ii. Concrete chimneys and their copings are in good finely shaped conditions.
- iii. All the tower members are correctly used, strictly according to the approved drawing and are free from defects or damages, what-so-ever.
- iv. All bolts are properly tightened, punched, tack-welded and painted with zinc rich paint.
- v. The stringing of conductors and earth wire has been done as per the approved sag and tension charts and desired clearances are clearly available.
- vi. All conductor and earth wire accessories are properly installed.
- vii. All other requirements to complete the work like fixing the danger plate, phase plate, number plate, anti-climbing devices, aviation signal (wherever required) etc. are properly installed. The double coded painting has been done where required as per aviation rules.
- viii. Wherever required, it should be ensured that revetment is provided.
- ix. The line insulation is tested by the contractor by providing his own equipment, labour etc. to the satisfaction of the SECI to ascertain the insulation conditions of the line.
- x. The original tracings of profile and route alignment as well as tower design, structural drawings, bill of material and shop drawings of all towers with all extns are submitted to the Owner for reference and record.
- xi. All towers are properly grounded.
- xii. Conductor continuity test is carried out to verify that each conductor of the overhead line is properly connected electrically.
- xiii. The line may be charged at a low value of power, frequency, voltage for the purpose of testing.

2.57 COMPLETION DESIGN: -

The contractor has to supply free of cost complete drawing and information to the Engineer in Charge: -

“Complete as executed (as-built) drawings/documents of the line showing each and every structure as actually erected, double insulator points, roads and railway crossings, together with measured spans. All major or small river crossings shall also be indicated. At all deviation points the angles shall be marked in degrees. The coordinates of all the locations of the line as finally erected shall also submit by the contractor along with final tower schedule. All kuchcha and metalled roads, trees, structures, ponds and other obstructions etc. within 50 meters on either side of the route shall be clearly indicated.

The approved drawings and documents shall be submitted in form of scanned pdf documents. Soft copy of all drawings have to be submitted in autoCAD.

Customer: Solar Energy Corporation of India Limited (SECI), New Delhi
Project: 100 MW (AC) Solar PV Project (200MWp DC capacity)
Transmission Line work for 132kV DCDS Overhead Transmission line

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Rev00

These drawings shall also show any communication or Power lines within 35 meters on either side of the line.

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SECTION 2

PART-B)

The scope of work in this specification is general guideline for Maintenance requirement.

1. SCOPE OF WORK FOR MAINTENANCE OF TRANSMISSION LINE

A) The scope of work covered includes :

- i) routine patrolling of transmission lines at regular intervals as per norms
- ii) visual inspection of jumpers, disc insulators and detection of punctured insulators in insulator failure prone areas
- iii) looping , chopping and bush clearance to maintain line clearance
- iv) inspection of foundations and completeness of tower members, cross arms, cross bracings, stay earthing, anti-climbing devices, danger plates & signs
- v) Replacement of missing/ damaged tower members, pole locations, vibration dampers etc.
- vi) minor repair of tower foundations
- vii) pre & post monsoon inspections
- viii) special patrolling on tripping of lines
- ix) Repair of conductor, earthwire and all other items not specifically mentioned in this specification and/or BPS but are required for the smooth flow of power through the transmission line, unless specifically excluded in the specification.

B) Before proceeding with the work, the contractor shall fully familiarise himself with the site conditions. It shall be the responsibility of the contractor to arrange all inputs required for detailed engineering and execution of maintenance contract. The contractor shall be fully responsible for providing all maintenance tools & tackles etc. needed for maintenance of the line, materials for civil works, systems and services specified or otherwise which are required for smooth flow of power through the transmission lines.

All materials required for the civil works (including cement and steel), all necessary maintenance tools & tackles shall be arranged and transported to sites associated with the above scope of work under clause No. 1 by the contractor at his cost and expense. Nothing shall be arranged and provided by the owner, whatsoever.

- i) The contractor at his cost shall arrange, secure and maintain all insurance as may be pertinent to the works and obligatory in terms of law against all perils. The responsibility to maintain adequate insurance coverage at all times during the period of contract shall be of the contractor alone. The contractor shall be responsible for the

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safety and security of the employees of the contractor & his sub-contractors throughout execution of the works. The contractor's failure in this regard shall not relieve him of any of his contractual responsibilities and obligations and the owner will not entertain any claim in this regard.

- ii) The perils required to be covered under the insurance shall include all risks, but not limited to fire and allied risks, miscellaneous accidents, workmen compensation risks, theft, pilferage, riot and strikes and malicious damages, civil commotions, weather conditions, accidents of all kinds etc.
- iii) All costs on account of insurance liabilities covered under the contract will be on contractor's account and will be included in contract price.
- iv) Any other items not specifically mentioned in the specifications but which are required for satisfactory operation of the transmission line are deemed to be included in the scope of the specifications unless specifically excluded.

2. AAILABILIT :

Response time for rectification of any tripping/fault developed in the transmission lines must be such that the outage period is reduced in order to achieve the availability of power required as per prescribed norm.

Availability of the system under jurisdiction of the contractor/firm for a given period means the time in hours during that period the electricity power will be available at its rated voltage of 132KV at the receiving end. The same shall be calculated in percentage of total hours in a given period for 132KV. The onus of satisfying owner in respect of outage time due to aforesaid events shall rest on contractor/firm.

Availability of power at individual 132KV transmission line shall be worked out as per the following formula:

Aaila ilit : -

Ma imum time in hours) aaila ilit o po er 100 /Total time in hours)

The availability to be maintained by the successful contractor shall be 99% minimum for the transmission lines.

For aaila ilit elo penalt as per ontra tpro isions shall e pa a le.

3. EUIPMENTS FACILITIES

The bidder should have its own equipment facilities for the maintenance/erection of transmission line towers, stringing etc. and should furnish the following:

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- (i) List of equipments along with documents/registration to prove ownership.
- (ii) The names of regular employees along with their trade or field of qualification and experience.

. **GENERAL TECHNICAL CONDITIONS:**

This section covers technical requirements pursuant to the contract and will form an integral part of the contract. The contractor's proposal shall be based on the basis of equipments and materials complying fully with the requirements specified herein. It is recognized that contractor may have standardized on the use of certain standards, processes or procedures different than those specified herein. Unless brought out clearly, the bidder shall be deemed to conform to this specification scrupulously.

The transmission lines shall be inspected periodically as per the specification for maintenance purposes to detect any faults which may lead to break down of electric supply and necessary repair should be done immediately.

Patrolling of transmission lines shall be carried out periodically, however, pre-monsoon and post-monsoon checks shall be treated as most important and should be very thorough. The frequency of patrolling shall be increased during monsoon period depending upon special prevailing condition of the lines.

The patrolling party shall be equipped with all necessary tools and tackles, instruments including and not limited to inspection book and formats, drawings, measuring taps, etc.

The main points that are to be noted during inspection of transmission lines are as follows:

Structures: Seriously leaning structures, deformed/buckled members, missing fasteners and members, accessories removed, protective coating like galvanizing or paint disappeared, suspension and terrain attachment for insulator damaged.

Foundations: Signs of external damage, settled or washed out soil below designed ground level over foundation within uplift frustum perimeters, tilted stubs, cracks or breaks in chimney top, slippage of stubs from encasing chimney concrete, uneven settlement of footings, damage/disappearance of tower footing protections, line revetment, retaining walls, abutments and breast walls etc.

Insulator fittings: Damage to insulators and string fittings, surface pollution of a bad nature, missing components like nuts, pins, washers, burnt out fittings, cracked insulator unit, bird droppings, dense spiders' webs etc.

Conductor Earth jumper fittings: Strands cut and open up, loose jumpers gone out of shape and causing infringement of live metal clearance, fallen trees on its branches on conductor or earthwire, checking healthiness of mid-span joints, etc.

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Earthin s: Damaged broken or missing earthing strip or wire of the tower footing, damaged broken or missing of copper bond connections etc.

Ri ht o a its learan es: Shrubs & trees growing within right of way causing obstruction and infringement of line to ground faults.

. OTHER POINTS:

- i) Any construction work near/below the lines causing infringement in line safety or electrical clearance, bird's nest on structure use of structure for permanent support or pull of other objects, huts, newly constructed underneath thee lines, nearby river/nallah, embankment condition or its change of course/flowing patterns etc.
- ii) A special patrolling/inspection of the line shall be carried out after severe wind/hail storm, quakes/landslides, sabotage, forest fire, folds heavy rains. The purpose of such inspection is to detect any damage or breakage on line and to affect the necessary repairs immediately in consultation with purchaser.
- iii) When any line trips or faults very often, it shall be inspected to ascertain the nature of fault such as loose sag, tree branches touching the line etc. and to find out the amount of repair work involved with a view to avoid recurrence of such faults.
- iv) The workers engaged by the contractor should be duly covered by proper insurance taking into account of workmen compensation acts, etc.
- v) Handling of all materials, such as conductor, earthwire, insulators, hardware fittings and accessories, tower members etc. shall be as per owner's standards.
- vi) Shutdown of transmission lines wherever required shall be arranged by engineer-in-charge well in advance and shall be intimated to the contractor before 24 hours of the scheduled maintenance work. In the event of cancellation of such shutdown due to system exigencies the schedule work may have to be rescheduled for which contractor shall be offered to carry other suitable maintenance works and no idling claim shall be entertained.
- vii) Patrolling schedule to be placed in advance and to be approved by owner. Report to be Submitted on weekly basis or as decided by site engineer during finalisation of schedule.
- viii) No work whether shut down is required or not shall be carried by the contractor without prior intimation to site engineer of owner. In case shut down is required for any such work 'permit to work' shall be obtained from the owner by the contractor or his representative before proceeding to work.
- ix) Photograph of locations where jungle cutting/cleaning carried out in infringement areas are to be submitted along with the line patrolling report.

. ENGINEER S SUPER ISION:

To eliminate delay and avoid disputes and adherence to quality assurance plan, the owner reserves the right to supervise any maintenance work carried out by the contractor. Necessary clearance shall be obtained by the contractor from the site engineers of owner for any completed job.

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Supervise the quality assurance program implementation at all stages of the works.

. PLACEMENT OF LABOURS T & P VEHICLES ETC.

Adequate manpower, T&P & inspection/transportation vehicles shall be placed at the Both end sub-stations. Accommodation of personnel & storage of contractor's T&P, spare materials & vehicles etc. there shall be arranged, maintained by the contractor themselves at no extra cost.

. CO-ORDINATION WITH OTHER AGENCIES CONTRACTORS:

- Necessary co-ordination shall be maintained with other agencies and contractor while maintaining the lines.
- Necessary co-ordination shall be maintained & permission shall be obtained with SECI/BHEL during maintenance of 132KV transmission line. Similarly any other permission from any state government department, statutory bodies shall be obtained by the contractor.

. COMPLETENESS OF TENDER:

The tender shall be complete in all respects and include all items, services, which may not be specifically mentioned in this specification by which are essential for the completeness of the works/services

SECTION - 3**1.0) PROJECT INFORMATION**

01.	Name of project	100 MW (AC) Grid Interactive Solar PV Power Plant with 150 MWh Battery Energy Storage System (BESS)
02.	Name of work	132 kV, through Double circuit Double string transmission line from solar PV Power plant project site till 132 kV CSPTCL Substation at Thelkadi, Chhattisgarh
03.	Customer	Solar Energy Corporation of India (SECI) Limited
04.	Location	District Rajnandgaon, Chhattisgarh.
05.	Coordinates of the Project Location	Lat: 21°5'32.89"N, Long 80°50'30.37"E (Tentative)
06.	Remote end of transmission line	132 kV CSPTCL Substation at Thelkadi, Chhattisgarh
07.	Distance to connecting substation (approx.)	33 kMs.
08.	Nearest Urban Area	Rajnandgaon (25 km)
09.	Nearest Highway	Nagpur ó Bhandara ó Rajnandgaon óRaipur Highway (AH46 or NH-6)
10.	Nearest Railway Station	Dongargarh (15 km)
11.	Nearest Domestic Airport	Swami Vivekananda Airport, Raipur (approx. 80 kms)
	Other Details	
12.	Construction Water	It is the responsibility of the contractor.
13.	Construction Power	It is the responsibility of the contractor.
14.	Right of way	It is the responsibility of the contractor.
15.	Statuary clearances/ permits/licenses	It is the responsibility of the contractor.

2.0) CONTACT PERSON: Transmission Business Group/ BHEL

FOR CONTRACTUAL ISSUES	FOR ENGINEERING ISSUES	FOR CONTRACT EXECUTION ISSUES
<p>MUKESH PASWAN AGM (TBSM),</p> <p>10TH Floor, Plot no.:- C-20, 1A/1, Joy towers, C Block, Phase 2, Industrial Area, Sector-62, Noida, Distt. Gautambudh Nagar, UP-201309 PHONE: 0120-6748454/ 09560989092 E-mail: paswan@bhel.in</p>	<p>ASHOK KUMAR MEENA, DGM (TBEM)</p> <p>VIVEK KAPIL (Sr DGM/(TBEM)</p> <p>09TH Floor, Plot no.:- C-20, 1A/1, Joy towers, C Block, Phase 2, Industrial Area, Sector-62, Noida, Distt. Gautambudh Nagar, UP-201309 PHONE: 0120-6748545/07797602171/ 0120-6748539/09818080691 E-mail: akmeena@bhel.in/ vivekk@bhel.in</p>	<p>RAJIV KUMAR LAL</p> <p>Sr DGM & SECTOR HEAD (TBWS) WESTERN SECTOR HQ, VADODARA C-18, BHEL TOWNSHIP GOTRI ROAD, GAYATRI NAGAR, VADODARA- 390021 PHONE: 09557494442 E-mail: rajivlal@bhel.in</p>