TECHNICAL SPECIFICATIONS

FOR

ENGINEERING PROCUREMENT AND CONSTRUCTION (EPC)

UNDER

INTERNATIONAL COMPETITIVE BIDDING (ICB)

FOR

"ASSOCIATED TRANSMISSION SYSTEM FOR RAPP UNIT-7 & 8"

ISSUED BY

RAPP TRANSMISSION COMPANY LTD. (RAPPTCL)
(A wholly owned subsidiary of IndiGrid Ltd.)

Address for Correspondence:
RAPP Transmission Company Ltd.,
C/o IndiGrid Ltd.,
Unit No. 101, First Floor, Windsor, Village
KoleKalyan, Off CST Road, Vidyanagari Marg,
Kalina, Santacruz East, Mumbai 400 098
Phone: +91-7208493885; Mail: info@indigrid.com

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BRIEF SCOPE FOR RAPPTCL TRANSMISSION LINE

The brief scope of work covered under the Transmission Lines associated with the RAPPTCL project include:

(i) Check survey as per shared route. Following details are attached in annexure.

a. Annexure-1; Diversion Route Plan & Profile.

b. Annexure -2; Tower Schedule for Diverted Route.

c. Annexure -3; BOQ for Dismantling of existing TL and New TL construction.

(ii) Classification of foundation based on trial soil pit, backfilling, compaction, curing, for different type of tower and their approval by the owner. Benching, if necessary, Pit excavation, Template fitting, Stub setting, Casting of foundation, (including special foundation locations viz. pile/well foundation locations) for tower footings, revetment wall as per Contractor/Owner's foundation drawing approved by the Owner.

(iii) Arranging of Right of way (ROW) and payment of compensations of crops, trees etc. arranging forest/PTCC, Railway crossing, power line crossing etc. and all other statutory clearances will be in the scope of contractor right from inception of the project till completion of the line.

(iv) Erection of towers, providing tack welding of normal bolts and nuts , tower earthing, fixing of insulator strings, stringing of conductor, OPGW and earth-wire along with all necessary line accessories;

(v) Fabrication and supply of all types of 400 kV transmission line towers including River crossing towers (wherever applicable) as per Contractors/Owners design/drawing including fasteners, step bolts, hangers, D-shackles, tower accessories etc;

(vi) Acquisition of all ROWs, obtaining statutory and other clearances/approvals from Govt. Agencies (Railways, PTCC, power line crossing etc.) and Electrical Inspectorate on behalf of the owner.

(vii) Supply of all types of tower accessories viz., phase plate, circuit plate (Where ever applicable), number plate, danger plate, anti climbing device and Bird guard (Where ever applicable);

(viii) Supply of Earth wire, Conductor accessories & Earth-wire accessories;

(ix) Painting of towers & supply and erection of span markers, obstruction lights (wherever applicable) for aviation requirements (as required);

(x) Testing and commissioning of the erected transmission lines

(xi) Other items not specifically mentioned in this Specification and / or BPS but are required for the successful completion and commissioning of the transmission line, unless specifically excluded in the Specification.

CHAPTER - I

SPECIFICATION

FOR

CHECK SURVEY FOR TRANSMISSION LINE

CONTENTS

1.0 SCOPE

1.1 This Specification covers the minimum technical requirements for check survey including route alignment, line peg marking, optimization of locations, contouring to be done on the basis of Tower Spotting Data provided by owner.

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

The scope of work inter-alia shall include the following:-

a. Check survey including digitised contouring at undulated / hilly tower locations.

b. Check Survey includes route alignment, finalization of length, tower spotting, line peg marking, rechecking of crossing & bisection point of each location with deviation angle.

1.2 The Contractor must note that the Owner shall not be responsible for loss or damage to properties, trees etc. due to Contractor's work during survey. The Contractor shall indemnify the Owner for any loss or damage to properties, trees etc. during the survey work.

1.3 The Contractor should note that Owner will not furnish satellite imageries or topographical maps prepared by Survey of India, but will make available assistance that may be required in obtaining these by providing letters of recommendation to the concerned authorities.

1.4 The work shall be carried out by the Contractor using modern surveying techniques. The Bidder shall indicate in his offer, the detailed description of the procedure to be deployed. The details of the equipment and facilities including software's for image processing, computer aided tower spotting, etc. available with the Bidder or his associates shall also be furnished with the bid.

2.0 **Detailed Check Survey**

2.1. The check survey shall be conducted to locate tower locations on ground conforming to the approved profile and tower schedule.

2.2. The co-ordinates of all the tower locations shall also be recorded using GPS/Total-Station of positional accuracy less than 3m for easy relocating. The position of all tower locations shall be marked in the final digitized route alignment drawing with relative distances from any permanent bench mark area.

2.3. The Contractor shall also collect required data at each tower location in respect of soil strata, ground water level, history of water table in adjacent areas/surface water, distance from permanent bench mark (these details to be furnished in a tabulated form) and classify the suitable type of foundation at each tower location based on the data.

2.4. **Calibration Of Equipment**

The Contractor shall ensure that all the equipment/instruments are properly calibrated at the start of the work to reflect factual values. If demanded by the

Owner, the Contractor shall have the instruments tested at an approved laboratory at his cost and the test reports shall be submitted at the earliest to Owner. If the Owner desires to witness such tests, the Contractor shall arrange for the same.

2.5. Field work

General

The Contractor shall have on site all required survey instruments to carry out the work accurately according to specifications and drawings. All the specified locations for boreholes and field tests shall be set out at site by the Contractor from two established reference grid lines, shown to him by the Owner, or as indicated in the drawing. If required, the Contractor shall set out the base lines and the locations of boreholes and field tests with reference to the property line as indicated by the Owner or as indicated on the drawing. At each location of boreholes, plate load tests and other field tests, the Contractor shall establish the ground prior to commencing of the operations. The ground level shall be related to an established bench mark or to a GTS bench mark or as directed by the Owner or indicated on the drawing.

If the area, where the field tests are located, is likely to be inundated by tidal waters, the field work shall include provision for temporary fill, erection and removal of platforms, making good the ground, access, etc., as necessary for carrying out the work in this area. Payment, if any, for any such works will be as per rate quoted in the Schedule of Quantities. If there is no special item provided for this in the Schedule of Quantities, it is expected that the cost of the same has been catered for in rates for other items and no extra claims will be entertained on this account.

The Contractor shall submit with his bid the list of equipment/ apparatus he would mobilize to site, if work is awarded to him. If necessary, to complete the work within the stipulated time, the Contractor shall mobilize additional equipment without additional cost to the Owner.

CHAPTER - II

SPECIFICATION

FOR

SUPPLY OF TOWER, FOUNDATION Etc. and ERECTION, STRINGING, TESTING AND COMMISSIONING OF TRANSMISSION LINE

CONTENTS

1.0 SCOPE

This Specification covers technical requirements for transmission line tower superstructure and accessories intended to be used in the following 400 kV Overhead Transmission Lines:

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

The scope covers quoting for the following:

Name of the Line	Conductor per phase	Earth Wires
400 kV Double Circuit Line	Twin ACSR Moose	One 24F OPGW and One 7/3.66 Galvanized Stranded Earth wire

The Bidder may carry out Topographic survey to estimate the quantities of the various items in respect of each of the individual lines.

The scope of works by the Contractor for the selected bid shall cover:

a) Detailed check survey,
b) Fabrication of proto type tower, its ground assembly and proto-inspection of all towers including extensions.
c) SUPPLY:
   i. towers as per owner's design & drawings including fabrication, galvanizing, packing and forwarding, transportation, delivery and unloading at destination stores of all types of towers & its extensions, stub, stub setting templates, including bolts, nuts, washers, hangers, D-shackle etc.
   ii. all type of tower accessories like circuit plate, phase plate, number plate, danger plate; bird guard(where ever applicable); anti-climbing device; earthing.
   iii. Earth-wire
   iv. Conductor accessories(except Spacer damper) & Earth-wire accessories
d) Preparing construction drawings for earthing;
e) Constructing tower foundations;
f) Erection of towers, tack welding of bolts & nuts including supply and application of zinc rich primer & two coats of enamel paint, tower earthing; hoisting of insulator strings, stringing/sagging of conductors, earth-wire/OPGW along with all necessary line accessories;
g) Providing benching and revetment walls, etc all complete.
h) Painting of towers & supply and erection of span markers, obstruction lights (wherever applicable) for aviation requirements (as required).
i) Testing and commissioning of the erected transmission lines.
j) The owner will supply the Insulator, hardware, conductor, OPGW and OPGW accessories. The scope of the contractor shall also include the receipt of the same at site, storage, transportation to location, stringing/sagging, fixing of all supplied items by the owner.
k) Other items not specifically mentioned in this specification and / or BPS but are required for the successful commissioning of the transmission line, unless specifically excluded in the specification.

l) Owner shall provide structural drawings, shop drawings & Bill of Materials of all type of transmission line towers and its extensions as required to the contractor after placement of award.

m) Owner shall provide standard foundation drawings for all type of tower for below mentioned soil types:
   - Dry
   - WET
   - PS
   - FS
   - DFR
   - WFR

n) Site specific foundation design like raised chimney, shallow foundation etc. are in the scope of contractor. Same is to be submitted for owner's approval prior to construction of foundation at site.

1.1. **A.** The unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in this document but are essential for the satisfactory completion of various works.

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

2.0 TRANSMISSION TOWER

2.1 Tower Description

The double circuit towers of following types:

a. DA, DB, DC and DD type towers based on usage
b. Transposition Towers

Note: The above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance.

2.1.1 The towers shall be of self-supporting lattice steel type, which shall be designed to carry the line conductors with necessary insulators, earth wires/OPGW and all the fittings/accessories under all the specified loading conditions.

2.1.2 The towers shall be hot-dipped galvanized using mild steel and high tensile steel sections using PG grade material as per IS 2062:2011. Bolts and nuts with flat washers shall be used for connections.

2.2 Electrical Clearances

The required phase to phase spacing and horizontal spacing for 400kV D/C line shall be governed by the tower design as well as minimum live metal clearances for 400kV voltage level under different insulator swing angles. The minimum live metal clearances for 400kV D/C line may be considered as follows:

(1) Under stationary conditions

- From tower body: 3.05m

(2) Under swing conditions
- 22 deg : 3.05m
- 44 deg : 1.86m

However the phase to phase spacing and circuit to circuit spacing for 400kV D/C line shall not be less than 8m and 11m respectively.

i. Conductor temperature of 85^0C with no wind.

ii. All electrical clearances shall be as per the relevant statutory regulations.

iii. Minimum clearances to be considered from live parts to tower body shall be as follows:

For 400kV Double Circuit Line

Swing Angle and Clearances	Swing from Vertical (in Degree)	Minimum Clearance (in mm)
I Suspension Insulator String	0	3050
	22	3050
	44	1860
Tension String	Live part of Tension String to Tower Body / Cross Arm.	3050
Min Ground Clearance (85Deg NW)	-	8840
Min phase to phase spacing	-	8000
Min circuit to circuit spacing	-	11000

Temperatures of Conductors and Earth Wires

The temperatures to be considered in the design are as follows:

Parameter	Value
Minimum Ambient Temperature	0^0C
Average Ambient Temperature or Every Day Temperature	32^0C
Maximum Ambient Temperature	50^oC
Maximum Temperature for Conductor	85^0C
Maximum Temperature for Stranded Earth Wire and for OPGW	53^0C

2.3 Tower Drawings

2.3.1 The relevant drawings for all the towers and their extensions shall be furnished to the contractor by the Owner which shall include structural drawings and shop drawings, Bill of Materials.

2.3.2 The Contractor shall arrange for proto-assembly for each tower type, which shall be inspected by the Owner. After successful proto-assembly inspection, the drawings and bill of materials shall be modified, if/as necessary. The final drawings and bill of materials shall be updated with the next revision number and shall be approved by the Owner, before taking up the mass fabrication.

2.3.3 The mass fabrication shall be taken up from the proto corrected shop drawings. The overall responsibility of correctness lies with the Contractor and he shall ensure that all the tower members can be assembled/fitted while erecting without any undue strain on them.

2.3.4 All the drawings shall have a proper Title Box displaying the name of M/s RAPP on the right hand bottom corner. All the drawings shall carry the following statement and shall be displayed conspicuously on the drawings:
WARNING: THIS IS PRIOPRIETORY ITEM AND ALL RIGHT IS STRICTLY RESERVED WITH M/s RAPP.

2.3.5 While submitting the structural drawings, bill of materials, shop drawings and any other drawings pertaining to the subject transmission line, the contractor shall clearly indicate on each drawing below mentioned items:

- M/s RAPP Specification No.
- Name of the specific transmission line
- Name of the project
- Revision No.
- Date

The same practice is also to be followed while submitting distribution copies & other drawings.

2.3.6 The Contractor shall also prepare the detailed drawings for all the tower accessories like Number plate, Danger plate, Circuit plate, Phase plate, bird guard, Anti-climbing device, Step bolt, D-shackle, etc. including earthing drawings, benching, Revetment & Retaining wall drawings. These shall be submitted to the Owner for review and approval. The further execution shall be based on the approved drawings.

2.3.7 The drawings submitted by the contractor shall be approved/commented by the owner as the case may be within fifteen(15) days of receipt of drawings in his office. If the design/drawings are commented by the owner, the contractor shall submit the revised design/drawings duly incorporating all comments within ten(10) days of date of issue of comments. The contractor shall submit three(3) sets of all approved structural drawings and BOM for tower & its extensions as well as other drawings for further distribution by the owner.

2.4 Materials

2.4.1 Tower Steel

Indian Standard steel sections and plates of tested quality to be used for towers, extensions, stubs and stub setting templates, shall conform to IS 2062:2011 (with yield stress 250 MPa) and (with yield stress 350 MPa). However, use of steel grade having designated yield strength more than 355 MPa is not permissible.

Steel plates below 6mm size exclusively used for packing plates/pack washers conforming to IS: 1079 (Grade 0) are acceptable. However, if below 6mm size plates are used as load bearing plates viz. as gusset plates, joint splices, etc., the same shall conform to IS 2062: 2011 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to E-250 & E-350 Grade (but with designated yield strength not more than 355MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength and metallurgical properties may also be used in place of plates for packing plates/packing washers.

During execution of the project, if any particular section is not available, the same shall be substituted by higher section by the Contractor at no extra cost to the Owner. However, the prior design approval for such substitution shall be obtained from the Owner.

The source of raw steel and raw steel sections shall be approved by the Owner subject to the following:

a. Vendor shall procure steel billets from SAIL, RNIL, JINDAL, TISCO & Adhunik Metalics Ltd only.
b. SGL/MS marking shall be embossed on the rolled MS sections & SGL/HT shall be embossed on rolled HT sections apart from their own logo and colour coded.

2.4.2 Fasteners: Bolts, Nuts and Washers

It shall be ensured that the fasteners provide positive attachment at all times and under the various different conditions as the tower structures are subjected to vibrating loads. All tower members shall be joined together by Hexagonal bolts and nuts.

Flat washer shall be provided under each nut. All Hexagonal head bolts, nuts and flat washers including their galvanizing shall conform to IS: 12427. The bolts shall be of 16/20 mm dia. and of property class 5.6 as per IS: 1363 (Part-III) and matching nut shall be of property class 5.0 as per IS: 1367 (Part-VI).

All bolts and nuts shall be galvanized and shall have Hexagonal heads being forged out of the solid, truly concentric and square with the shank, which must be perfectly straight.

The shear strength of bolts for 5.6 grade should be 310 MPa minimum, as per IS: 12427. Bolts should be provided with washer face in accordance with IS: 1363 (Part-I) to ensure proper bearing.

Nuts should be double chamfered as per the requirements of IS: 1363 (Part-III). It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.

Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.

All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

To avoid bending stress in bolts or to reduce the same to a minimum, no bolt shall connect aggregate thickness of more than three times its diameter.

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

To ensure effective quality control during manufacture, it is essential that the manufacturer should have in-house testing facility for all tests like weight of zinc coating, shear strength and other tests, etc. The manufacturer should also have proper Quality Assurance System, which should be in line with the requirement of this specification, and IS: 14000 series Quality System Standard.

2.5 Tower Accessories

2.5.1 Step Bolts

Each tower shall be provided with step bolts conforming to IS: 10238 on two diagonally opposite legs at spacing not exceeding 450 mm apart and extending from 2.5 m above the ground level to the top of tower. Each step bolt shall be provided with two nuts and two plain washers on one end to fasten the bolt securely to the tower and a button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load of not less than 150 kg. The Owner reserves the right to get the step bolt tested as per IS: 10238 by the Contractor without any extra cost.

2.5.2 Attachment for Insulator Strings Clamps

a) For the attachment of suspension insulator string, a suitable swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The design and supply of D-shackles, strain plate, etc are in the scope of Contractor.

b) On tension towers, strain plates of suitable dimensions and adequate strength shall be provided on the underside of each cross-arm for taking the hooks or D-shackles of the tension insulator strings. Complete details of the attachments shall be provided by the Contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate, etc before connecting the insulator string, the same shall be supplied by the Contractor.

2.5.3 Attachment for Earth wire Clamps

Provision shall be made on the towers for the attachment of ground wire and OPGW clamps.

Earth wire suspension clamps, tension clamps, U-bolts and D-shackles, all as necessary shall be supplied by the Contractor. The detailed drawings shall be submitted by the Contractor for Owner's approval.

2.5.4 Anti-climbing Device and Bird Guards

All the towers shall be fitted with barbed wire type anti-climbing devices, which shall be as per enclosed drawing. The height of the anti-climbing device shall be provided approximately at 3 m above the ground level. The barbed wire shall conform to IS: 278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS: 1340.

Necessary holes shall be provided on the tower members for installation of the anti-climbing device.

All the suspension towers shall be fitted with bird guards at the cross arm tips.

2.5.5 Danger, Number, Circuit and Phase Plates

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

a) Each tower shall be fitted with danger plate, number plate, two circuit plates and sets of phase plates. The transposition towers shall have provision of fixing phase plates on both the transverse faces.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS: 2551 and shall be in single red colour on the front of the plate.

c) The corners of the number, danger and circuit plates shall be rounded off to remove sharp edges.

d) The letters of number plates and circuit plates shall be in red enamel with white enamel background.

2.5.6 Aviation Requirements

Provisions for conformity with aviation requirements shall be in the scope of Contractor. These requirements shall conform to IS: 5613 (Part 3/Sec 1).

2.6 Tower Fabrication

The fabrication of towers shall be in accordance with the provisions made in the following sub-clauses:

2.6.1 Except where specified hereinafter, details of fabrication shall conform to the relevant clause of IS: 802(Part II): 1995 & Approved MQP from owner.

2.6.2 The tower members shall be accurately fabricated to assemble together easily at site without any undue strain on them or the bolts.

2.6.3 No angle member shall have the two leg flanges brought together by closing the angle.

2.6.4 The diameter of hole shall be 1.5 mm more than the diameter of bolt.

2.6.5 All parts of the towers shall be cut to correct lengths and fabricated in accordance with the approved shop drawings. Welding of two or more pieces to obtain the length of member specified will not be allowed. Members shall be straight to the permissible tolerances or better when required to ensure proper fit before being laid off or worked and after galvanizing.

2.6.6 Normally butt splices shall be used. The components constituting the joint shall have a total strength greater than the heavier of the members connected. Lap splices may be used for connecting members of unequal sizes. The inside angle of lap splice shall be grind of the heel to fit the fillet of the outside angle. All splices shall develop full strength of the members connected through bolts. Butt as well as lap splices shall be made above and as close to the main panel points as possible.

2.6.7 Joints shall be so designed and detailed as to avoid eccentricity as far as possible. However, where the connections are such that the elimination of gusset plates would result into eccentric joints; gussets plates and spacer plates may be used in conformity with modern practices. The thickness of gusset plates shall not be less than 6 mm.

2.6.8 The use of fillers in the connections should be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate where necessary, to avoid the use of fillers. Each diagonal shall be in one piece without splices or centre gusset and it shall be connected at the point of intersection by one or more bolts.

2.6.9 All parts of the towers shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to collect and hold water.

2.6.10 All similar parts shall be made strictly interchangeable. No rough edges shall be permitted any where throughout the work.

2.6.11 Straightening

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

. The following machines should be used for straightening.

(1) For angle sections up to 110x110x10 mm: Roller straightening machine

(2) For higher angle sections: Beam bending machine and Hydraulic press

2.6.12 Cutting

The cut surfaces shall be clean, smooth, reasonably square and free from any distortion.

2.6.13 Bending

Mild steel angle sections up to 75x75 mm (thickness up to and including 6 mm) shall be bent cold up to and including bend angles of 10 Degrees. Angles above 75x75 mm (thickness up to and including 6mm) and up to and including 100x100 mm (thickness up to 8 mm) may also be bent cold up to bend angles of 5 Deg. All other angle sections and bend angles not covered above shall be bent hot. All plates up to 12 mm thickness shall be cold worked up to a maximum bend angle of 15 Deg. Hot bending shall be employed for greater bend angles and thicker plates. Bends on HT sections shall be done hot. All hot bent material shall be air-cooled. The bends shall be of even profile and free from any surface damages.

2.6.14 Drilling and Punching

Holes in the members shall either be drilled or punched with CNC machines and shall not be formed by flame cutting process. All burrs left by punching or drilling shall be completely removed. Punching may be adopted for sections with thickness up to 16 mm. For thicker sections, drilling shall be done. The holes near the bend line of bent member on both sides of bend line should be punched/drilled after bending and relative position of these holes shall be maintained with the use of proper templates/jigs and fixtures.

All burrs left by drills or punch shall be removed completely. When the tower members are in position, the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

2.6.15 Erection Mark

Each individual member shall have unique identification number, mark conforming to the component number given to it in the fabrication drawings. This mark shall be embossed at every two-meter length of the member with the die of 16mm size prior to galvanizing and shall be legible after galvanizing.

P-Q-R-S

P = Code alphabet identifying Owner

Q = Code alphabet identifying Tower type

R = Code alphabet identifying batch of manufacturing

S = Code numerical identifying member number

The above unique number mark shall be prefixed by letter ‘H’ for high tensile members.

The Contractor shall maintain necessary records to facilitate the traceability (upto the source of the raw material) of the members based on this unique identification numbering system.

Owner's approval for unique identification marking shall be obtained prior to fabrication of tower.

2.6.16 The contractor shall take prior approval of the Owner in respect of the tower fabrication works.

2.7 Galvanizing

Fully galvanized towers shall be supplied. Hot dip galvanization of the tower members shall conform to IS: 2629 and IS: 4759 and that of fasteners to IS: 5358. The stubs also shall be fully hot dip galvanized. The galvanization shall be done after all the fabrication work is completed except that the nuts may be tapped or re-run after galvanization. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned into finger throughout the length of the threads of bolts and shall be capable of developing full strength of the bolts. Excess zinc shall not remain in threads, in holes, at member ends in connection areas. Post treatment (chromating) recommended as per IS: 2629 shall be carried out after galvanizing. Zinc used shall be as specified in IS 209 or IS 13229.

All galvanized material shall withstand Tests as per IS: 2633.

2.8 Check Assembly of Towers

Based on the approved fabrication drawings, the Contractor shall fabricate and assemble in his works for inspection by the Owner or his authorized representative, one tower of each type as finally approved for checking the fabrication accuracy and workmanship. The proto-assembly shall be in a horizontal position. Proto-assembly made on ground in horizontal position shall be adequately supported to prevent distortion and overstressing of members to ensure proper fit and shall be accomplished without extraordinary efforts to align bolt holes or to force pieces into position. For the proto-assembly, bolts and nuts shall be not more than finger tight.

The Contractor shall provide facilities to the Owner or their representatives for inspection of materials during manufacturing stage of proto assembly

2.9 Standards

2.15.1 The design, manufacturing, fabrication, galvanization, testing, and materials used for manufacture shall conform to the following Bureau of Indian Standards (BIS), which shall mean latest revisions with amendment/Changes adopted and published, unless specifically stated otherwise in the Specification. In the event of supply of materials conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

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

Bureau of Indian Standards (BIS)	Title
IS: 209	Specification for Zinc
IS: 278	Specification for Galvanized Steel Barbed Wire for Fencing
IS: 800	Code of Practice for general construction in steel
IS: 802 (Part I)	Code of Practice for use of structural steel in overhead transmission line towers
Sec-1	Materials and Loads
Sec-2	Permissible stresses
IS: 802 (Part II)	Code of Practice for Use of Structural Steel in Overhead Transmission Line Towers - Part II : Fabrication, Galvanizing, Inspection and Packing
IS: 802 (Part III)	Code of practice for use of structural steel in overhead transmission line towers - Part III : Testing
IS: 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
IS: 875	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Part 3 : Wind Loads
IS: 1200	Methods of measurement of building and civil engineering works: Part 1 to 28
IS: 1340	Code of practice for chromate conversion coating on zinc and cadmium coated articles and zinc base alloys
IS: 1363	Hexagon Head Bolts, Screws and Nuts of Product Grade `C' - Part 1 to 3
IS: 1367	Technical Supply Conditions for Threaded Steel Fasteners - Part 1 to 20
IS: 1477	Code of Practice for Painting of Ferrous Metals in Buildings - Part 1: Pre-treatment, Part 2: Painting

Bureau of Indian Standards (BIS)	Title
IS: 1573	Specification for Electroplated Coatings of Zinc on Iron and Steel
IS: 1852	Rolling and cutting tolerances for hot rolled steel products
IS: 1893	Criteria for earthquake resistant design of structures
IS: 2016	Specification for Plain Washers
IS: 2062	Steel for General Structural Purposes - Specification
IS: 2074	Ready Mixed Paint, Air Drying, Red Oxide Zinc Chrome, Priming – Specification
IS: 2551	Danger Notice Plates
IS: 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS: 2633	Methods for testing uniformity of coating of zinc coated articles
IS: 3043	Code of Practice for Earthing
IS: 3063	Fasteners - Single coil rectangular section spring lock washers – Specification
IS: 3757	Specification for High Strength Structural Bolts
IS: 4000	Code of practice for high strength bolts in steel structures
IS: 4759	Hot-dip zinc coatings on structural steel and other allied products
IS: 5358	Hot dip galvanized coatings on fasteners
IS: 5369	General Requirements for Plain Washers and Lock Washers
IS: 5613	Code of Practice for Design, Installation and Maintenance for Overhead Power Lines - Part 3 : 400 kV Lines - Section 1 : Design, Section 2 : Installation and Maintenance
IS: 6610	Specification for Heavy Washers for Steel Structures
IS: 6623	High Strength Structural Nuts - Specification
IS: 6639	Specification for Hexagon Bolts for Steel Structures

Bureau of Indian Standards (BIS)	Title
IS: 6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles
IS: 7215	Tolerances for fabrication of steel structures
IS: 8500	Structural Steel - Micro-alloyed (Medium and High Strength Qualities – Specification
IS: 10238	Fasteners - Threaded Steel Fastener - Step Bolts for Steel Structures
IS: 12427	Fasteners - Threaded Steel Fasteners - Hexagon Head Transmission Tower Bolts – Specification
	Indian Electricity Rules
	Railway Regulations for Electrical Crossings of Railway Tracks

2.10 Earthing

2.10.1 The Contractor shall measure the tower footing resistance (TFR) of each tower after it has been erected and before the stringing of the earth wire during dry weather. Each tower shall be earthed. The tower footing resistance shall not exceed 10 ohms. Pipe type earthing and counter poise type earthing wherein required should be done in accordance with IS: 3043 and IS: 5613.

2.10.2 The earthing will vary depending on soil resistivity. For soil resistivity less than 1500 Ohm-meter, earthing shall be established by providing 4 lengths of 30-metre counterpoise wire (total 120m length wire). For soil resistivity greater than 1500 Ohm-meter, earthing shall be established by providing 4 lengths of 70-metre counterpoise wire (total 280 m length wire).

2.10.3 For River Crossing towers/pile foundation, galvanized earthing strip of flat 50x6 mm is to be provided in two legs of tower for each location. The proper arrangement of connecting these strips by 16 mm bolts shall be provided in the stub. For pile foundation, the strip has to be taken up to scour level along the concrete of pile foundations. Only bolted connection are allowed for connecting this strip to achieve desired length. Contractor shall submit the detailed drawing for approval by the Owner before installation.

2.11 Packing (Tower Wise)

2.11.1 Angle section shall be wire bundled.

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

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

2.11.4 The packing shall be properly done to avoid losses and damages during transit. Each bundle or package shall be appropriately and properly marked.

3.0 FOUNDATION

3.1 General

All materials, design, detailing and construction methods for foundations shall be as per the latest revision of relevant Indian Standards except as set out and specified below. In case of incompatibility between Indian Standards and the specifications herein, the more demanding parameters shall govern.

Foundation includes supply of all the materials such as cement, sand, coarse aggregates, reinforcement steel, and related all the construction material / equipments, etc.

3.2 Classifications of Foundations

Depending upon the type of soil, water table and the presence of surface water, the foundations have been classified as follows (except for pile foundation).

3.2.1 Normal Dry Type

To be used for locations where water table is below the foundation depth and the soil met is cohesive and homogeneous upto the full depth, having clay content of 10-15%.

3.2.2 Sandy Dry Type

To be used for locations where water table is below the foundation depth and the soil met is cohesion less (pure sand) or negligible cohesion (sand mixed with soil), having clay content of0-10%.

3.2.3 Wet Type

To be used for locations:

i. Where water table is above the foundation depth and upto 1.5 meters below the ground level.
ii. Where standing surface water is for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

3.2.4 Partially Submerged Type

To be used at locations where water table is at a depth between 0.75 meters to 1.5 meters below the ground level and the soil met is normal and cohesive.

3.2.5 Fully Submerged Type

To be used at locations where water table is at a depth within 0.75 meters below the ground level and the soil met is normal and cohesive.

3.2.6 Black Cotton Soil Type

To be used at locations where soil is cohesive having inorganic clay exceeding 15% and characterized by high shrinkage and swelling property (need not necessarily be black in colour)

3.2.7 Soft Rock/Fissured Rock Type

To be used at locations where strata met is decomposed or fissured rock, hard gravel, kankar, limestone, laterite, or any other soil of similar nature. Under cut foundation is to be used at these locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted.

In case of dry locations dry fissured rock foundations shall be adopted.

3.2.8 Hard Rock Type

To be used at locations where strata met requires chiseling, drilling and blasting is required for excavation. For these locations, rock anchoring is to be provided to resist uplift forces. For design purpose, rock level shall be considered at ground level and no overburden soil weight shall be considered for resisting the uplift.

3.2.9 Shallow Type

Based on geotechnical investigation, there may be necessity, especially in sandy soils with water table present; to have shallow depth spread footings, where the depth of footing needs to be restricted to 1.5 to 2.5 m below ground level.

3.3 In addition to the above types, depending on the site conditions, other types of foundations, suitable for Intermediate conditions under the above classifications, shall also be designed and provided to effect more economy.

3.4 The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation; and approval for the same shall be obtained from the Owner.

3.5 The properties of various types of soil shall be considered as per CBIP publication No. 268.

3.6 Type of Foundations

3.6.1 Reinforced Cement Concrete footing shall be used for all type of normal towers. All the four footings of the tower and their extensions shall be similar, irrespective of the forces acting on each leg. The Contractor shall submit the detailed designs and drawings for the foundations of all tower types, under all soil conditions for the approval of the Owner.

3.6.2 After excavating the pit, the casting of every foundation shall be started only after the Owner representative has granted his approval to do so. Similarly, after curing the cast foundation for the required time, back filling of earth shall also be started after the Owner permission to do so.

3.6.3 For all soils other than Hard Rock, the total depth of foundations below the ground level shall not be less than 2.0 m. The corresponding minimum depths for Hard Rock foundations shall be 1.0m.

3.6.4 The maximum depth of foundations for all types of towers (except special structures and foundations approved by the Owner) shall not be more than 3.0 m below the ground level.

3.7 Loads on Foundations

The foundations shall be designed to withstand the reactions at tower base obtained from the structural stress analysis of the tower, and transformed along three mutually orthogonal directions, one along stub angle slope and the other two being normal to the slope, and further increased by 10% as compared to the corresponding tower reactions.

The base reactions shall be composed of the following: -

a) Maximum tension or uplift along the slope of the leg
b) Maximum compression or down-thrust along the slope of the leg
c) Maximum horizontal shear or side-thrust

3.8 Design of Foundations

3.8.1 Safe bearing capacity (SBC) for the foundations shall be calculated as per the guidelines specified in relevant IS codes.

i. SBC for the foundation resting in:-
   (a) soil shall be calculated as per the guidelines specified in IS: 6403, IS: 8009 (Part I) and IS: 1904.
   (b) rock shall be calculated as per the guidelines specified in IS: 12070 and IS: 13063.
ii. Special tower foundations involving piles shall be designed as per the guidelines specified in IS: 2911(Part I/Sec2), IS: 8009 (Part 2) and IS: 14593.

3.8.2 The strength design shall ensure safety against all stress resultants (viz. shear, bending and axial stresses) during each of the maximum down thrust and uplift conditions taken along with accompanying side thrusts. Particularly, the base slab shall be checked for stresses due to bending moment and shear force arising during

down-thrust and uplift conditions, while the chimney portion shall be designed as a composite section for combined action of compression or tension force and associated bending moments due to horizontal shears. The anchoring of stub and cleat shall be done to check anchoring stress in down-thrust and uplift case.

3.8.3 The foundation shall be designed to satisfy all specified loading conditions.

3.8.4 The thickness of concrete in the chimney portion of the tower footing shall provide minimum cover of not less than 100mm from any part of the stub angle to the nearest outer surface of the concrete at all dry locations. At all wet locations, the chimney shall have a clearance of 150mm from any part of the stub angle.

The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto the lower most joint level between the bottom lattices and the main corner leg of the tower. 50 mm thick lean concrete pad grade M10 (1:3:6 nominal mix) of the size of base of the footing will be provided below all foundations.

The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100mm or more than 150mm in case of dry locations and not less than 150mm or more than 200mm in case of wet locations.

The foundation shall be so designed that the Centre of Gravity (C.G.) of tower leg coincides with the C.G. of chimney and C.G. of chimney coincides with the C.G. of base pyramid or slab whichever is provided. In case this provision is not followed, the resultant eccentricities and additional forces because of eccentricities shall be considered in the design of foundations.

The portion of the stub in the pyramid shall be designed to take full down thrust or uplift loads by the cleats combined with the bond between stub angle and concrete in pyramid portion.

i. <u>RCC Type Foundation</u>:

The RCC foundations shall be designed in accordance with Limit State Method prescribed in IS 456, latest edition, employing the same properties of materials, permissible stresses and mode of design as specified therein.

The chimney portion shall be designed as composite section for combined action of compression or tension force and associated bending moments due to horizontal shear. Minimum four bars of diameter not less than 12mm shall be provided running throughout the chimney portion to the bottom of footing and bent there at 90^0 in the bottom tier of footing keeping the minimum cover required. The stub shall not be considered as reinforcement in the chimney for either of the down thrust or uplift cases.

ii. <u>Hard Rock Foundation</u>

Where foundations are installed in rock, the stub leg shall be set a minimum depth of 0.9 m into a concrete block and sufficient stub cleats used to ensure full transfer

of load within the foundation. The upper part of the stubs shall be encased in concrete to a height of 225mm above ground level. To ensure adequate uplift resistance, a sufficient number of reinforcing bars shall be grouted into the rock, using an expanding grout, for a minimum depth of 1.2 m from the base of the excavation. The diameter shall not be less than 12mm. The grouting hole shall normally be 40mm greater than the diameter of the bar. The reinforcing bars shall have adequate bond length within the concrete block.

Resistance against sliding shall be generated by casting the foundation against the rock surface, for which excavation shall be the exact size of the foundation. After casting the concrete block against the rock surface, the gap between the rock and the concrete block shall be plugged by injecting an expansive grout under pressure. This shall be done in the presence of the Owner, and to his approval. There shall be no back-filling without the Owner's approval. Such foundations shall be approved by the Owner before the erection of the support or stub legs proceeds. Type testing of rock anchor bars shall be carried out.

3.9 Construction of Tower Foundations

- Owner shall provide standard foundation drawings for all type of tower for below mentioned soil types:
    - Dry
    - WET
    - PS
    - FS
    - DFR
    - WFR
- Site specific foundation design like raised chimney, shallow foundation etc. are in the scope of contractor. Same is to be submitted for owner's approval prior to construction of site specific foundation.

3.9.1 Excavation

3.9.1.1 Excavation work in a section must not be started until the tower schedule and profile of that section has been approved by the Owner.

3.9.1.2 Except as specifically otherwise provided, all excavation for footings shall be made as per approved design of the foundation. The excavation walls shall be vertical and the pit dimensions shall be such as to allow a clearance of not more than 150mm on all sides from the foundation pad except for foundations in soft and hard rock. In soft rock and hard rock foundation, excavation will be of the exact size of the foundation. 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 that may have accumulated in the excavation shall be removed by the Contractor before placing concrete.

3.9.1.3 The soil to be excavated for tower foundations shall be classified as follows:

a) Dry Soil

Soil removable by means of a spade and shovel. Excavation done in dry soil for wet, partially submerged, fully submerged and wet black cotton type of foundations shall also be covered under this.

b) Wet Soil

Where the subsoil water table is encountered within the range of foundation depth or land, where pumping or bailing out of water is required due to presence of surface water, shall be treated as wet soil. The excavation done in wet soil in case of wet, partially submerged, fully submerged and wet black cotton type of foundations shall also be covered under this.

c) Dry Fissured Rock

Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition, which can be quarried or split with crow bars, wedges or pickaxes. However, if required, light blasting may be resorted to for loosening the material, but this will not in any way entitle the material to be classified as hard rock.

d) Wet Fissured Rock

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

e) Hard Rock

Any rock excavation, other than specified under fissured rock above, for which blasting, drilling, chiseling are required.

3.9.1.4 No extra charge shall be admitted for the removal of fallen earth into a pit or borehole once excavated.

3.9.1.5 Where rock is encountered, the holes for tower footings shall preferably be drilled. Blasting where resorted to as an economy measure, shall be done with utmost care to minimize fracturing rock and using extra concrete for filling the blasted area. All necessary precautions for handling and use of blasting materials shall be taken. In case where drilling is done, the stubs may be shortened suitably with the approval of the Owner.

3.9.1.6 The Contractor shall supply requisite blasting material and be responsible for its storage and use.

3.9.1.7 Indian Standard IS: 3764 shall be followed regarding safety.

3.10 Stub Setting

3.10.1 For all towers the Contractor shall submit for approval the proposed method for setting of stubs.

3.10.2 The stubs shall be set correctly and precisely in accordance with approved method at the exact location, alignment and levels with the help of stub setting templates and leveling instruments. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to Owner by Contractor.

3.10.3 Setting of stub at each location shall be approved by Owner.

3.10.4 For river crossing towers, props may be used with complete accuracy and high skilled supervision, subject to prior approval from Owner.

3.10.5 Stub Setting Templates

3.10.5.1 All the stub setting templates/props as required shall be arranged by the Contractor at his own cost for all heights of towers. Stub templates/props as required shall be of adjustable type and painted.

3.10.5.2 The Contractor shall deploy sufficient number of templates for timely completion of the line without any extra cost to Owner.

3.10.5.3 One set of each type of stub setting template shall be supplied to the Owner, on completion of the project, at no extra cost to Owner.

3.11 Concrete

3.11.1 All cement to be used shall be Portland cement meeting the requirements of the relevant Indian Standards (mainly IS: 269), from an approved manufacturer. Cement shall be adequately protected from moisture or contamination during transportation and storage at site. Cement in bags shall be limited within a heap of 13 bags in store and 7 bags at site. No cement containing lumps or deleterious matter shall be used.

3.11.2 The concrete used for the foundation shall be of M20 grade (i.e. of 20N/mm^2 cube compression strength at the end of 28 days); with 20mm downgraded stone metal for chimney portion and slab portion and 40mm downgraded stone metal for slab/pyramid portions. Aggregates shall conform to specifications for coarse and fine aggregates from natural sources for concrete as per IS: 383. The methods used for the preparation of concrete, and all its properties regarding its strength under compression, tension, shears, punching and bending etc., as well as workmanship shall conform to IS456.

3.11.3 **Fine Aggregates:** The sand used for the concrete shall be composed of hard siliceous materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts. The sand shall conform to Zone 1 Grade to IS: 383, which is the coarse variety with maximum size of 4.75 mm. Zone II Grade of fine aggregates may also be used.

3.11.4 **Coarse Aggregates:** The aggregates shall be of clean broken hard granite or other stone specified or approved by the Owner. It shall be of hard, closed-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 matters. 40mm aggregate

shall be of size as will pass through a mesh of 40mm measured in the clear and 20mm aggregate through 20mm square mesh measured in clear. All fine and coarse aggregates shall be obtained from sources approved by the Owner.

3.11.5 The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali organic materials or other deleterious substances. Salty or brackish water should not be used. Potable water is generally satisfactory.

3.11.6 Though not generally expected, sulphate-resisting cement may be necessary in certain areas of the line route, and the cost of this shall be deemed to have been included in the rates entered in the Schedule of Rates for concrete and foundation items. Sulphate resisting Portland cement shall be in accordance with IS standards and shall be obtained from a source approved by the Owner. The Owner shall decide the locations where it shall be mandatory for the Contractor to use sulphate-resisting cement. The Contractor shall certify that the proposed cement is of the required quality regarding resistance to corrosion due to sulphates. Methods of testing this quality shall be deemed to have been included in the rates quoted. The use of aluminous cements will not be permitted.

3.12 Batching and Mixing of Concrete

3.12.1 It shall be Contractor's responsibility to carry out tests on samples for concrete mixture design that the Contractor proposes to employ in foundation concrete. The test result of the proposed mixture together with data for water cement ratio and slump shall be submitted to the Owner for approval at least four (4) weeks before the commencement of concreting operation. The trial mix proportions shall be approved if the average compressive strength of a set of 9 specimens tested at 28 days exceeds 21N/mm^2, with not more than 3 specimen being less than 20N/mm^2, and no single specimen being less than 17 N/mm^2.

3.12.2 The Contractor shall be responsible for maintaining the mixture, control and testing of concrete throughout the working period. Neither the mix proportions nor the source of the supply of materials shall be altered without the prior approval of the Owner.

3.12.3 The minimum cement content, the water cement ratio, the slump and all other characteristics of concrete shall be demonstrated to conform to the relevant Indian Standards.

3.12.4 The concrete shall be mixed with an approved concrete mixer. In no case shall hand mixing be allowed. The Contractor shall provide the measuring equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. The equipment shall be constantly maintained in first-class workable condition during the working period. The concrete mixing shall be cleaned and inspected at suitable intervals in the presence of the Owner.

3.12.5 Each time the work stops, the mixer shall be cleaned out, and while recommencing; the first batch shall have 10% additional cement to allow for sticking in the drum.

3.12.6 In difficult location, where it is not possible to transport the concrete mixer, the Owner may allow hand mixing of concrete. In such cases 10% additional cement shall be used over and above that being used for such foundation where mixer is being used. Additional cost in such cases shall be borne by the Contractor.

3.12.7 Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency but in no case the mixing is done for less than 2 minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place, the concrete shall be transported from the place of mixing to place of final deposit as rapidly as practicable by methods (transit mixers), which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

3.12.8 The concrete should be mixed as stiff as the requirement of placing the concrete in the forms or moulds with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.

3.12.9 In the event that the Contractor proposes to use ready mixed concrete for foundation work approval must first be obtained from the Owner, who will inspect the batching plant and sand, cement and broken stone used in the making of concrete at the work. No ready mixed concrete shall be used in foundation work, if it has been mixed in the lorry during its journey to site for more than 45 minutes prior to placing. At the discretion of the Owner, ready mixed concrete may be used in foundation if the journey to site is in excess of 45 minutes, if the cement is added to the drum at site and is thoroughly mixed prior to placing. Alternatively and at the discretion of the Owner, if the ready mixed lorry carries its own water drum, water may be added to the cement and aggregate in the mixing drum during the lorry's journey provided the concrete is not mixed for more than 45 minutes prior to placing. The Owner's decision to reject any of the above methods of supplying ready mixed concrete shall be final.

3.12.10 Concrete shall not be directly poured from a height more than 1.5m to avoid mix segregation.

3.12.11 Proper forms or moulds adequately braced to retain proper shape while concreting should be used for chimney and pyramid or slab portions. The mould should be watertight so that cement cream should not come out leaving only sand and jelly consequently forming of honeycombing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

3.12.12 The stub angle shall be free of rust and cleaned thoroughly and painted with cement paste, made of 1 part of cement and ¾ part of water (cement slurry) to a thickness of 1.6mm before the concrete is laid against the stub angle. The painting with cement slurry shall be done each time to such a height before the cement wash becomes dry.

3.12.13 Concrete shall, in all cases, be placed in the presence of the Owner. No concrete shall be placed until the Owner has approved the excavated surface, stub setting, and inspection of formwork and completion of all preparation work. Adequate

chutes or other approved method shall be employed to place concrete. All concrete shall be consolidated to the maximum practicable density with a concrete vibrator and make surface smooth and free from pockets and honeycomb.

3.12.14 The concrete shall be laid in 150mm layers and consolidated well so that the cement cream works up to the top and no honeycombing are left in the concrete. Concreting is to be done continuously so that the subsequent layers are laid before the final setting of the bottom layer begins.

3.12.15 If fresh concrete is to be laid on old concrete less than a week old, the surface of the old set concrete should be chipped and cleaned thoroughly with wire brush and washed with a layer of thick cement slurry before the new concrete is laid. If, however, the concrete is more than 10 days old, the top layer of the set concrete should be chipped and cleaned thoroughly with wire brush and water and layer of cement mortar (1:2) 12 mm thick shall be laid evenly after giving a coat of cement slurry, as specified above to ensure proper bonding between old and new concrete. If a foundation is damaged after stringing, it shall be brought to the notice of the Owner, and rectified as directed by him.

3.12.16 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 rainwater falling on the coping.

3.12.17 In wet locations, the site must be kept completely de-watered both during the placing of the concrete and for 24 hours after completion. There should be no disturbance of concrete by water during this period.

3.12.18 The forms or mould shall not be removed before a lapse of about 24 hours after the completion of concreting. After removal of the forms, the concrete surface, where required shall be repaired with a rich cement and sand mortar in the shortest possible time.

3.12.19 For concreting during hot weather and cold weather, adequate provision shall be made to maintain the suitable concrete temperature.

In hot weather, the concrete temperature shall not increase beyond 40^0C at the time of placement of fresh concrete.

In cold weather, the temperature of the concrete shall not be less than 4.5^0C in moderate weather or 10^0C when the mean daily temperature drops below 4.5^0C.

3.13 Reinforcement

3.13.1 All materials, activities and methods regarding reinforcing steel shall conform to the relevant I.S. Codes, particularly to IS: 432 for mild steel bars and wires, IS: 1786 for High Strength bars and wires, and IS: 1566 for steel wire fabric. The Contractor shall provide certificates stating origin and process of manufacture of reinforcing steel, and submit test certificates from supplier to the Owner. At the discretion of the Owner, samples of reinforcing steel selected by the Owner shall be tested by the Contractor at a local laboratory of the Owner's choice, to demonstrate the tensile

strength of the steel. The cost of such testing shall be deemed to be included in the Scheduled Rates of Items.

3.13.2 The wire shall be 1.25mm in diameter or heavier black annealed iron wire. Preformed clips or attachments shall be of proper design and strength so that reinforcing bars are rigidly supported / held in position, and are not capable of movement during concrete pouring.

3.13.3 Reinforcing steel shall be protected from damage during transportation and during storage. It shall be stacked horizontally with adequate supports to prevent distortion. Bars of different lengths and diameters shall be stacked separately and marked for easy identification.

3.13.4 Reinforcing steel shall be cold bent without any application of heat, by a slow and regular movement. Bending shall be done accurately to dimensions given in the bar bending schedule or foundation drawings in accordance with IS: 2502.

3.13.5 Bars having cracks or splits on the bends shall be rejected.

3.13.6 Immediately before placing concrete, it shall be ensured that reinforcing steel is free from dirt, detrimental scale, paint, mortar, oil, or other foreign substances.

3.13.7 Reinforcing steel embedded or partially embedded in the concrete shall remain completely undisturbed for a minimum period of 24 hours, or longer if the Owner so directs, after a unit of concrete placement has been completed.

3.13.8 Steel shall be placed accurately in accordance with the Drawings. It shall be tied securely at each intersection. Metal or concrete chairs and metal spreaders of approved types shall be used where necessary for support or spacing of steel bars.

3.13.9 Wood supports or spreaders shall not be used.

3.13.10 Splicing of bars except where shown on the Drawings shall not be permitted without the prior written consent of the Owner. Bar splicing shall be by overlapping, as indicated on the drawings, and the lap lengths shall not be less than 52 times the diameter of the smaller bar.

3.14 Backfilling, Compacting, and Removal of Stub Templates

3.14.1 Following opening of form work and removal of shoring and strutting, if any, backfilling shall be started after repairs, if any, to the foundation concrete. The space around the foundation shall be cleared of all debris, and filled with earth in layers not exceeding 200 mm, each layer being leveled, wetted and tamped properly before the succeeding layer is laid. Each layer of earth shall be consolidated by ramming with approved mechanical compaction machines. Special care shall be taken to prevent any wedging action against the footing. The backfill shall be compacted to 95% of the maximum dry density obtainable in the standard Procter density test as specified in relevant standards. The excavation and placing

operations shall be such that material when compacted will be blended sufficiently to secure best practicable degree of compaction, impermeability and stability.

3.14.2 The backfilling and grading shall be carried up to an elevation of about 75mm above the finishing ground level to drain out water. After backfilling, 50mm high earthen embankment 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.

3.14.3 The fill materials will be subject to the Owner's approval. To the extent available, the selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods of earth, salts, sulphates, organic or other foreign materials. All earth clods shall be broken or removed. 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. Where excavated material is mostly rocks, the boulders shall be broken to maximum size of 80 mm, mixed with properly graded fine material consisting of earth to fill up the voids and the mixture used for filling. If any selected fill material is required to be borrowed, Contractor shall make arrangements for bringing such material from outside borrow pits at his cost irrespective of lead & lift. The material as well as source shall be subject to prior approval of the Owner. The approved borrow area shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Topsoil containing salts/sulphates and other foreign material shall be removed. The material so removed shall be burnt or disposed off as directed by the Owner. Contractor shall make necessary access road to borrow area, and maintain the same, if such access road does not exist, at his cost.

3.14.4 The stub-setting template shall be opened only after the completion of backfilling in the pits to full depth.

3.15 Curing

The concrete, after it is 24 hours old, shall be cured by keeping concrete wet continuously for a period of 10 days after laying. The pit may be backfilled 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 chimney top shall be kept wet for the remainder of the prescribed period of 10 days. The uncovered concrete chimney above the back-filled earth shall be kept wet by providing empty cloth or hessian bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by frequent pouring of water on them.

3.16 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.

3.17 Protection of Tower Footing

3.17.1 Tower spotting shall Endeavour to minimize the quantity of revetment required.

3.17.2 The work shall include providing all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in nallahs, river bed undulated terrain, etc., including suitable revetment or galvanized wire netting and meshing packed with boulders. The top cover of stone revetment shall be sealed with M15 concrete (1:2:4 mix). Contractor shall recommend protection at such locations wherever required.

3.17.3 Tower footings shall generally be backfilled using soil excavated at site unless deemed unsuitable for backfilling. In the latter case, backfilling shall be done with borrowed earth of suitable quality irrespective of lead. The backfilling shall also include the required lead and consolidation and leveling of earth after backfilling.

3.17.4 The activity of random rubble masonry revetment shall include excavation, construction of random masonry in 1:5 mortars, creating weep holes, providing filter material behind weep holes, and providing top sealing band with M15 concrete, etc all complete. The volume of random rubble masonry revetment shall be measured from bottom to top sealing band.

3.17.5 For some of the locations in nallahs, river bed or undulated terrain, etc., boulders of min. 150mm dimension bounded and packed in galvanized 8 SWG wire mesh with 152 square mesh size are to be provided. These stones shall be provided in crates size of 2.0mx2.0m or as deemed suitable for a particular location. The cage/stack measurement shall be taken in cubic meters with 15% deduction for voids.

3.18 De-watering

3.18.1 Contractor shall furnish all materials and equipment and perform all work required for de-watering during line construction activities. The de-watering shall be inclusive of de-watering equipment, its transport and installation at site, and of all operational costs like skilled and unskilled man-power, fuel, maintenance charges, etc. all complete.

3.18.2 There shall not be any separate item for de-watering in the Schedule of Rates. It shall be assumed that the quoted rate for any item that could require de-watering (e.g. excavation, concreting for footings, special works like revetment or excavation for any other purpose, etc.) is inclusive of de-watering.

4.0 TOWER ERECTION, STRINGING AND INSTALLATION OF LINE MATERIAL

4.1 General

4.1.1 The details of the scope of erection work shall include the cost of labour, all tools and plant such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work.

The Bidder shall indicate in his bid, the sets of stringing equipment he would deploy exclusively for each transmission line. The stringing equipment shall be of adequate capacity to string simultaneously a bundle of Twin ACSR 'Moose' conductor.

4.1.2 The Contractor shall be responsible for transportation of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at his own cost till such time the erected line is taken over by the Owner. Similarly, the Contractor shall be responsible for proper storage, safe custody, loss or damage of all the Owner supplied items, if any, for incorporation in the works and shall maintain and render proper account for all such materials at all times.

4.1.3 Contractor shall setup required number of stores along the line and exact location of such stores shall be discussed and agreed to between the Contractor and the Owner.

4.1.4 The Bidder shall furnish a brief write-up on the 'Execution methodology' he proposes to deploy for each of the above mentioned transmission lines. The brief shall include the following activities:

a. Obtaining of ROW, Railway, PTCC & other statutory approvals/Clearances
b. Material management
c. Store management
d. Stringing/sagging
e. Final checking
f. Deployment of Tools & Plants for each activity
g. Manpower deployment

4.2 Treatment of Joints and Minor Galvanization Damage

4.2.1 Before starting assembly, minor defects in hot-dip galvanized members shall be repaired first by cleaning. After ensuring that the surface is dry, two coats of zinc rich paint having at least 90% zinc content conforming to relevant Indian Standard shall be applied to the satisfaction of the Owner. Also for the line portion in highly polluted areas, the surfaces at joints shall be cleaned and applied with a coat of zinc rich paint specified above.

4.3 Assembly of Towers

4.3.1 Towers shall be erected on the foundations, not earlier than 14 days after concreting. The Contractor shall give complete details of erection procedures he proposes to adopt.

4.3.2 The method of erection of towers shall ensure the following:

(a) Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match the hole positions at joints and to facilitate this, tommy bars not more than 450mm in length may be used;

(b) Prior to commencement of erection of an upper section, the lower section shall be completely braced, and all bolts fitted in accordance with approved drawings to prevent any mishap during tower erection.

(c) All plan diagonals relevant to a section of tower shall be in place prior to taking up the assembly of an upper Section;

(d) All bolts shall have their nuts facing outside of tower for horizontal or nearly horizontal bolt connections and downwards for vertical bolt connections.

(e) Tower shall be fitted with number, danger, phase and circuit plates as well as anti-climbing device and bird guards (on suspension towers), as described;

(f) After complete erection of the tower, all blank holes, if any, are to be filled by bolts and nuts of correct size.

4.4 Tightening of Bolts and Nuts

4.4.1 All nuts shall be tightened properly using correct size spanner and torque wrench. Before tightening, it will be verified that filler washers and plates are placed in relevant gap between members, bolts of proper size and length are inserted, and one flat washer is inserted under each nut. In case of step bolts, flat washer shall be placed under the outer nut. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. It may be better to employ four persons, each covering one leg and the face to his left.

4.4.2 The threads of bolts projecting outside the nuts shall be punched at three positions on the diameter to ensure that the nuts are not loosened in course of time. If during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced forthwith.

4.4.3 The threads of all the bolts, projected outside the nuts shall be welded at two diametrically opposite places. The circular length of each welding shall be at least 10mm. The welding shall be provided from ground level to bottom cross arm for double circuit towers. However, for river crossing towers, the welding shall be provided from ground level to 30m height from stub level. After welding zinc-rich paint with at least 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

4.5 Insulator Hoisting

Suspension insulator strings shall be used for suspension towers and tension Insulator strings on tension towers. The strings shall be fixed on the tower just prior to the stringing of conductors. Damaged insulators and strings, if any, shall not be employed in the assemblies. Prior to 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 that purpose. For checking the soundness of insulators, IR measurement using 5 kV (DC) Megger shall be carried out on insulators. Corona control rings/arcing horns shall be fitted in an approved manner. Torque wrench shall be used for tightening various line materials and components, such as suspension clamp for conductor and earth-wire/OPGW, etc., whenever recommended by the manufacturer of the same.

4.6 Handling of Conductor and Earth-wire

4.6.1 Running Out of the Conductors

4.6.1.1 While running out the conductors, care shall be taken such 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 Contractor shall be entirely responsible for any damage to tower or conductors during stringing. A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors.

4.6.1.2 The sequence of running out shall be from the top downwards i.e. the earth-wires/OPGW shall be run out first, followed by the conductors in succession. Unbalanced loads on towers shall be avoided as far as possible.

4.6.1.3 The Contractor shall take adequate steps to prevent clashing of sub-conductors until installation of the spacers/spacer dampers. Care shall be taken that sub-conductors of a bundle are from the same Contractor and preferably from the same batch so that creep behaviour of sub-conductors remains identical. During sagging, care shall be taken to eliminate differential sag in sub-conductors as far as possible. However, in no case shall sag mismatch be more than 25mm.

4.6.1.4 Towers not 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.

4.6.1.5 When the transmission line runs parallel to existing energized 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-wires during stringing operations. The Contractor shall also take adequate safety precautions to protect personnel from this potential danger by the way of providing travelling ground.

4.6.2 Running Blocks

4.6.2.1 Immediately after running out, the conductor shall be raised at the supports to the levels of the clamp and placed into running blocks. The groove of the running blocks shall be of such a design that the seat is semi-circular and larger than the diameter of the conductor/earth-wire, 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.

4.6.2.2 The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end, will be fitted on the cross-arms 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.

4.6.3 Repairs to Conductors

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

4.6.3.2 Repairs to conductor if necessary, shall be carried out during the running out operations, with repair sleeve. Repairing of conductor surface shall be carried out only in case of minor damage, scuff marks, etc., keeping in view both electrical and mechanical safety requirements. Number of damaged strands shall not exceed one-sixth (1/6) of the total strands in outer layer. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

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

4.6.4 Enroute Crossings

Derricks or other equivalent methods shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines, etc have to be crossed, to ensure non-interruption in their normal services and also damage caused to property. However, shut down shall be obtained by the Contractor, while working at crossings with existing overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire/OPGW and accessories in the field and also to ensure safe operation.

4.7 Stringing of Conductor and Earth-wire/OPGW

4.7.1 The stringing shall be done by the control tension method, with the help of tension stringing equipment. The equipment shall be capable of maintaining a continuous tension.

4.7.2 The bidder shall give complete details of the stringing methods he proposes to follow. Prior to stringing, the Contractor shall submit the stringing charts for the conductor and earth-wire/OPGW showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the line for the approval by the Owner.

4.7.3 A controlled stringing method suitable for simultaneous stringing of the sub-conductors shall be used. The four conductors making up one phase bundle shall be pulled in and paid out simultaneously. These conductors shall be of matched length. Conductors or earth-wires/OPGW shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

4.7.4 Stringing of OPGW shall be carried out carefully under the supervision of the professional agency.

4.8 Joints

4.8.1 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 shall be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the accessory manufacturer.

4.8.2 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.

4.8.3 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.

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

4.8.5 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.

4.9 Tensioning and Sagging In Operations

4.9.1 The tensioning the sagging shall be done in accordance with the approved stringing charts. The conductors shall be pulled up to the desired sag and left in running blocks 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 conductor shall be clamped within 56 hours of sagging in.

4.9.2 The sag shall be checked in the first and the last span of the section in case of sections upto 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.

4.9.3 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.

4.9.4 At sharp vertical angles, conductor and earth-wire/OPGW sags and tensions shall be checked for equality on both sides of the angle on running blocks. The suspension insulator assemblies will normally assume verticality when the conductor is clamped.

4.9.5 Tensioning and sagging operations shall be carried out in calm weather, when rapid changes in temperature are not likely to occur.

4.10 Clipping In

4.10.1 Clipping of the conductors in position shall be done in accordance with the manufacturer's recommendations. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.

4.10.2 The Jumpers at section and at angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if found necessary, to restrict jumper swing to design values.

4.10.3 Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

4.11 Fixing of Conductors and Earth-wire/OPGW Accessories

Conductor and earth-wire/OPGW accessories including spacers, spacer dampers (for bundle conductor) and vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer's instruction within 24 hours of the conductor/earth-wire/OPGW clamping. While installing the conductor and earth-wire/OPGW accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories. Torque wrench shall be used for fixing the Dampers/Spacer Dampers, Suspension Clamps, etc. and torque recommended by the manufacturer of the same shall be applied.

4.12 Replacement

If any replacement are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without first reducing the tension on the tower by proper guying techniques or releasing of the conductor. If the replacement of cross-arms 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.

4.13 Permitted Extra Consumption of Line materials

4.13.1 The quantity of conductor and earth wire to be incorporated in the line shall be worked as per the following norms.

Quantify of Conductor	=	Line Length* as per detailed survey x 3 phases x Nos. of conductor per bundle x 2 (for Double Circuit Line)
Quantity of Earth wire	=	Line length* as per detailed survey x nos. of ground wires

* For calculation of conductor & Earth wire requirement in hilly stretches, inclined distance between the towers may be considered instead of horizontal distance (considered for line length).

4.13.2 The Contractor shall make every effort to minimize breakage, losses and wastage of the line materials during erection. However, the Contractor shall be permitted and extra consumption of line materials up to the limits specified in Table 5.1 and shall be permitted to dispose of the scrap, if any at the end.

Table 5.1 : Permitted extra consumption of line materials	
Item	**% of permitted extra consumption**
Conductor	0.5
Earth wire	1.0

4.13.3 In case of conductor and earth wire, the permitted extra consumption limit of 0.5 percent & 1 percent respectively is inclusive of sag, jumpering, damage, loss and wastage etc.

4.13.4 The Contractor shall required to return empty conductor and earth wire drums to the Owner immediately.

4.13.5 Any conductor and earth wire drum which has been opened by the Contractor shall not be taken back by Owner and the unused conductor or earth wire in such drums may be treated as waste permissible within the overall limits specified in Table 5.1.

4.13.6 The Contractor shall return to the Owner all Owner supplied material not incorporated in the works, except those permitted by Owner as scrap in terms of Table 5.1. Otherwise, the Contractor shall pay in respect of such excess materials which he is unable to return at rates corresponding to the actual cost of procurement plus (i) 15% for OSM procured under domestically funded packages; and (ii) 26.5% for OSM procured against packages funded by multilateral funding agencies. The “cost of procurement” for the above purpose shall be F O R destination site cost of OSM as per LOA of the respective packages plus taxes & duties plus price variation (if positive) applicable as on the date of issuance of TOC for Tower Package. In case of contract in foreign currency, Bills clearing (BC) Selling, Market Rate of Exchange (MRE) established by State Bank of India (SBI) as prevalent on date of TOC shall be applicable for converting into Indian Rupees.

5.0 FINAL CHECKING, TESTING AND COMMISSIONING

After completion of the works, final checking of the line shall be carried out by the Contractor to ensure that all foundation works, tower erection and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected in order to ensure that:

a) Sufficient backfilled earth covers each foundation pit and is adequately compacted;

b) Concrete chimneys and their copings are in good condition and finely shaped.

c) All tower members are used strictly according to final approved drawing and are free of any defect or damage whatsoever.

d) All bolts are properly tightened, punched, tack welded and painted with zinc rich paint;

e) The stringing of the conductors, earth-wire and OPGW has been done as per the approved sag and tension charts and desired clearances are clearly available;

f) All conductor, earth-wire and OPGW accessories are properly installed;

g) All other requirements for completion of works such as fixing of danger plate, circuit plate, phase plate, number plate, anti-climbing device, bird guard, aviation signal have been fulfilled.

h) Wherever required, that proper revetment (erosion protection) is provided;

i) All the design and drawing documents, bill of materials, plan and profile drawings, and survey documents are submitted to the Owner for reference and record.

j) The insulation of the line as a whole is tested by the Supplier through provision of his own equipment, labour etc., to the satisfaction of the Owner.

k) All towers are properly grounded.

l) The line is tested satisfactorily for commissioning purpose.

m) Any defect found as a result of testing shall be rectified by the Contractor forthwith to the satisfaction of the Owner, without any extra charges.

n) Before taking over the line by the Owner, the line shall be energized at full working voltage.

6.0 Field Quality Plan

All field activity shall be carried out in accordance with Standard Field Quality Plan as given in appendix as per to this specification

Annexure

FIELD QUALITY PLAN FOR RAPPTCL TRANSMISSION LINES

S. No.	Description	Items	TestD/Checks	Check/Testing by owner	Accepting authority in Owner
				Extent	
1	Check Survey	Tower Location & Final Length	i) Alignment ii) Final Length iii) Tower spotting iv) Line Peg Marking v) Bisection Point vi) Deviation Angle vii) Rechecking of Crossings	100% at Field -do-	Line-Incharge

S. No.	Description	Items	Tests/Checks	Check/Testing by owner	Accepting authority in Owner
2.	Tower Foundation	**A. Materials** 1. Cement	1. Source approval	As proposed by Contractor	Owner
			2. Physical tests	Review of all MTC's and one sample for every 500 MT	Line incharge
			3. Chemical Tests Chemical composition of Cement	100%% review of MTC by Contractor	Line Incharge
		2. Reinforcement Steel	1. Source approval	As proposed by Contractor	Owner
			2. Physical and Chemical analysis test	All MTC's	Line Incharge
		3. Coarse Aggregates	1. Source approval	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Owner approved lab	Line Incharge
			2. Physical tests	One sample per lot of 200 cum or part thereof	Line Incharge
		4. Fine aggregate	1. Source approval	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Owner approved lab.	Line Incharge
			2. Physical test	One sample per lot of 200 cum or part thereof	Line Incharge

S. No.	Description	Items	TestD/Checks	Check/Testing by owner	Accepting authority in Owner
		5. Water	1. Cleanliness (Water shall be fresh and clean)	100% visual check at Field	Site Engineer
		B. Classification	2. Suitability of water for concreting	100% Visual Check at Field	Site Engineer
			1. Visual observation of soil strata 2. Ground water level 3. History of water table in adj. Area/surface water 4. Soil Investigation wherever required	100% at Field	a. Line incharge b. In case of FS/PS acceptance by Project Incharge c. For Spl. Fdns./pile fdns. Acceptance by Project In-charge
		C. Concrete Works a. Before concreting			
		1. Bottom of excavated earth 2. Stub setting 3. Reinforcement steel	Depth of foundation 1) Centre Line 2) Diagonals 3) Level of stubs Placement	100% at Field -do- -do-	Line incharge -do- -do-
		b. During concreting			
		1. Workability	Slump test	100% at field	Section incharge
		2.Concrete strength	Cubes comp strength	One sample of 3 cubes in each tower locations	Line incharge
3	Pile foundations	1.All materials like cement, steel, coarse/fine aggregate, water	To be tested as per procedure enumerated in the respective columns above		
		2.Before concreting	1.Check for center line of each pile	100%	Line incharge
			2.Check for dia/vertically of each pile	-do-	-do-

S. No.	Description	Items	TestD/Checks	Check/Testing by owner	Accepting authority in Owner
			3.Check for depth of each pile	-do-	-do-
		3.During concreting			
		a. Workability	1.slump test	Every one hour for each pile	Site Engr.
		b. Concrete strength	2. Cubes compressive strength	One set for each pile. For Pile caps, beams, Chimney, one sample for every 20 Cum. or part thereof for each day of concreting.	Section Incharge.
4	Tower Erection	1. Materials a. Tower member/bolts & nuts/washers/accessories	Visual checking for 1. Stacking 2. Cleanliness 3. Galvanizing 4. Damages	100% at stores	Site Engineer
		2. Erection of Super-structure	1. Sequence of erection	100% at field	Site Engineer
			2. Check for completeness	-do-	-do-
			3. Tightening of nuts and bolts	-do-	-do-
			4. Check for verticality	-do-	-do-
			5. Tack welding for bolts & nuts	100% at Field	Site Engineer
		3. Tower footing resistance (TFR)	TFR at locations before and after earthing.	100% at Field	Line Incharge
5	Stringing	1. Materials			
		a. Insulators	1. Visual check for cleanliness/glazing/cracks/and white spots.	100% at Field	Site Engineer
			2. IR Value	One test per sample size of 20 for every lot of 10,000 of min.50M ohms	-do-

S. No.	Description	Items	TestD/Checks	Check/Testing by owner	Accepting authority in Owner
				Extent	
		b.Conductor	On receipt, 1. Visual check of drum.	100% at stores	Site Engr.
			2. Check for seals at both ends, and owner sticker on outer end	-do-	-do-
		c.Eathwire	Check for seals at both ends	100% at stores	-do-
		2.Field activity			
		a.Before stringing	Readiness for stringing	Readiness certificate to be submitted by contractor	Line incharge
		b.During stringing	(Conductor/Earth-wire)		
			1. Scratch/cut check (Visual)	100% at Field	Site Engineer
			2. Repair sleeve	-do-	-do-
			3. Mid span Joints	-do-	-do-
			4. Guying (in case of towers not designed for one side stringing)	-do-	Section Incharge
		c. After stringing	Check for,		
			1. Sag/Tension	-do-	Site Engr.
			2. Electrical clearances	-do-	-do-
			i) Ground clearance	-do-	-do-
			ii) Live metal clearance etc.	-do-	-do-
			3. Jumpering	-do-	-do-
			4. Copper bond	100% at Field	Site Engineer
			5. Placement of spacer/damper	-do-	-do-
6.	Final Testing				
	a. Pre-commissioning of lines	a. Readiness of lines for pre-commissioning	1. Completeness of line. 2. Meggar test of line	100%	Project Incharge

S. No.	Description	Items	TestD/Checks	Check/Testing by owner	Accepting authority in Owner
	b. Commissioning of line	Readiness of lines for commissioning	2. Digital photograph of each tower to ascertain the completeness of tower.	-do-	-do-
			3. Electrical Inspectors clearance from CEA.	-do-	-do-

CRITERIA FOR CEMENT

ORDINARY PORTLAND CEMENT					
S. No.	**Name of the test**	**Ordinary Portland Cement 33 grade as per IS 269**	**Ordinary Portland Cement 43 grade as per IS 8112**	**Ordinary Portland Cement 53 grade as per IS 12269**	**Remarks**
a)	**Physical tests**				To be conducted in apprd. Lab
(i)	Finenes s	Specific surface area shall not be less than 225 sq.m. per Kg. or 2250 Cm2/gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm2/gm.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm2/gm.	Blaine's air permeability method as per IS 4031 (Part-2)
(ii)	Compre ssive strength	72+/- 1 hour : Not less than 16 Mpa (16 N/mm2) 168+/-2 hour : Not less than 22 Mpa (22 N/mm2) 672+/-4 hour : Not less than 33 Mpa (33 N/mm2)	72+/- 1 hour : Not less than 23 Mpa (23 N/mm2) 168+/-2 hour : Not less than 33 Mpa (33 N/mm2) 672+/-4 hour : Not less than 43 Mpa (43 N/mm2)	72+/- 1 hour : Not less than 27 Mpa (27 n/mm2) 168+/-1 hour : Not less than 37 Mpa (37 N/mm2) 672+/-1 hour : Not less than 53 Mpa (53 N/mm2)	As per IS 4031 (Part-6)
(iii)	Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	As per IS 4031 (Part-5) -do-
(iv)	Soundn ess	Unaerated cement shall not have an expansion of more than 10mm when tested by Le chatlier and 0.8% Autoclave test.	Unaerated cement shall not have an expansion of more than 10mm when tested by Le chatlier and 0.8% Autoclave test	Unaerated cement shall not have an expansion of more than 10mm when tested by Le chatlier and 0.8% Autoclave test.	Le chatlier and Autoclave test as per IS 4031 (Part-3)
b)	**Chemical composition tests**				Review of MTCC only

		a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02	a) Ratio of percentage of lime to percentage of silica, alumina % iron oxide **0.66 to 1.02**	a) Ratio of percentage of lime to percentage of silica, alumina % iron oxide **0.66 to 1.02%**	
		b) Ratio of percentage of alumina to that of iron oxide **Minimum 0.66%**	a) Ratio of percentage of alumina to that of iron oxide **Minimum 0.66**	a) Ratio of percentage of alumina to that of iron oxide **Minimum 0.66%**	
		c) Insoluble residue, percentage by mass **Max. 4.00%**	c) Insoluble residue, percentage by mass **Max. 4.00%**	c) Insoluble residue, percentage by mass **Max. 4.00%**	
		d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	
		e) Total sulphur content calculated as sulphuric anhydride (SO3), percentage by mass **Not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.**	e) Total sulphur content calculated as sulpuric anhydride (SO3), percentage by mass **Not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.**	e) Total sulphur content calculated as sulpuric anhydride (SO3), percentage by mass **Not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.**	
c)	**Total loss on Ignition**	Not more than 5 percent	Not more than 5 percent	Not more than 5 percent	

S. No.	**Name of the test**				**Remarks**
2.	**POZZOLANA PORTLAND CEMENT AS PER IS 1489**				
a)	**Physical tests**	i) Fineness	Specific surface area shall not be less than 300 sq.m. per Kg. or 3000 Cm2/gm		
		ii) Compressive strength	72+/- 1 hour : Not less than 16 Mpa (16 N/mm2) 168+/-2 hour : Not less than 22 Mpa (22 N/mm2) 672+/-2 hour : Not less than 33 Mpa (33 N/mm2)		
		iii) Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes		
		iv) Soundness	Unaerated cement shall not have an expansion of more than 10mm When tested be Le Chatlier and 0.8% autoclave test.		Le chatlier and Autoclave test as per IS 4031 (Part-3)
b)	**Chemical composition tests**				
		a) Magnesia percentage by mass Max. 6%			Review of MTCC only

		b) Insoluble material, percentage by mass x + 2 (100-x)/100 where x is the declared % of pozzolana in the PPC			-do-
		c) Total sulphur content calculated as sulpuric anhydride (SO3), percentage by mass **Not more than 2.75 and 3.0 when tri-calcium aluminate percent by mass is 7 or less and greater than 7 respectively.**			-do-
c)	**Total loss on Ignition**	Not more than 5 percent			

S. No.	**Name of the test**	**Mild and medium tensile steel as per IS 432**	**Cold twisted Deformed bars Fe 415 as per IS 1786**	**Remarks**
i)	Chemical analysis test	Carbon (For 20 mm dia and below) 0.23% Max. Carbon (For over 20 mm dia) 0.25%	Carbon 0.30% Max	
		Sulpher 0.055%	Sulpher 0.060%	
		Phosphorus 0.055%	Phosphorus 0.060%	
			Sulpher & Phosphorus 0.11%	
ii)	Physical tests	a) Ultimate Tensile stress For all dia bars 410 N/Sq.mm. (min.)	a) Ultimate Tensile stress 10% more than actual 0.2% proof stress but not less than 485 N/Sq.mm.)	Testing in approved lab
		b) Yield stress (N/Sq.mm) min. For bars upto 20 mm dia 250 For bars above 20 mm dia 240 c) Percentage of elongation 23%	b) 0.2% of proof stress/Yield stress (N/Sq.mm) min. For bars upto 20 mm dia 415 c) Percentage of elongation 14.5% (min.)	Testing in approved lab
iii)	Bend & Rebend tests	Pass	Pass	Testing in approved lab

3.	**Coarse Aggregates**										
i)	Physical Tests										
	a. Determination of particles size	a. IS Sieve Designation	**%age passing for Single-Sized Aggregate of nominal size**					**Percentage Passing for grades Aggregate of nominal size**			
			40 mm	**20 mm**	**16 mm**	**12.5 mm**	**10 mm**	**40 mm**	**20 mm**	**16 mm**	**12.5 mm**
		63 mm	100	-	-	-	-	-	-	-	-

		40 mm	85 to 100	100	-	-	-	95 to 100	100	-	-
		20 mm	0 to 20	85 to 100	100	-	-	30 to 70	95 to 100	100	100
		16 mm	-	-	85 to 100	100	-	-	-	90-100	-
		12.5 mm	-	-	-	85 to 100	100	-	-	-	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 35	30 to 70	40 to 85
		4.75 mm	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	-	-	-	-	0 to 5	-	-	-	-
	b. Flakiness index		Not to exceed 25%								
	c. Crushing Value		Not to exceed 45%								
	d. Presence of deleterious material		Total presence of deleterious materials not to exceed 5%								
	e. Soundness test (for concrete work subject to frost action)		12% when tested with sodium sulphate and 18% when tested with magnesium sulphate								

4.	**Fine aggregates**				
i)	Physical Tests	**IS Sieve Designation**	**Percentage passing for graded aggregate of nominal size**		
	a) Determination of particle size		**F.A. Zone I**	**F.A. Zone II**	**F.A. Zone III**
		10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns 12.5 mm	15-34	35-59	60-79
		300 microns	5 to 20	8 to 30	12 to 40
		150 microns	0-10	0-10	01-0
	b) Silt content		Not to exceed 8%	Not to exceed 8%	Not to exceed 8%
	c) Presence of deleterious material	Total presence of deleterious materials shall not exceed 5%			

	d) Soundness Applicable to concrete work subject to frost action	12% when tested with sodium sulphate and 15% when tested with magnesium sulphate

CRITERIA FOR CONCRETE WORK

1)	**Concrete**	a) Workability	Slump shall be recorded by slump cone method and it shall between 25-55 mm.
		b) Compressive strength	Three samples of 15 cm cube for 28 days compressive strength for all concrete works except pile foundation work shall be taken. For pile foundation works, six cubes, three for 7 days testing and balance three for 28 days testing shall be taken.

Notes:

1.0 For nominal (volumetric) concrete mixes, compressive strength for 1:1.5:3 (Sand: Fine aggregates: Coarse aggregates) concrete shall be 265 kg/Sq.cm. for 28 days.

2.0 ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR NOMINAL MIX CONCRETE :

a) the average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Engineer-in-charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of the specified strength, it will be restricted to 30% only for computation of strength.

c) If the actual average strength of accepted sample is equal to or higher than specified upto 30%, the strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-charge.

e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-charge shall reject the defective portion of work represent by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall taken at the risk and cost of contractor. If, however, the Engineer-in-charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the Contractor.

General Notes:

1.0 This standard Field Quality Plan is not to limit the supervisory checks which are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.

2.0 All materials should have clearance from Owner before they are erected.

3.0 Contractor shall be responsible for implementing/documenting the SFQP. Documents shall be handed over by the contractor to Owner after the completion of the work.

4.0 Project incharge means over all incharge of work. Line Incharge means incharge of the line. Section in-charge means incharge of the section.

5.0 In case of deviation the approving authority will be one step above the officer designated for acceptance in this quality plan subject to minimum level of Line incharge.

6.0 Acceptance criteria and permissible limits for tests are indicated in the Annexures. However for further details/tests Owner specification and relevant Indian standards shall be referred.

7.0 Tests as mentioned in this FQP shall generally be followed. However Owner reserves the right to order additional tests wherever required necessary at the cost of the EPC contractor.

8.0 All counter checks/tests by Owner shall be carried out by Owner's official's atleast at the level of Site Incharge.

CHAPTER - III

SPECIFICATION

FOR

BARE STRANDED OVERHEAD GROUND WIRE

TABLE OF CONTENTS

1. SCOPE

This Specification covers technical requirements for Design, Engineering, Manufacture, Inspection, Testing and Performance of Bare Concentric-Lay Galvanized Steel Stranded Overhead Ground Wire to be installed on Transmission Line Towers intended to be used for shielding purposes for the following 400 kV Transmission Lines:

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

2. CROSS REFERENCES

This Material Standard Specification shall be read in conjunction with the General Conditions of Contract, Purchase Order or Contract Schedules for project, as applicable and other associated general Requirements for All Equipment/Materials, which shall be considered as an integral part of this Specification.

3. APPLICABLE CODES AND STANDARDS

The ground wire shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendment/Changes adopted and published, unless specifically stated otherwise in the Specification.

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

Sr. No.	Standard	Title
3.1	IS: 209	Quality of Zinc
3.2	IS: 2141	Specification for Hot dip Galvanized stay strand
3.3	IS: 4826	Hot Dip Galvanized Coatings on Round Steel Wires
3.4	IS: 12776	Specification for Bare Stranded Galvanized Steel Wires
3.5	ASTM A363	Standard Specification for Zinc-Coated (Galvanized) Steel Overhead Ground Wire Strand
3.6	BS: 183	Standard Specification for General Purpose Galvanized Steel Wire Strand

4. DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 General

4.1.1 The overhead ground wire strand shall be of manufacturer's standard design but shall meet or exceed the requirements of this Specification in all respects.

4.1.2 Manufacturer's drawings, as required shall show the outline ofthe overhead ground wire strand, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall beindicated.

4.2 Design Criteria

4.2.1 The maximum ambient temperature (50°C) shall be regarded as the basic temperature with the referenced service conditions.

4.2.2 The ground wire shall be high-strength grade galvanized steel wire.

4.2.3 The nominal diameter of the overhead ground wire strand and the number and nominal diameter of coated / clad wires in strand shall be as per **TableI**:

TABLE I

Type of Strand	Number and Nominal Diameter of Strands (mm)
Galvanized Steel Wire	7/3.66

4.3 Ratings

4.3.1 The overhead ground wire shall have the ratings as specified in Data Sheet and as shown in the Technical Description of Galvanized Stranded Earth wire in **Table II** below:

TABLE II

Technical Description of Galvanized Stranded Earth wire		
Sr. No.	**Description**	**Details**
1	Details of earth wire	
2	Stranding and wire diameter	7/3.66 mm
3	Material	As per Clause 4.1 of IS 12776
4	**Element**	**% Composition**
a)	Carbon	0.55 max
b)	Manganese	0.4 to 0.9
c)	Phosphorous	0.04, max
d)	Sulphur	0.04, max
e)	Silicon	0.15 to 0.35
5	**No of strands**	
a)	Steel core	1
b)	Outer steel	6
6	Total sectional area (sq.mm.)	73.646
7	Overall diameter (mm)	10.98
8	Approximate mass (kg/km)	583
9	Calculated DC resistance at 20 deg. C	2.5
10	Minimum breaking force of galvanized earth strand (KN)	68.4

Technical Description of Galvanized Stranded Earth wire		
Sr. No.	**Description**	**Details**
11	Direction of lay of outer layer	Right hand
12	Length of lay (mm)	
	Standard	181
a)	Maximum	198
b)	Minimum	165
13	Equivalent modulus of elasticity of galvanized steel earth strand (kg/sq.mm.)	19x10^3
14	Coefficient of linear expansion (per deg. C)	11.5x10^-6
SINGLE WIRE BEFORE STRANDING		
15	Tensile grade of wire	C
16	Min. Breaking load of strand after stranding (KN)	10.58
17	Diameter of wire (mm) Standard	3.66
18	Maximum	3.74
19	Minimum	3.58
20	Minimum elongation in 200 mm gauge length, before stranding	4%
21	Minimum elongation in 200 mm gauge length, after stranding	3.5%
GALVANIZING		
23	Zinc coating	
24	Minimum 1 minute dips (Before stranding)	3
25	No of one minute dips (After stranding)	2
26	No of ½ minute dips (After stranding)	1
27	Minimum weight of Zn-coating on wire (gm/sq.m.)	
	Before stranding	300
	After stranding	275
28	Quality of zinc (IS 209)	Zn 99.95 Purity
29	Process of galvanizing	Hot dip

4.4 Materials

4.4.1 The base metal shall be steel made by the open-hearth, basic-oxygen or electric-furnace process.

4.4.2 The galvanized steel shall be of such quality and purity that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall have the properties and characteristics prescribed in this specification.

4.4.3 The steel wire strand shall be coated with any grade of zinc conforming to ASTM B6. The zinc (galvanized) coating shall be class C as specified in ASTM A 363.

4.5 Fabrication

4.5.1 The bare overhead ground wire strands shall be constructed in conventional concentric-lay strand type.

4.5.2 Stranding shall be sufficiently close to ensure no significant reduction in diameter when stressed to 10 percent of the specified strength.

4.5.3 All wires in the strand shall lie naturally in their true positions in the complete strand. They shall tend to remain in position when the strand is cut at any point or be readily replaced by hand and then remain in position.

4.5.4 There shall be no strand joints or strand splices in any length of the completed strand. Electric-welded butt joints are only permitted to be made prior to start of cold drawing to final size. There shall be no joints of any kind made in the finished wires composing the strand.

4.5.5 The strand shall be free from imperfections and consistent with good commercial practices. The zinc-coating shall be smooth, continuous and of reasonably uniform thickness.

4.6 Elongation

4.6.1 The elongation of the high-strength galvanized overhead ground wire strand shall be as per the values indicated in **Table II** above.

4.6.2 Elongation shall be observed while applying tension load and the reading when fracture occurs shall be taken as elongation of specimen.

4.7 Diameter Variations

The diameter of the galvanized steel earth-wire forming the strand shall conform to the nominal diameter and limits shown in **Table II** above.

5. Tests and Standards

5.1 Type Tests on Earth wire

The following tests shall be conducted once on a sample/samples of earth wire for every 500 Kms of production from each manufacturing facility:

(a)	UTS test	As per IS 12776 &
(b)	DC resistance test	Approved GTP

5.2 Acceptance Tests on Earth wire

(a)	Visual and dimensional check on drum	IS:1778 & approved Drawing & MQP
(b)	Visual check for joints scratches etc. and lengths of earth wire	
(c)	Dimensional check	As per Approved GTP & MQP
(d)	Lay length check	
(e)	Galvanizing test	
(f)	Torsion test	
(g)	Elongation test	
(h)	Wrap test	IS:398 (Part-II)
(i)	DC resistance test	
(j)	Breaking load test	
(k)	Chemical Analysis of steel	) IS:7904 & Approved GTP, MQP

5.3 Routine Tests on Earth wire

(a) Check for correctness of stranding

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

(c) Check that drums are as per Specification.

5.4 Tests During Manufacture

(a)	Chemical analysis of zinc used for galvanizing	))	As per practice
(b)	Chemical analysis of steel	)	

5.5 Testing Expenses

5.5.1 Testing charges for the type test shall deemed to be included in the quoted price.

5.5.2 Bidders shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by them.

5.5.3 In case of failure in any type test the Contractor is either required to manufacture fresh sample lot and repeat all the test successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case fresh lot is manufactured for testing then the lot already manufactured shall be

rejected. The decision of the Purchaser in this regard shall be final and binding on Contractor.

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

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

5.6 Additional Tests

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

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

5.7 Sample Batch For Type Testing

5.7.1 The Contractor shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from *Owner*'s Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by *Owner*.

5.7.2 The Contractor shall offer at least three drums for selection of sample required for conducting all the type test.

5.7.3 The Contractor is required to carry out all the Acceptance tests successfully in presence of *Owner*'s representative before sample selection.

5.8 TEST FACILITIES

The manufacturer's testing facilities shall have the following:

5.8.1 Tensile testing machine, resistance measurement facilities, burette, thermometer, barometer and associated equipment.

5.8.2 The valid calibration certificate of each machine/equipment.

6. PACKING AND SHIPPING

The Packing requirements shall be the following:

6.1 The Reel and Drum design shall conform to IS: 1778. Manufacturer shall submit drum design as per IS: 1778 to Owner for approval.

6.2 The Standard length shall be as specified in Clause 7 of IS 12776.

6.3 Methods of packaging, marking and shipping shall be submitted to the Owner for review and acceptance.

DATA SHEET
BARE STRANDED OVERHEAD GROUND WIRE (OGW)
(To be furnished by the bidder along with his Bid)

Sr. No.	Description	Specified Values	Quoted Value
1	Details of earth wire		
2	Stranding and wire diameter	7/3.66 mm	
3	**Element**	**% Composition**	
a)	Carbon	0.55 max	
b)	Manganese	0.4 to 0.9	
c)	Phosphorous	0.04, max	
d)	Sulphur	0.04, max	
e)	Silicon	0.15 to 0.35	
4	**No of strands**		
a)	Steel core	1	
b)	Outer steel	6	
5	Total sectional area (sq.mm.)	73.646	
6	Overall diameter (mm)	10.98	
7	Approximate mass (kg/km)	583	
8	Calculated DC resistance at 20 deg. C	2.50	
9	Minimum breaking force of galvanized earth strand (KN)	68.4	
10	Direction of lay of outer layer	Right hand	
11	Length of lay (mm)		
a)	Maximum	198	
b)	Minimum	165	
12	Equivalent modulus of elasticity of galvanized steel earth strand (kg/sq.mm.)	19x10^3	
13	Coefficient of linear expansion (per deg. C)	11.5x10^-6	
SINGLE WIRE BEFORE STRANDING			
14	Tensile grade of wire	C	
15	Min Breaking load of strand after stranding(KN)	10.58	
16	Diameter of wire (mm) Standard	3.66	
17	Maximum	3.74	
18	Minimum	3.58	
19	Minimum elongation in 200 mm gauge length, before stranding	4%	
20	Minimum elongation in 200 mm	3.5%	

Sr. No.	Description	Specified Values	Quoted Value
	gauge length, after stranding		
	GALVANIZING		
21	Zinc coating		
22	Minimum 1 minute dips (Before stranding)	3	
23	No of one minute dips (After stranding)	2	
24	No of ½ minute dips (After stranding)	1	
25	Minimum weight of Zn-coating on wire (gm/sq.m.)		
	Before stranding	300	
	After stranding	275	
26	Quality of zinc (IS 209)	Zn 99.95 Purity	
27	Process of galvanizing	Hot dip	
28	Grade/Type of OGW Strand		
a.	Nominal Diameter of Strand (mm)	3.66	
b.	Number and Nominal Diameter of Coated/ Cladded Wires in Strand	7/3.66	
29	Minimum Breaking Force of Galvanized Earth Strand (kN)	68.4	
a.	DC Resistance Rating at 20°C (Ω /km)	2.50	
b.	AC Resistance Rating at 75°C (Ω /km)		
30	Type of Coating		
a.	Class of Coating		
b.	Weight of Coating		
31	Type of concentric-lay-stranding		
a.	Direction of Lay		
32	Type of Reel		
a.	Number of matched reels per set		
b.	Required total length of OGW Strand		
c.	If not matched reel, tolerance in OGW strand length per reel (m)		

DATA SHEET

BARE STRANDED OVERHEAD GROUND WIRE
(To be furnished by the bidder along with his Bid)

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE SPECIFIED BY OWNER

B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR:

C. OTHER PARTICULARS TO BE FILLED BY BIDDER/VENDOR/SUPPLIER

	Actual Manufacturer of Material	Vendor/Supplier/ Contractor
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with date		

Official Seal/Stamp of the Company

CHAPTER - IV

SPECIFICATION

FOR

Conductor & Earth-Wire Accessories

TABLE OF CONTENTS

1.0 SCOPE

This Specification covers technical requirements for Design, Engineering, Manufacture, Inspection, Testing and Performance of conductor & Earth-wire accessories intended to be used for the following 400 kV Transmission Lines:

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

2.0 CROSS REFERENCES

This Material Standard Specification shall be read in conjunction with the GCC/SCC/etc as applicable and other associated Requirements for all Equipment/Materials, which shall be considered as an integral part of this Specification.

3.0 APPLICABLE CODES AND STANDARDS

The latest revision/amendments of the following Codes and Standards shall be applicable for the equipment/material covered in this specification. In case of conflict, the vendor/manufacturer may propose equipment/material conforming to one group of Industry Codes and Standards quoted hereunder without jeopardizing the requirements of this specification.

3.1 BSI 3288/ Specification for Insulators and Conductor Fittings for Overhead Power Lines

3.2 ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3.3 ASTM A143 Standard Recommended Practice for safeguard against embrittlement of Hot-dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

3.4 ASTM A384 Standard Practice for safeguarding against warfage and distortion during Hot-dip Galvanizing of Steel Assemblies

3.5 ASTM A90 Standard Methods of Test for weight of coating on Zinc coated (Galvanized) Iron or Steel Articles.

3.6 ASTM A239 Standard Method of Test for locating the thinnest spot in Zinc (Galvanized) coating on iron or steel articles by Preece Test (Copper Sulphate dip)

3.7 IEC 61854 Overhead Lines. -- Requirements and Tests for Spacers.

3.8 Other standards to be referred:

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1992 Part-IV	Aluminium conductors for overhead transmission purposes: Part 4 Aluminium alloy stranded conductors	
3.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS : 2121 (Part-II)	Specification for Conductor and Earth-wire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	
5.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
6.	IS:2629	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
7.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.		Ozone test on Elastomer	ASTM- D1 171
9.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
11.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO : 1460 (E)
12.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437 NEMA:107 CISPR
13.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
14.	IS:9708	Specification for Stock	
15.		Overhead Lines - Requirements and Tests for Stockbridge type Aeolian Vibration Dampers.	IEC 61897

4.0 DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 General

4.1.1 The conductor & Earth-wire accessories shall be of manufacturer's standard design and shall meet or exceed the requirements of this Specification in all respects.

4.1.2 All accessories associated with conductors & overhead ground wires for attachments with the structures are included in this specification. These broadly include, but are not limited to the following:

a. MSCJ, Repair Sleeve, T-connector & Twin rigid spacer for conductor.
b. Suspension & Tension clamp, MSCJ, Repair Sleeve, Stockbridge type vibration dampers & copper bond for earth-wire.

4.1.3 All the conductor & Earth-wire accessories shall be accordance with latest applicable standards and with highest quality of workmanship to the satisfaction of the Owner.

4.1.4 Manufacturer's drawings, as required in the specification, shall show the outline of the conductor & Earth-wire accessories, together with all pertinent dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

4.2 Design Criteria

4.2.1 Service conditions referenced in specification shall be the basis of design criteria.

4.2.2 The line hardware shall be of cotter type design and radio-influence voltage interference free.

4.2.3 The bolts and nuts shall conform IS:6639 and shall be galvanized as per IS:1367(Part-13)/IS:2629.

4.3 Ratings

4.3.1 The ratings of conductor & Earth-wire accessories shall be in conformity with the rating of corresponding equipment to which these will be connected.

4.3.2 The tensile strength of dead-end clamps (bolted) shall be equal to the breaking strength of ground wires.

4.4 Materials

4.4.1 All the materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate specifications cited herein.

4.4.2 The conductor & Earth-wire accessories, except for cotter keys, shall be made of a good commercial grade of malleable iron, ductile iron, cast iron, mild steel, forged steel, high tensile steel and aluminium / aluminium alloy. The cotter keys & split pins shall be made of stainless steel.

4.4.3 The conductor & Earth-wire accessories with socket ends shall be furnished with a positive locking device of the split cotter key type. The conductor & Earth-wire accessories with clevis ends shall be furnished with a positive locking device of the cotter key type or bolted type.

4.4.4 The line hardware shall be hot-dip galvanized in accordance with the standard, except that the zinc coating thickness shall be 110 micron (770gm/m²) for all items other than nuts, bolts and washers.

TABLE-1

Details of Material

Sl. No.	Name of Item	Material Treatment	Process of Standard	Reference Remarks
1.	Security Clips	Stainless Steel/Phosphor Bronze	-	AISI 302 or 304-L/ IS-1385
2.	Ball Fittings., Socket, All shackles, links, clevis,	Class-IV Steel	Drop forged& normalized Hot dip galvanized	As per IS: 2004
3.	U Bolts	Stainless Steel or High Strength Al. alloy 6061/6063 or 65032/63400	Forged & heat treated	AISI 302 or 304-L ASTM-B429

4.5 Fabrication

4.5.1 The contours, edges and corners of the conductor & Earth-wire accessories shall be rounded to eliminate areas of high corona stress concentration.

4.5.2 The conductor & Earth-wire accessories having ball and socket couplings shall be compatible with applicable ANSI Standards.

4.5.3 Workmanship and general finish shall be of the highest grade and the best modern practice to the satisfaction of Owner. All components of the same design and designation shall be identical and like components shall be interchangeable.

4.5.4 Split cotter keys shall be humped to maintain the key in the locked or unlocked positions and shall have prongs spread to prevent withdrawal from the socket. The design of the keys shall be such that their engagement and

disengagement can be achieved with the use of standard transmission hot-line tools without excessive force required.

4.6 Marking

Each conductor & Earth-wire accessories shall bear a marking identifying the following :

4.6.1 Manufacturer's identification mark
4.6.2 Manufacturer's Catalog number
4.6.3 Dimensions
4.6.4 Strength rating
4.6.5 Year of manufacture
4.6.6 Owners name—"INDIGRID" The

marking shall be legible and indelible.

5.0 TECHNICAL REQUIREMENTS

The corona extinction voltage shall not be less than maximum system voltage (line to ground) multiplied by a factor of at least 1.2. All energized accessories shall be corona free at this voltage. All conductor & Earth-wire accessories shall be designed for hot line maintenance operations.

5.1 Conductor & Earth-wire Accessories

5.1.1 For galvanized steel overhead ground wires, suspension clamps shall be made of galvanized steel.

a. The suspension clamps/AGS for ground wires shall be compatible with the material of ground wires and shall be designed to withstand a vertical load equal to rated strength of ground wire.

5.1.2 The dead-end support clamp (bolted type) for ground wire shall develop 95% of the full rated strength of the overhead ground wire and under this condition, no slippage shall occur.

5.1.3 Repair sleeve of compression type shall be used to repair earth-wire with not more than 2 strands broken. The sleeve shall have smooth surface. The sleeve shall be rounded to avoid damage to the earth-wire.

5.1.4 The connector shall be used for jumper connection at Transposition tower. The connector shall be strong to withstand the working loads and have resistivity less than 75% of the equivalent length of the conductor. Leg sleeve of the connector shall be kept 15 deg from vertical and horizontal plane of the conductor in order to minimize the jumper pull at the welded end.

5.1.5 Mid span compression joint shall be used for joining two lengths of conductor. The joint shall have resistivity less than 75% than the equivalent

length of conductor. The joint shall be capable of withstanding load of 95% of ultimate tensile strength of the conductor.

5.1.6 The contractor shall provide Colored globules Line Markers as per IS: 5613 (Part 3/Sec1)

5.1.7 Vibration Dampers

a. The vibration dampers shall be suitable for use on ground wires of specified sizes. The vibration dampers shall be of the Stockbridge type having clamp compressed or cast on to the steel messenger wire between the weights. All ferrous components shall be protected by zinc coating according to the specified relevant ASTM Standards and coating thickness. The damper clamp shall be designed in such a manner that moisture cannot accumulate anywhere in the damper. Each damper weight shall be provided with drain hole.

b. The manufacturer shall study the sag-tension data and environmental conditions to ascertain the damper spacing and the number required.

c. The clamp body shall be of aluminium alloy. The clamp body and clamp cap shall each have minimum effective length in bearing on conductor of not less than 65mm for metal surfaced clamps and 40mm for rubber surfaced clamps. The clamping bolts shall be of 12/16mm diameter.

d. The clamping area shall be such that damper neither slips nor damages the conductors.

6.0 Guaranteed technical particulars

The Standard technical particulars to adhered by the contractor / manufacturer are furnished below:

A. Standard Technical Particulars of conductor & Earth-wire accessories

for 400 kV D/C Line with Twin ACSR Moose Conductor

Mid span compression Joint for ACSR MOOSEConductor				
Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200	
3.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	34.00 ± 0.5	11.05 ± 0.2

ii)	Outside diameter	mm	54.00 ± 1.0	21.00 ± 0.5
iii)	Length	mm	735 ± 5	250 ± 5
4.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension(Corner to corner)	mm	53.00 ± 0.5	20.20 ± 0.5
ii)	Outside dimension (face to face)	mm	46.00 ± 0.5	17.50 ± 0.5
5.	Slip strength	KN	153.2	
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
7.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320	
8.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000	
9.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanizing	%	99.95 (IS 209) or 98.5 (IS 13229)	
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute	

Repair sleeve for ACSR MOOSE Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter	mm	34.00 ± 0.5
ii)	Outside diameter	mm	54.00 ± 1.0
iii)	Length	mm	300.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
i)	Outside dimension(Corner to corner)	mm	53.00 ± 0.5
ii)	Outside dimension (face to face)	mm	46.00 ± 0.5
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

T-connector for ACSR MOOSE Conductor			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		Aluminium of purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
	i) Inside diameter	Mm	34.00 ± 0.5
	ii) Outside diameter	Mm	54.00 ± 1.0
	iii) Length	mm	400.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
	i) Outside dimension(Corner to corner)	mm	53.00 ± 0.5
	ii) Outside dimension (face to face)	mm	46.00 ± 0.5
4.	Axial tensile strength of welded portion of T-connector	KN	30
5.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
7.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

TWIN RIGID SPACER FOR TWIN ACSR MOOSE CONDUCTOR

Sl.	**Description**	**Unit**	**Particulars / Value**		
1.	Material of				
	(a) Clamp		Al Alloy IS:4600 or Equivalent		
	(b) Body		Galvanised Steel / Al Alloy 4600 or Equivalent		
2.	Elastomer (*if used*)				
	(a) Shore hardness		65 - 80		
	(b) Temp. range for which designed	°C	Upto 95°C		
3.	Minimum ultimate tensile strength of spacer				
	(a) Compressive load	kN	15		
	(b) Tensile load	kN	7		
4.	Slipping strength of spacer clamp	kN	**Clamp type**	**Longitudnal Load (kN)**	**Maxm Slip permitted (mm)**
			Metal – Metal Bolted	6.5	1
			Rubber loaded	2.5	2.5
			Preformed rod	2.5	12
5.	Maximum magnetic power loss of at sub conductor current of 500	Watts	Below 1 watt.		

	amperes, 50Hz AC		
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
7.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	µV	Below 1000

B. Standard Technical Particulars of Accessories for 7/3.66mm Earth-wire

Mid span compression Joint for 7/3.66 mm GS Earth-wire					
Sl.	**Description**	**Unit**	**Particulars/ Value**		
			Aluminium / Filler Sleeve	Steel Sleeve	
1.	**Material of Joint**		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)	
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200		
3.	Weight of Zinc coating	gm/m^2	610		
4.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	11.50 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	32.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	400 ± 5	230 ± 5	60 ± 5
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
iii)	Length	mm	430 (approx)	265 (approx)	
6.	Slip strength	KN	65		
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earth-wire	%	75		

Flexible Copper Bond for 7/3.66 mm GS Earth-wire			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Stranding		37/7/0.417
2.	Cross sectional area	Sq.mm	35.4
3.	Minimum copper equivalent area	Sq.mm	34

4.	Length of copper cable	mm	500 + 5
5.	Material of lugs		Tinned copper
6.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

Vibration Damper for 7/3.66 mm GS Earth-wire			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/mild steel/Zinc alloy duly hop dip galvanised
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	135
5.	Slip strength of stranded messenger cable (mass pull off)	kN	2.5
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	2.5
	(b) After fatigue test	kN	2
7.	Resonance frequencies range	Hz	10 to 60
8.	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%	+/-40 (Maximum)
9.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)

Suspension Clamp for 7/3.66 mm GS Earth-wire			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material of components**		
	(a) Shackle		Forged Steel
	(b) Clamp Body & Keeper		Malleable cast iron / SGI
	(c) U- Bolt		Mild Steel
2.	Total Drop (Maximum)	mm	150
3.	Breaking Strength (Minimum)	kN	25
4.	Slipping Strength	kN	12 to 17
Tension Clamp for 7/3.66 mm GS Earth-wire			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material of components**		
	(i) Anchor Shackle		Forged Steel
	(ii) Compression Clamp		
	a) Steel Sleeve		Mild Steel
	b) Aluminium sleeve		Aluminium of purity 99.5%

	c) Aluminium Filler sleeve		Aluminium of purity 99.5%		
3.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	120-200		
4.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	11.50 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	245 ± 5	205 ± 5	25 .0
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
6.	Slip strength	KN	65		
7.	Minimum Breaking strength of assembly (excluding clamp)	KN	70		
8.	Compression Pressure	Ton	100		

7.0 Tests and Standards

7.1 Type Tests

The failure of any one conductor & earth-wire accessories shall constitute failure to meet the requirements of this specification.

7.1.1 Mid Span Compression Joint for Conductor and Earth wire

(a)	Chemical analysis of Material	) IS:2062, IS:733)
(b)	Electrical resistance test	) IS:2121-(Part-II),)
(c)	Heating cycle test	)
(d)	Slip strength test	
(e)	Corona extinction voltage test (dry)	As per Approved drawings
(f)	Radio interference voltage test (dry)	

Note : Tests mentioned at (c), (e) & (f) are not applicable to mid span compression joints for earth wire.

7.1.2 T-Connector for Conductor

(a)	Chemical analysis of materials	) As per practice)
(b)	Electrical resistance test	) IS:2121-(Part-II)
(c)	Heating cycle test	)

(d)	Axial tensile load test for welded portion	)As per Specification & IS:5561
(e)	Corona extinction voltage test (dry)	)))As per approved) drawing)
(f)	Radio interference voltage test (dry)	

7.1.3 Repair Sleeve for Conductor

(a)	Chemical analysis of materials	
(b)	Corona extinction voltage test (dry)	AS per Approved drawings
(c)	Radio interference voltage test (dry)	

7.1.4 Flexible Copper Bond

(a)	Slip, Strength Test	)IS:2121

7.1.5 Vibration Damper for Earth wire

(a)	Chemical analysis of materials	
(b)	Dynamic characteristics test	IS: 2633, IS:6745
(c)	Vibration analysis	As per IS:9708, &
(d)	Clamp slip test	Approved drawings
(e)	Fatigue tests	
(f)	Damper efficiency test	

7.1.6 Earth wire Suspension Clamp Assembly

(a)	Chemical analysis of materials	
(c)	Mechanical strength test	IS:2121, IS: 2633 & approved Drawings
(c)	Clamp slip strength Vs Torque test for suspension assembly	

7.1.7 Earth wire Tension Clamp Assembly

(a)	Chemical analysis of materials	
(b)	Mechanical strength test (excluding clamp)	Approved Drawings & IS:2121, IS: 2633

(c)	Slip strength test on tension assembly	Approved Drawings & IS:2121, IS: 2633
(d)	Electrical resistance test on tension clamp	

7.1.8 Heating cycle test on mid span compression joint and T – connector for Conductor shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., test conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of Owner. The test reports submitted shall be for the tests conducted within the last 5 (five) years prior to the date of Bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / manufacturing change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Owner.

7.2 Acceptance Tests

7.2.1 Mid Span Compression Joint for Conductor and Earth wire

(a)	Visual examination and dimensional verification	)IS:2121 -(Part-II))
(b)	Galvanising test	) IS: 2633, IS:6745
(c)	Hardness test	) IS:2121 -(Part-II)

7.2.2 T-Connector for Conductor

(a)	Visual examination and dimensional verification	)IS:2121 -(Part-II)-)
(b)	Axial tensile load test for welded portion	) As per Specification/drawing & IS:5561

7.2.3 Repair Sleeve for Conductor

(a)	Visual examination and dimensional verification	)IS:2121 -(Part-II)-)

7.2.4 Flexible Copper Bond

(a)	Visual examination and dimensional verification	IS:2121 &
(b)	Slip strength test	As per approved drawing

7.2.5 Vibration Damper for Earth-wire

(a)	Visual examination and dimensional verification	
(b)	Galvanising test	
	(i) On damper masses	
	(ii) On messenger cable	
(c)	Verification of resonance frequencies	IS:2121-(Part- II) & approved drawing
(d)	Clamp slip	
(e)	Clamp bolt torque test	
(f)	Strength of the messenger cable	
(g)	Mass pull off test	) as per approved drawings
(h)	Dynamic characteristics test	) IS: 9708

7.2.6 Earth wire Suspension Clamp Assembly

(a)	Visual examination and dimensional verification	
(b)	Galvanising test	IS:2121-(Part-II) &
(d)	Clamp slip strength test	Approved drawing
(d)	Mechanical strength test on each component	

7.2.7 Earth wire Tension Clamp Assembly

(a)	Visual examination and dimensional verification IS:2121(Part-II)	
(b)	Galvanising test	IS : 2121(Part-II)
(c)	Slip strength test for tension clamp	
(d)	Mechanical strength test on each component (excluding clamp)	
(e)	Hardness test	)

7.3 Routine Tests

7.3.1 For Conductor and Earth wire Accessories

(a)	Visual examination and	)IS:2121-(Part-II)

	dimensional verification	)Clause 6.2 &6.3
(b)	Proof Load Test	)As per practice

7.4 Tests During Manufacture

On all components as applicable

(a)	Chemical analysis of Zinc used for galvanising	))
(b)	Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings.	)))))))As per practice
(c)	Chemical analysis, hardness tests and magnetic particle inspection for forgings	))

7.5 Testing Expenses

7.5.1 Testing charges for the type test shall deemed to be included in the quoted price.

7.5.2 In case of failure in any type test, the Bidder whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 7.1 of this specification or to repeat that particular type test at least three times successfully at his own expenses.

7.5.3 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

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

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

7.5.6 The Contractor shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of testing in India and at least 6 weeks advance in case of testing abroad) of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

7.6 Sample Batch For Type Testing

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

7.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

7.7 Schedule of Testing and Additional Tests

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

(a) Submission of drawing for approval.

(b) Submission of Quality Assurance Plan for approval.

(c) Offering of material for sample selection for type tests.

(d) Type testing.

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

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

DATA SHEET

LINE HARDWARE

(To be furnished by the bidder along with his Bid)

DESIGN AND CONSTRUCTION REQUIREMENTS

Sr.No.	Specification	Specified Value	Quoted Value
1	Type of line hardware		
2	Manufacturer's Drawing No.		
3	Material		
4	Dimensions (mm)		
5	Strength rating (kN)		
6	Thickness/Weight of coating		
7	Quantity required		

DATA SHEET

LINE HARDWARE

(To be furnished by the bidder along with his Bid)

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE SPECIFIED BY OWNER

B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR :

C. OTHER PARTICULARS TO BE FILLED UP BY BIDDER/VENDOR/SUPPLIER/ CONTRACTOR:

	Actual Manufacturer of Material	Vendor/Supplier/ Contractor
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with date		

CHAPTER - V

SITE REQUIREMENTS

Site Requirements:

Keeping in view of the project time lines and to meet the milestones, the EPC turnkey contractor shall follow the below aspects diligently during the execution of works at site

1. Separation of ROW resolution team and work execution team is required to be put in place for making the work front available continuously for smooth execution of the works. The EPC turnkey contractor shall be dealing & liasoning with the relevant govt. authorities as and when required for ROW resolution. The construction manager shall be enabled suitably with sufficient team and resources. Detailed plan of forming the teams for execution of the things shall be submitted by the contractor to the project in charge before commencement of works for acceptance.

2. Necessary evaluation mechanism of deciding the compensations shall be devised right in the beginning of the project. Contractor shall ensure timely disbursement of compensations tree or crop or any other well in time so as to avoid any public agitation/ unrest for the execution of works. The contractor's Construction Manger at site shall be adequately enabled for doing all the needful in this matter. The owner shall be provided the record of the compensations released for maintaining as a licensee for reference as may be sought by various authorities. Separate team for disbursing the compensation payments shall be engaged without mixing the responsibilities with execution team members.

3. Safety and security of the work place and work men will have to be ensured by the contractor for smooth execution of the works. Necessary preventive and proactive measures shall be put in place by the EPC contractor as per the directions of the project/ site in charge from time to time based on the site conditions.

4. Separate teams shall be engaged for enumeration, preparation of documentation & submission of tree cutting applications to the concerned officers for approval shall be arranged much in advance as directed by the site in charge. A suitable program in this respect shall be submitted by the contractor for acceptance by the site in charge. Clearance of the corridor be done well in advance before initiating the stringing works so as to maintain no damages happen to the conductors during stringing.

5. Detailed planning of executing the EHV power line crossings shall be done much in advance considering the inputs of seasonal load flows and staggering days. The plan shall be submitted to the site in charge for acceptance. All EHV crossings outage be arranged by the EPC turnkey Contractor as per requirement. In the unlikely event, if the outage is not available, stringing by live line crossing technique shall be arranged by the contractor. All other power line crossings LT/11KV/33KV outages should be timely arranged by the contractor so that it does not hamper planned stringing schedule even if it amounts to providing temporary arrangements like cable bypass etc. for uninterrupted works.

6. Any issues from time to time during the course of execution as directed by the Project/ Site In-charge in the interest of the project for faster execution shall be implemented by the EPC turnkey contractor diligently.

CHAPTER - VI

BRIEF DESCRIPTION OF

HEALTH

SAFETY ENVIRONMENT & QUALITY

1. Quality Assurance, Inspection & Testing

1.1 Quality Assurance

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

(a) His organization structure for the management and implementation of the proposed quality assurance programme.

(b) Documentation control System.

(c) Qualification data for Contractor's key personnel.

(d) The procedure for purchase of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing including process controls and fabrication and assembly controls.

(f) Control of non-conforming items and system for corrective action.

(g) Control of calibration and testing of measuring and testing equipments.

(h) Inspection and test procedure for manufacture.

(i) System for indication and appraisal of inspection status.

(j) System for quality audits.

(k) System for authorising release of manufactured product to the Owner.

(l) System for maintenance of records.

(m) System for handling storage and delivery and

(n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to critical and important items of supply.

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

1.1.1 Quality Assurance Documents

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

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

1.2 QUALITY ASSURANCE & INSPECTION PROGRAMME

1.2.1 The Contractor shall supply all the materials, equipment and services conforming to high standard of Quality and Workmanship commensurate with Indian standards and practices. The Contractor shall implement a Comprehensive Quality Management Programme in line with the Owners Technical Specifications, for the items manufactured at his own works as well as the items procured from other manufacturers. The salient features of association of the Owner in this Quality Management Programme are as follows:

1.2.1.1 Vendor Approvals: In respect of the items identified for vendor approval by the Owner, the Contractor shall procure the materials and items only from the vendors duly approved by the Owner. For vendor assessment and approval, the Contractor shall provide necessary vendor details to the Owner and shall coordinate assessment visit, wherever so required by the Owner.

1.2.1.2 Manufacturing Quality Plan Approvals: In respect of the items identified for Quality Plan approval by the Owner, the Contractor shall submit the Quality Plans and related reference documents to the Owner for his review and approval. While approving the Quality Plan, the Owner shall also identify the specific tests/ checks envisaged to be conducted in presence of the Owner.

1.2.1.3 Inspection by Owner: In respect of the inspection/ testing stages envisaged as Witness/ Hold point by the Owner, the Contractor shall raise inspection call to the Owner with advance notice period as per the contract.

1.2.1.4 The Contractor shall provide to the representatives of Owner, at all reasonable time, a free access to the manufacturing works and related premises of the Contractor and vendors.

1.2.1.5 Non-conformity Dispositioning: The Contractor shall dispose any non-conformity observed in the products or services only with due approval from the Owner.

1.2.1.6 The Contractor shall facilitate the quality audits by the Owner at the works and establishments related to manufacture of the supplies under the Contract.

1.2.1.7 Material Despatch Clearance Certificate: The Contractor shall dispatch the material and items to project site only after obtaining Material Despatch Clearance Certificate (MDCC) issued by the representative of the Owner after satisfactory compliance of inspection and testing requirements. The MDCC shall be one of the necessary documents for claiming payment against dispatch of the material/ equipment.

1.2.1.8 QA Documentation Package: The Contractor shall submit to the Owner, QA Documentation package for major equipment consisting of the technical documents and inspection / test records.

1.2.2 The Contractor shall provide relevant technical inputs and documents to the Owner for activities related to Field Quality at project site in line with the

recommendations, standards and practices of the original equipment manufacturers.

1.2.3 The Owner reserves the right of approval of Quality Plans, Vendor approvals and inspection of equipment and services, which is recognized and accepted by the Contractor and the Owner.

1.2.4 The language of the documents, correspondence/communication and equipment displays/ software- interface, shall be English.

1.2.5 The status of progress and effectiveness of implementation of QA Management System shall be periodically reviewed jointly by the Contractor and the Owner.

1.3 Owner's Supervision

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

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

a) Interpretation of all the terms and conditions of these Documents and Specifications.

b) Review and interpretation of all the Contractor's drawings, engineering data etc.

c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.

d) Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.

e) Issue certificate of acceptance and/or progressive payment and final payment certificate.

f) Review and suggest modification and improvement in completion schedules from time to time, and

g) Supervise the Quality Assurance Programme implementation at all stages of the works.

1.4 Inspection and Tests

1.4.1 Inspection

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

1.4.1.2 The Contractor shall give the Owner's Inspector fifteen (15) days (in case of domestic testing and thirty (30) days (in case of foreign testing), as the case may be, written notice of any material being ready for testing. The contractor shall give the notice for inspection and shall associate in the inspection with Employee's inspector. All such inspections shall be to the Contractor's account except for the expenses of the Owner's inspector. The Owner's inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days (in case of domestic testing) and thirty (30) days in (in case of foreign testing) of the date of which the equipment is notified as being ready for test/inspection or on a mutually agreed date, failing which the Contractor may proceed with the test in accordance with the technical specification after informing the Owner in writing and he shall forthwith forward to the inspector duly certified copies of test reports / certificates in triplicate.

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

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

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

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

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

b) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

1.4.1.8 The Owner or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the

fabrication of the Owner's material for satisfying himself that the fabrication is being done in accordance with the provisions of the Specification.

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

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

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

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

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

1.4.2 Tests

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

1.4.2.2 **Type Tests** shall mean those tests which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.

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

1.4.2.4 **Routine Tests** shall mean those tests, which are to be carried out on the material to check requirements which are likely to vary during production.

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

1.4.2.6 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Owner.

1.4.2.7 Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified in as mutually agreed to between the Contractor and the Owner in the Quality Assurance Programme.

1.4.2.8 For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

1.5 Standard Technical Particulars

1.5.1 The Standard Technical Particulars of various items are given in the relevant part of the specification. The bidder is required to comply with the same

2. Environment, Social and Wildlife conservation Policy and its Implementation

2.1 Development and growth of mankind through Industrialization and unwarranted use of natural resources has inflicted considerable impact on Environment and Society. As a result, Environmental and Social issues have emerged as the focal point of global debate.

Owner's activities by their inherent nature and flexibility have negligible impacts on environmental and social attributes. In order to address these issues and to match the rising expectations of a cleaner, safer and healthier environment, the key principles of Owner's Environmental and Social Policy are:

i) Avoidance of environmentally and socially sensitive areas while planning project activities.

ii) Minimization of impacts when project activities occur in environmentally and socially sensitive areas.

iii) Mitigation of any unavoidable adverse impacts arising out of its projects.

2.2 Basic issues to be kept in mind while carrying out construction activities are to

i) Avoid socially sensitive areas with regard to human habitations and areas of cultural significance.

ii) Secure the interest of people affected by Owner's projects.

iii) Involve local people affected by transmission line projects as per requirement and suitability.

iv) Consult affected people in decisions having implication to them if considered necessary.

v) Apply, efficient and safe technology/practices.

vi) Keep abreast of all potential dangers to people's health, occupational safety and safety of environment and the respective mitigatory measures.

vii) Establish preventive mechanisms to guarantee safety.

viii) Mitigation measures in case of accidents.

ix) Avoid unwarranted cutting of trees in forest and non-forest area.

2.3 While constructing the lines through forest stretches (if any) the contractor will provide alternate fuel to its employee e.g. working labours/supervisors etc. in order to avoid cutting of forest woods.

2.4 Contractor will ensure safety to the wild life, during working/camping near to the National park.

2.5 Contractor during construction of lines in agricultural fields will ensure minimum damages to the crops, trees, bunds, irrigation etc. If the same is un-avoidable, the decision of Owner shall be final.

2.6 The waste/excess material/debris should be removed from the construction site including agricultural field, forest stretches, river etc. immediately after construction work.

2.7 The contractor will ensure least disturbance to the hill slope and natural drainage so as to avoid soil erosion. Natural drainage in plane area if disturbed is to be trained to the satisfaction of Owner

2.8 As far as possible existing path/kutchha road/approach shall be used for the construction.

2.9 The Contractor will ensure supply of stone chips/sand from authorized/approved quarry areas.

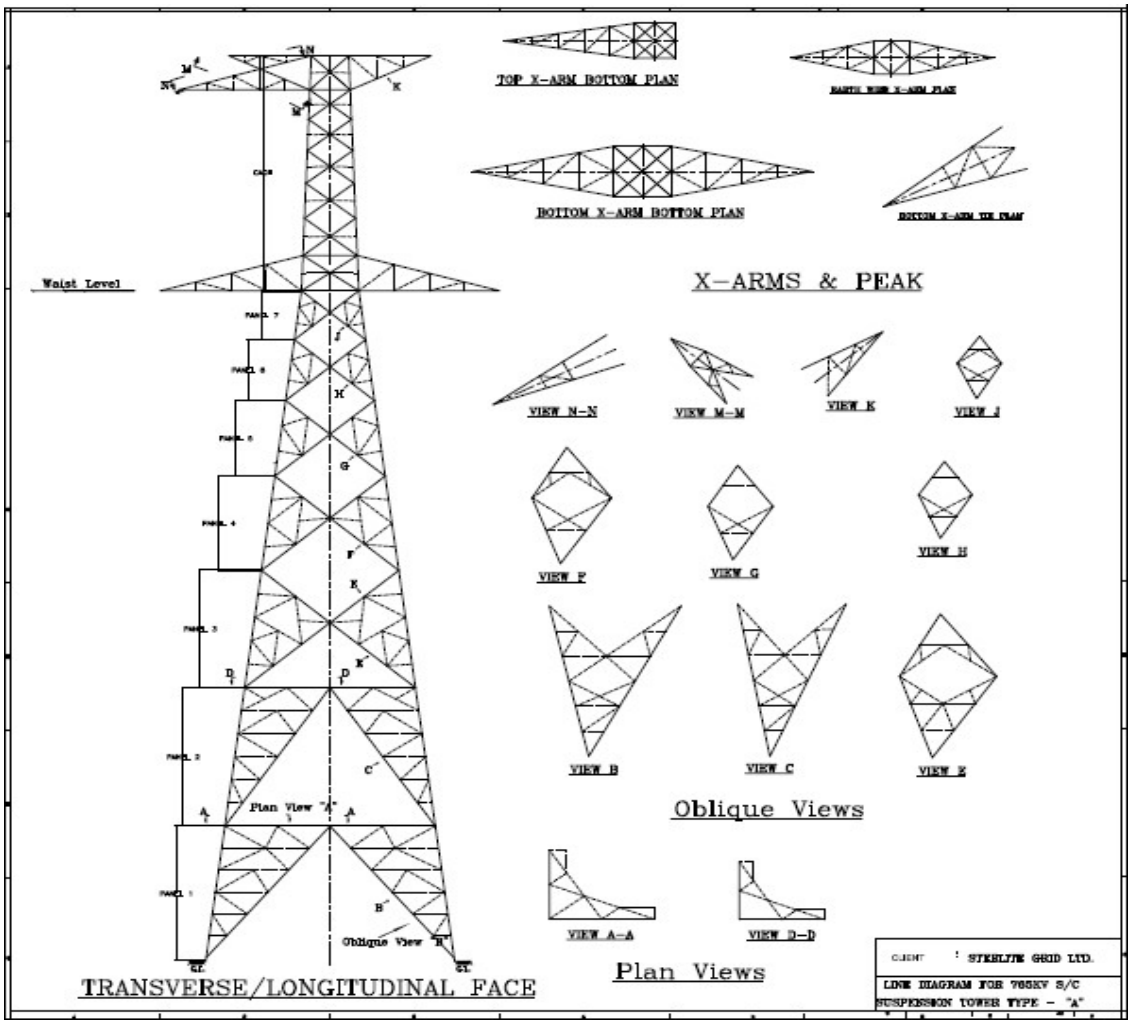
2.10 The contractor will submit safety procedures to be adopted by them/QAP/MQP/FQP etc, before execution of the job to the owner and must obtain their approval

3. Methodology of Erection of Tower at Site

The towers shall be erected on the foundations not less than 07 days after concreting or till such time that the concrete has acquired sufficient strength. Use of Tractor/Vehicle shall be avoided for erecting TL tower/Components during erection stage.

The tower structure consists mainly of:

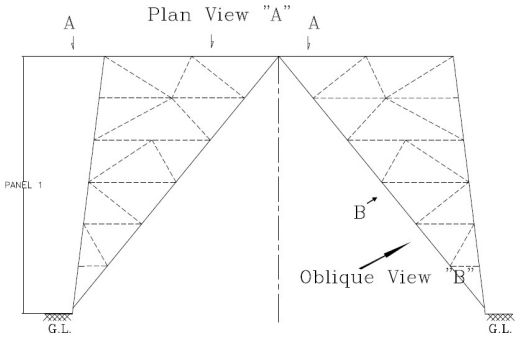
- Transverse & Longitudinal face
- Oblique View
- Plan View
- Cage
- Cross-Arms
- Plates
- Nuts/bolts

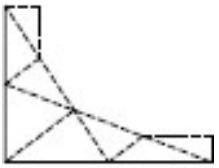
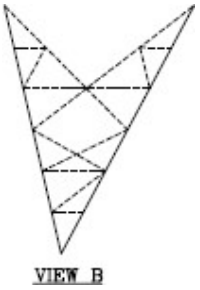


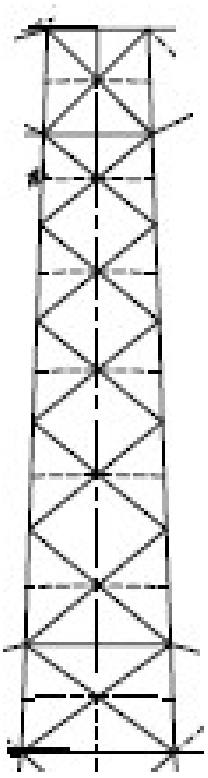
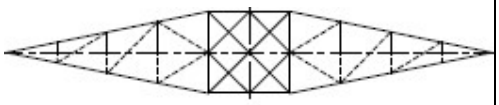
General Arrangement of Tower

Steps of Erection Methodology

The towers shall be erected panel by panel as per below mentioned steps as per approved structural drawings:

Step No.	Procedure & Checks	Diagram
1.	Erection of tower will start from first panel from Ground level i.e. erection progresses from the bottom/Stub upwards. Erection of tower shall be done member by member of the first panel. Four main corner leg members of the first panel of the tower are firstly erected followed by erection of bracings & redundant of transverse face & longitudinal face. Erection of 2nd panel be continued in the above manner and immediately after that the Oblique view &	

	Plan view of the First Panel with all plates be installed & nuts / bolts properly fitted / tightened. - **Checks before proceeding for erection of next panel:** **a. Each & every member of transverse & longitudinal face of first two panels to be erected.** **b. Each & every member of oblique & plan view of the first panel to be erected.** **c. Every plate to be fitted in the first & second panel. Every leg joint shall have one inside cleat & two cover plate fitted with all nuts/bolts tightened as per approved drawings.** **d. All Nuts/bolts of proper size & length to be fully fitted & completely tightened. No hole should be vacant without nuts/ bolts.** **e. Before tightening it shall be ensured that spring washers & pack plates are placed in relevant gaps between the members as shown in the GA drgs.** Erection of third panel should not be started before completion of all the above in the bottom panels in all aspects and visual verification / confirmation.	**PANEL-1**  VIEW A-A **PLAN VIEW**  VIEW B **OBLIQUE VIEW**
2.	Similarly all panels up to waist levels to be erected as per the above steps/process	
3.	After erection of tower up to waist level, All nuts/ bolts to be fully tightened completely. Erection of cage to be done as mentioned below: - Four main corner leg members of the cage of the tower are firstly erected followed by erection of bracings & redundant of transverse face &	

	longitudinal face of the cage, Oblique view & Plan view (if any) with all plates to be installed & nut/bolts properly fitted. - **Checks before proceeding for erection of X-arms & Peak:** **a. Each & every member of transverse & longitudinal face of the cage to be erected.** **b. Each & every member of oblique & plan view (if any) to be erected.** **c. Every plate to be fitted in all the panels. Every leg joint shall have one inside cleat & two cover plate fitted with all nuts/bolts tightened as per approved drawings.** **d. All Nuts/bolts of proper size & length to be completely tightened. No hole should be left vacant without nuts/ bolts.** **e. Before tightening it shall be ensured that spring washers & pack plates are placed in relevant gaps between the members.** Erection of X-arms should not be started before completion of Cage in all aspects and visual verification and certify for next panel erection.	 **CAGE**
4.	All X-arms & peak to be completely assembled at Ground with all nuts & Bolts tightened completely. Assembled X-arms & Peak shall be uplifted to the respective cage level (Starting from Top to bottom) and fitted with all plates & nuts / bolts tightened completely.	 BOTTOM X-ARM BOTTOM PLAN

4. STRINGING

4.1 WORK FORCE:

1. Screening of the skilled persons by site engineer and safety co-coordinator is a must.
2. Ensure adequate nos. of workers in the gang.
3. Concerned engineer should brief the scheme for stringing to the stringing gang and ensure that they follow the same.
4. Stringing gang should be screened thoroughly and briefed about the Safety requirement.
5. Ensure competent and experienced supervisors all the time.

4.2 TOOLS & TACKLES:

1. Inspect all the tools tackles and availability of test certificates.

4.3 HANDLING CONDUCTOR WIRE DRUMS:

1. To the possible extent cable drums should be transported by trucks / long bed trailer, except for short distances. All Loading & un-Loading should be done either by having ramp (Excavated slope) such that body of the truck will be at ground level or by using Hydra / cranes. Whenever Hydra / cranes are used, slings should be of adequate capacity. While deciding the capacity of the crane, Safe working loads for the particular boom angle to be checked up. This is very important to avoid accidents. After loading the drums into vehicle, proper wedges are to be provided and to be tied properly to avoid rolling of drums. Drums should never be dropped off from the truck/trailer.

2. While rolling the drums care should be taken to roll in proper direction as shown in the drum. Otherwise cable will get loosened and cause problems during conductor laying. Before rolling the drums, soil condition is to be checked up. Otherwise there is a possibility of sinking on one side of the drum and toppling. While rolling the drums in slopes, wedges should be provided at regular intervals to avoid drum picking up uncontrollable speed. Persons handling the drums should be always behind and on the sides of the drums and never in the front. This precaution is very essential and non-observance while handling the drums at slopes can be dangerous.

3. Never use cast iron pipes as drum jack shaft. Jacks should have proper and wide base to avoid tilting of jacks. Whenever the height of drum is more and packing is required, proper sleepers should be used.

4. Proper cordoning / barricading to be done while stringing activity is on.
5. Most important, thing to ensure is that the gang leader should have basic knowledge of rigging work.

4.4 STRINGING M/C:

1. Stringing m/c supplied by company is from different manufacturers. Working manual of it must always be available with the TSE.

2. Proper arrangements Hydra / crane etc. should be made available at site for safe loading / unloading of conductor drums.
3. Place the drum loading jacks on the plain & firm ground level.
4. Hydra only to be used to place the conductor drums over the loading jacks.
5. Before the operation of the stringing, The TSE machines (Tensioner & Puller m/c) to be thoroughly checked for all the mechanical and braking system by the P&M supervisor and also by the respective operators. Everyday maintenance is a must, especially greasing of the rotating parts.
6. Tensioner & Puller m/c should be placed a min. of 50 - 60 Mtrs. away and in co-linear to the towers. Much deviation from the line should be avoided.
7. Both the tensioner and the puller should be anchored on all the four sides rigidly and temporarily earthed.

4.5 GUYING OF TOWER:

1. All the anchor towers should be provided with adequate nos. of guys. It is preferable to have one guy each for every cross arm & also two guys for earth-wire point.
2. The guys should be more than 45 degrees to the ground. Back staying should be of steel wire rope - min. size 20mm. Anchoring for back -stays should be strong enough to withstand the intended load. Dead-men anchoring should be made by using wooden planks of 100mm dia, 2 Mtrs. Size, deeply buried to a excavated pit of size 2.0 x 1.5 x 2.5 Mtrs, duly attached by wire rope slings of 18mm and above. The pit should be properly compacted. In case the guying and back-staying arrangement has to be maintained for a long duration, then the anchoring area should be fenced and watchman should be posted round the clock.
3. Guy ropes are to be checked every day. When the gang moves from one anchor point to the next section, keep a watchman round the clock near the anchored guy ropes for the avoidance of misuse by miscreants. There is a possibility of cascading resulting in fatality.
4. Guying and back-staying is to be provided for one side stringing of D-type towers also.
5. Guying and back-staying arrangement should have to be connected through 10 MT. turn buckle & 10 MT. Tirfor / Wire rope winch etc. for adjustment of tension of the guy wires.
6. Electrical discharge rods should be of best quality and should be purchased from reputed manufacturer with test certificate
7. All the skilled workers at height and the operators should wear hand gloves.
8. If the transmission line is running parallel or crossing to any other HT/LT line, the workers will get induction effect on the conductors. Running earth must be provided during conductor paying out. Local earthing of the Tensioner & Puller must be ensured.

4.6 PAYING OUT & ROUGH SAGGING:

1. As far as possible, the conductor tension should be controlled in such a way that the conductors do not come close to the ground.
2. Sequence of paying out should be from top to bottom.

3. While doing tensioning work, fitters should stand inside tower body parts and not to be allowed to stand on the cross arms.
4. Walkie-talkie to be used compulsorily by the tensioner and puller operators and also in between supervisors. Battery level should be checked every day for walkie-talkie. It is preferable to have one or two spares. Flag man should be posted on each tower top during paying out.

4.7 WORK ON THE CONDUCTOR:

1. When the workmen have to move on insulators, they must wrap the safety belt around the insulator and then move. While moving he should slide the loop of safety belt lanyard along with his movement.
2. Only after releasing the four-sheave / Six Sheave pulley, skilled and experienced fitter shall be allowed to move on conductor for releasing the come-along clamps provided on conductors. After the job, the workmen should return back through the towers only. No workmen should descent from the conductor by using rope directly.
3. Man responsible for verifying the sag of conductor / earth wire should be knowledgeable & well experienced in respective area.
4. In case of any entanglement in lead wire of Six / four sheave pulley at height, no workmen will be allowed to go on the insulator to release. The lead wire should be first released & made tension free then only the workmen should be allowed for releasing the entanglement at height.
5. Final sagging must be done by using Regulated / Hand / Engine Operated Sag winch only. Tractor pulling is not permitted. Six / Four sheave pulley arrangement with 12mm FMC wire rope to be used for final sagging & tensioning of conductors.
6. Dynamometer method / Sag board with sag scope on the appropriate span should be used to measure the sag / tension as per the approved sag-tension chart. Conductor thermometer is a must for finding the correct temperature during final sagging.
7. During Clipping, Double sheave pulley block arrangement or turn buckle arrangement with rubber / cotton packing be used for lifting the conductors form the running blocks and to avoid damages to the conductors.
8. Spacer cycle must be used for fixing of spacer dampers. No monkey climbing is allowed.
9. In Hilly terrain, Arm stays be provided to all those towers under compression.
10. The D-shackles used for Final sag should be of Grade-63 or Grade-80 and the SWL capacity should be as per the specification. Test certificates is a must. Step bolts or any other bolts should not be used as the D-shackle pin.
11. The wire rope pulley block should be snatched hook or closed type and the SWL should be as per specification only.

4.8 OTHERS:

1. Before taking up stringing work, it is a must to ensure that the towers are fully tightened and all members are properly fixed. Through Final checking of towers must be done by competent person to ensure that no bolts are missing and all members are secured & tightened properly. Back filing of the foundations are done properly as well. Confirmation to be given by the Supervisor for commencement of stringing work.
2. Children and animals playing around the area should be removed from the region. Barricading the stringing area is a must. Nearby Villagers must be conveyed about the job operation and related hazards in details.
3. Work should not be executed in inclement weather conditions.
4. Always wear helmets with chin straps and double lanyard safety belt. With proper anchorage of the lanyard to two separate fixed anchor points.
5. Ensure proper housekeeping. Do not throw the empty insulator crates/boxes, wire straps, conductor bits/strands, Conductor drum PP sheet and paper corrugation sheets in open. The same should BE collected and returned to stores.
6. Work methodology should be clearly understood by all the persons at site including supervisors & workers.
7. First aid box with sufficient qty. of medicines & two trained first aid persons should be available in the gang. List of nearby doctors and medicals available be available with the gangs. One dedicated vehicle must always be available during stringing work.
8. All wooden dead-men (temporary anchoring) to be buried at a depth of not less than 2.5 meters.
9. While doing tensioning work, fitters should stand inside tower body parts and not to be allowed to stand on the cross arms.
10. Prior necessary permits/approvals to be taken from respective authorities like Electricity Authority, Highway, Railway and Forest department etc. before taking up work.
11. All the towers of the stringing section should be permanently earthed.
12. Jumpers are to be left disconnected in sections until all the work of the entire line is completed.
13. Local public & Animals should not be allowed to the stringing area.
14. For crossing of any existing charged line, shut down and permit to work for the existing line must be taken. Induction tester also shall be used to check the induction.
15. All the insulator strings should be thoroughly checked for any crack, damage, missing split- pins etc., before lifting them on to the cross arm of the tower.

4.9 ADDITIONAL PRECAUTIONS - FOR STRINGING IN THE VICINITY OF CHARGED OVERHEAD LINES AND IN AREAS WHERE INDUCED VOLTAGE IS ANTICIPATED:

1. All winches, pulleys and tensioner / puller must be properly earthed. Tensioner & puller operator should be provided with a HT insulated rubber mats.
2. Conductor running blocks are to be earthed.
3. All the conductors of the section are to be earthed through running earths.

4. Before breaking the continuity of the conductor at any point it must be ensured that the conductors at both ends of either side are properly earthed. Earth shall also be provided at both sides of the working point and shall remain in position until the conductor is reconnected.

4.10 SPECIFICATIONS OF MAJOR STRINGING TOOLS & PLANTS:

D-shackle – 63 Grade 5.0MT/10.0MT/12.5/25.0MT
Single Sheave Pulley – 4.5MT.
Double Sheave Pulley block – 8.5MT.
FMC Wire rope - 12mm, 18mm, 20mm, 22mm
Wire rope Slings 18mm, 20mm, 22mm
Tirfor – 10.0MT.
Turn Buckle (Hook & Eye) – 10.0MT.
Regulated sag Winch – 15.0 MT
Articulate / Swivel Joint – 10.0MT. / 25.0MT
Pilot Wire – 16mm
3 /4/5/7 Sheave Aerial Roller – 800 mm
Hydraulic Drum Lifting Jack – 8MT
Bolted type come along clamp – 8 MT

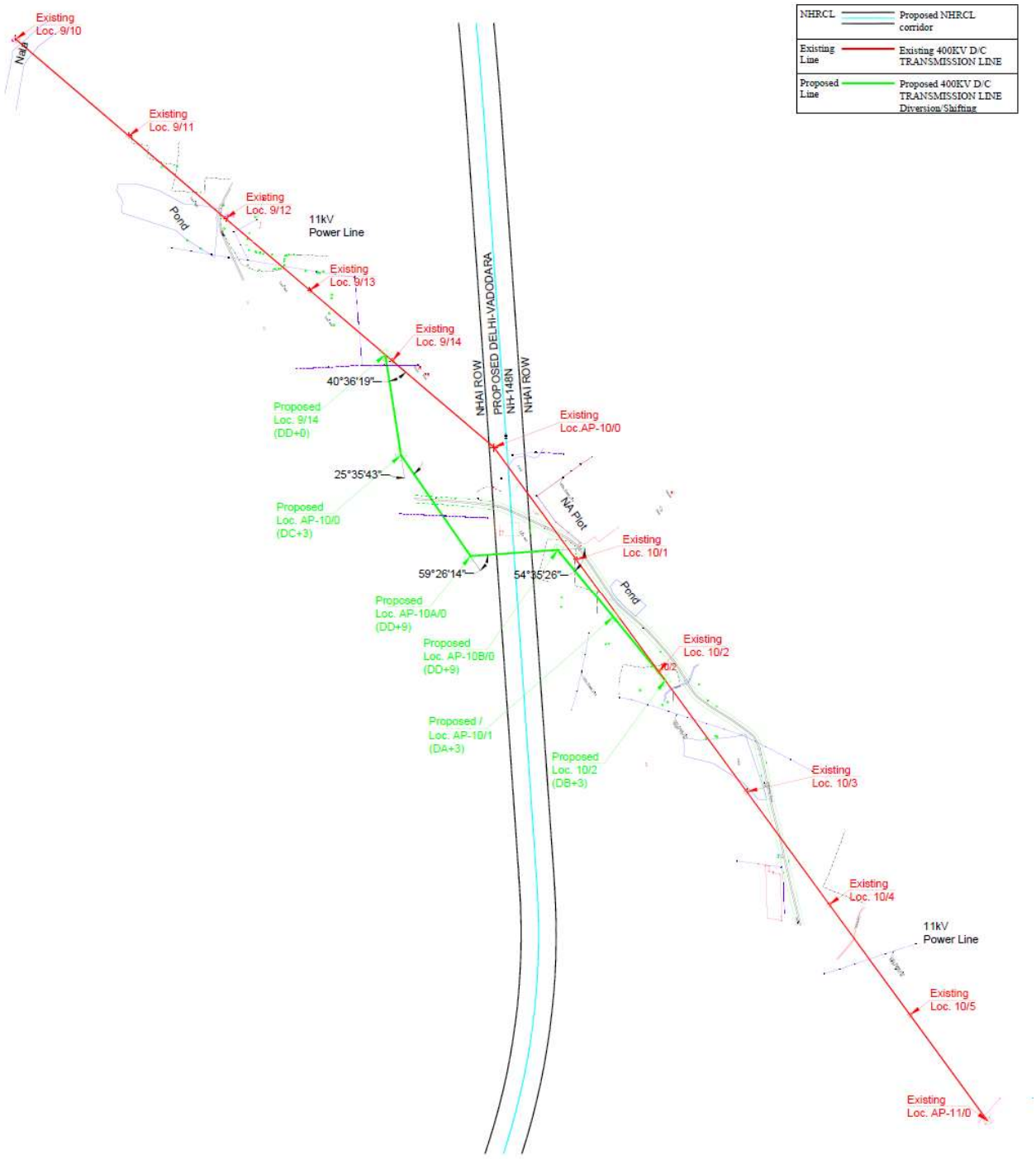
4.11 CHECKLIST - GENERAL

No	Description of Activity	Feedback (Y/N)	Remarks
General points common for all activities during Excavation, Casting of foundation, Erection of tower and stringing of conductor.			
1	Check whether the contractor has procured required quantity of PPE considering maximum numbers of erection gangs deployed at site.		
2	Supervisors / Workmen have been provided with required healthy PPEs like (Safety helmet/Safety belts/ Safety shoes/ Gum boots as applicable)		
3	Availability of First Aid box with required medicines at site.		
4	Instruction register is available at site.		
5	Ensure Supervisor / Gang leader always issues instruction to the workmen before start of work.		
6	All driver and plant operators are holding valid driving license.		
7	Check the vehicle for rescue is available at site.		

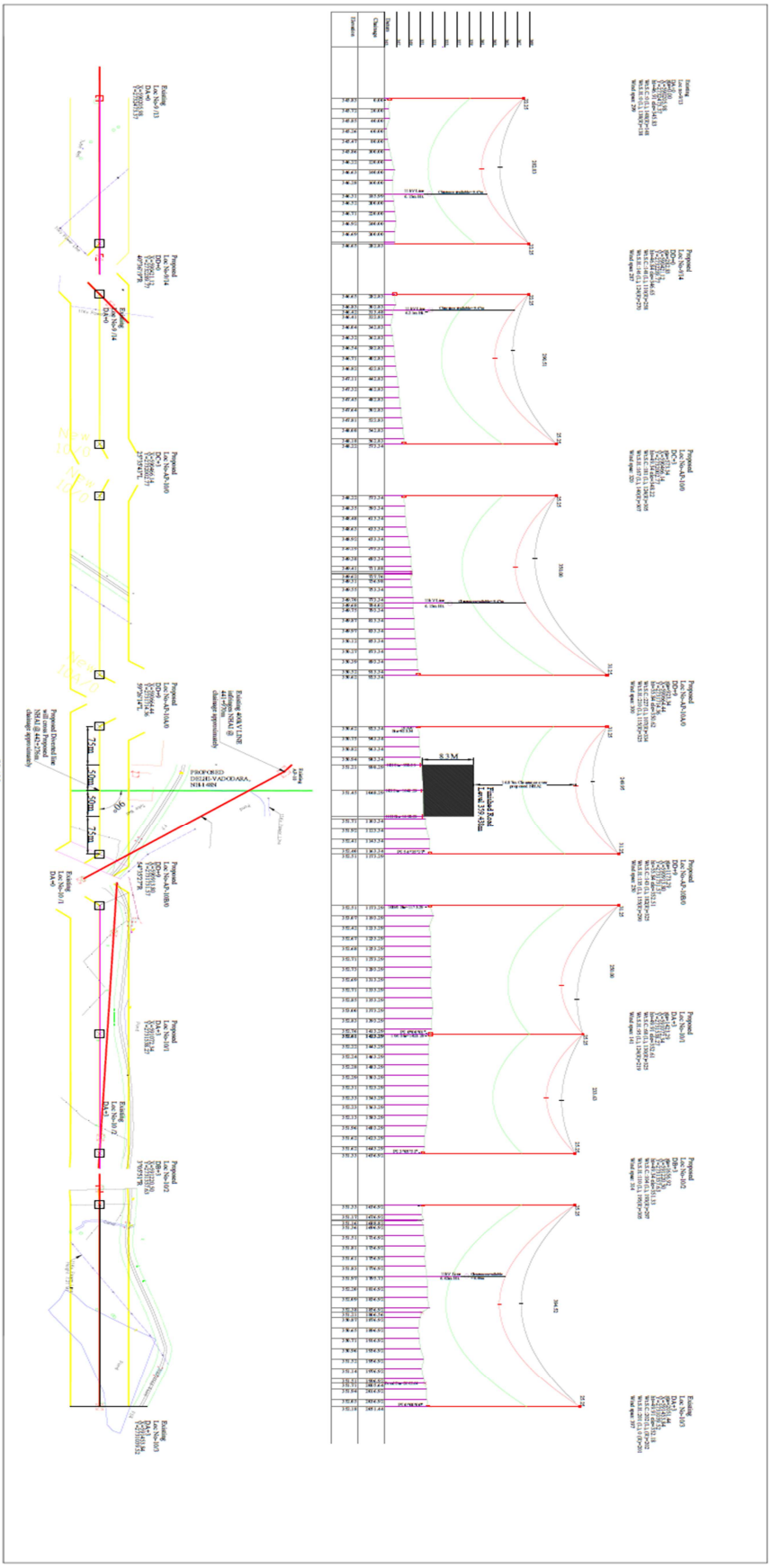
8	Ensure engaged labor are aware of the job.		
9	Check that the unskilled laborers are not engaged in skilled job.		
10	Ensure supervisor / workmen engaged in the field are aware of First Aid Techniques (such as in case of Electric shock, Fall from the height, Snake bite and the person rescued form buried under the debris etc.)		
11	Check for nearby Hospital / Doctor in case of emergencies arises.		
12	While transporting heavy consignment of conductor or earth wire drums from Central stores to site by the use of Cranes, Truck, and Tractor. the safety aspect for construction and failure of brake system of moving machinery is to be checked,		
13	At least one dry powder type of portable f ire extinguisher shall be provided especially where explosive or blasting agents are used for excavation.		
14	Check the competence (Qualification / experience) of supervisor / gang leader of contractor.		

ANNEXURE-1

1.0 Route Alignment Map



1.1 Profile Drawing for proposed diversion



TECHNICAL SPECIFICATIONS FOR CONDUCTOR

FOR

"ASSOCIATED TRANSMISSION SYSTEM FOR RAPP UNIT-7 & 8"

ISSUED BY

RAPP TRANSMISSION COMPANY LTD. (RAPPTCL))
(A wholly owned subsidiary of IndiGrid Ltd.)

Address for Correspondence:

RAPP Transmission Company Ltd.,
C/o IndiGrid Ltd.,
Unit No. 101, First Floor, Windsor,
Village KoleKalyan, Off CST Road,
Vidyanagari Marg, Kalina,
Santacruz East, Mumbai 400 098
Phone: +91-7208493885; Mail: info@indigrid.com

SPECIFICATION

FOR

ACSR BARE OVERHEAD LINE CONDUCTOR

TABLE OF CONTENTS

1. SCOPE

This Specification covers technical requirements for Design, Engineering, Manufacture, Inspection, Testing and Performance of ACSR Moose Conductor (ACSR), intended to be used as overhead electrical conductor for the following 400 kV Overhead Transmission Lines:

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

2. CROSS REFERENCES

This Material Standard Specification shall be read in conjunction with the General Conditions of Contract, Purchase Order or Contract Schedules for project, as applicable and other associated general Requirements for All Equipment/Materials, which shall be considered as an integral part of this Specification.

3. APPLICABLE CODES AND STANDARDS

.

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

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

The latest revisions of the following Codes and Standards shall be applicable for the material covered in this Specification. In case of conflict, the vendor/manufacturer may propose material conforming to one group of Industry Codes and Standards quoted hereunder without jeopardizing the requirements of this Specification.

Sr. No.	Standard	Title
3.1	IS: 398-Part 2 & 5	Aluminium conductors for Overhead Transmission Purposes
3.2	IS: 1778	Reels and Drums for Bare Conductors
3.3	IEC 1089	Round Wire Concentric-Lay Overhead Electrical Stranded Conductors
3.4	ASTM B549	Specification for Concentric-Lay-Stranded Aluminium Conductors
3.5	IS 209-1992 BS 3436-1986	Specification for zinc
3.6	IS1521-1991 ISO6892-1984	Method of tensile testing of Steel wire
3.7	IS 2629-1990	Recommendation practice for hot dip

		galvanizing of Iron and Steel
3.8	IS 2633-1992	Method of testing uniformity of coating on zinc coated articles
3.9	IS 4826-1992 IEC 888-1987 BS 443-1969	Galvanizing coating on Round steel wires
3.10	IS 6745-1990 BS 433-1969 ISO 1460-1973	Method of determining of weight of Zinc coating of zinc coated Iron and steel articles
3.11	IS 8263-1990 IEC 437-1973 NEMA 107-1964 CISPR	Method of radio interference Tests on High voltage Insulators
3.12	IEC 888-1987	Zinc coated steel wires for stranded conductors
3.13	IEC 889-1987	Hard drawn Aluminium wire for overhead line conductors

4. DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 General

4.1.1 The bare overhead ACSR conductor shall be of manufacturer's standard design but shall meet or exceed the requirements of this Specification in all respects.

4.1.2 Manufacturer's drawings, as required, shall show the cross-section of the bare overhead line conductor, together with all pertinent dimensions.

4.2 Design Criteria

4.2.1 The maximum ambient temperature (45°C) shall be regarded as the basic temperature with the service conditions.

4.3 Ratings

4.3.1 The bare overhead ACSR conductor ratings data shall be as specified in data sheet and the specifications given below:

4.3.2 The details of the ACSR Conductor are tabulated below as per IS: 398 (Part 2) & IS:398 (Part 5)

TABLE-1A: ACSR Conductor

		ACSR Moose
a.	Nominal Aluminium Area	597 mm²
b.	Stranding and wire Diameter	54/3.53mm-Al+ + 7/3.53mm-steel

c.	Overall diameter	31.77 mm
d.	Approximate mass	2004 kg/km
e.	Calculated D.C. resistance 20°C	0.05552 ohm/km
f.	Minimum UTS	161.2 kN
g.	Direction of lay of outer lay	Right hand
h.	Maximum operating temp.	85°C

4.3.3 The details of aluminium strand are as follows as per IS: 398 Part 2 & Part 5:

TABLE-1B: ACSR, Conductor-Aluminium Strand Details

Sr. No.	Description	3.53 mm dia
1	Minimum Breaking load before stranding	1.57 kN
2	Minimum Breaking load after stranding	1.49 kN
3	Maximum resistance @ 20°C	2.921 Ω/km
4	Nominal diameter of Strand	3.53 mm
5	Maximum diameter of strand	3.55 mm
6	Minimum diameter of strand	3.51 mm
7	Nominal cross sectional area	9.78 mm^2
8	Minimum purity of Al	99.50%

4.4 Materials

4.4.1 The bare overhead line conductors shall consist of concentric-lay-stranded conductors made from round aluminium wires and round steel core wires.

4.4.2 The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% copper content not exceed 0.04% as per IS: 4026. They shall have the same properties and characteristics as prescribed in IS: 398.

4.4.3 The aluminium used for cladding shall have a purity and quantity to meet the required thickness of not less than 10 percent of the nominal wire radius.

4.4.4 Application of neutral grease is not acceptable between layers of aluminium and steel core wires.

Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC : 888.

Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity as per IS209. It shall conform to and satisfy all the requirements of IS:209.

4.5 Workmanship and Make

4.5.1 All the aluminium strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc drawing and also after stranding.

4.5.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (profusion of wires), wire cross over, over riding, looseness (wire being dislocated by linger hand pressure and/or unusual bangle noise on lapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc), dirt, grit etc.

4.5.3 Joints in Wires: Aluminium Wires

4.5.3.1 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

4.5.3.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

4.5.3.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

4.5.4 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

4.5.5 Tolerances

The manufacturing tolerances to the extent indicated in the STP shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor

4.6 Fabrication

4.6.1 The bare overhead line conductor shall be constructed in conventional concentric-lay conductor type. The direction of lay of the outer layer shall be right hand and shall be reversed in successive layers.

4.6.2 No joints shall be made in the aluminium-alloy wires during the final drawing or in the finished wires. Joints may be made in the drawing stock and in the wire after heat treatment and prior to final drawing. No such joints shall be closer `than 7.5m to another or to either ends of the wire and not more than two such joints shall be present in any reel length of the conductor.

4.6.3 The surface of the wire shall be smooth and free from imperfections not consistent with good manufacturing practice.

4.7 Standard Length

a) The standard drum length of the conductor shall be 2000m in case of Moose. All drum lengths outside this limit of tolerance shall be treated as random lengths. Not less than 90% of the total quantity of the conductor shall be supplied in standard drum lengths.

b) Random drum lengths will be accepted provided no drum length is less than 80% of the standard drum length and the total quantity of such random drum lengths shall not be more than 10% of the total quantity ordered. However, the last 20% of the quantity ordered shall be supplied only in standard drum lengths as specified.

c) The Owner reserves the right to place orders for the drum lengths above the standard drum length on the same terms and conditions applicable for the standard drum lengths during the pendency of the Contract.

5. Tests and Standards

5.1 Type Tests

The following tests shall be applicable once on sample/samples of conductor for every 1500 Kms. of production from each manufacturing facility:

a)	DC resistance test on stranded conductor	As per Practice
b)	UTS test on stranded conductor	
c)	Radio interference voltage test (dry)	
d)	Corona extinction voltage test (dry)	

5.2 Acceptance Tests

a)	Visual and dimensional check on drum	As per Approved MQP
b)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	
c)	Dimensional check on Steel and Aluminium strands	
d)	Check for lay-ratios of various layers	
e)	Galvanizing test on steel strands	
f)	Torsion and Elongation tests on steel strands	
g)	Breaking load test on steel and Aluminium strands	
h)	Wrap test on Steel & Aluminium strands	IEC : 888 & 889
i)	DC resistance test on Aluminium strands	IEC : 889
j)	Procedure qualification test on welded joint of Aluminium strands	As per Practice
k)	Barrel Batten strength test	As per Practice

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

5.3 Routine Test

a) Check to ensure that the joints are as per Specification

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

c) Check that drums are as per Specification

d) All acceptance test as mentioned above to be carried out on each coil/ drum (as applicable)

5.4 Testing Expenses

5.4.1 The entire cost of testing for the type tests, acceptance tests and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Owner's representative.

5.5 Additional Tests

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

5.5.2 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test centre. In case of evidence of non

compliance, it shall be binding on the part of Supplier to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the Owner.

5.6 Test Reports

- Copies of type test reports shall be furnished in at least three copies alongwith one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.
- Test Certificates of tests during manufacture shall be maintained by the supplier. These shall be produced for verification as and when desired by the owner.

6. Inspection

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

6.2 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of conductor at various stages so that arrangements can be made for inspection.

6.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the Owner waives off the inspection in writing. In the latter case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed and test reports approved by Owner.

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

7 Test Facilities

The following additional test facilities shall be available at the Supplier's works:

a. Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer, digital ohm metre etc.

b. Standard resistance for calibration of resistance bridges.

c. Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

8 PACKING, MARKING AND SHIPPING

Packing shall meet the following in addition to the requirements specified.

8.1 Reel/Conductor Design

8.1.1 The conductors shall be packed in Reels/Drums conforming to IS: 1778.

8.1.2 Reels may be of wood or steel construction. Standard reel sizes shall be used, unless otherwise specified. If matched reels are required, the lengths of the conductor in each reel shall not vary by more than 50 m.

8.1.3 The bidder is free to offer Returnable steel conductor drums. Healthy drums may be used not more than three times.

8.1.4 The details of conductor drum are as per IS 1778.

a. Type of Wood: Seasoned softwood free from defects
b. Dimensions: To be calculated & submitted for approval by Owner

8.2 The line conductor shall be furnished in one length on reels with a permissible variation in length of ± 5%.

8.3 The line conductor shall be protected by wood lagging against damage during handling and shipment, and to facilitate long-term outdoor storage.

8.4 Methods of packing, marking and shipping shall be submitted to Owner for review and acceptance.

8.5 Packing and marking shall conform to IS: 398 (Part 5) for ACSR conductor.

8.6 Verification of Conductor Length - The Owner reserves the right to verify the length of conductor alter unreeling at least ten (10%) percent of the drums in a lot offered for Inspection.

DATA SHEET
BARE OVERHEAD LINE CONDUCTOR
(To be furnished by the bidder along with his Bid)

Project Title 400 kV RAPP Transmission Project

S. No	DESCRIPTION	Unit	ACSR Moose
1	Conductor type		
2	Classification as per IS: 398 (Part 4)		
3	Aluminium alloy area	mm²	
4	Rated strength	kN	
5	DC resistance at 20°C	Ω/km	
6	AC resistance at 75°C	Ω/km	
7	Concentric-lay type		
8	Joints per reel		
9	Total cross sectional area of Aluminium wire	mm²	
10	Number of aluminium-alloy wires		
11	Diameter of aluminium-alloy wires	mm	
12	Overall diameter	mm	
13	Overall weight	kg/km	
14	Type of reel (Steel or Wood)		
15	Matched reel required		
16	Number of matched reels per set		
17	Length of conductor per reel	m	
18	Weight of conductor per reel	kg	
19	If not matched reel, tolerance in conductor length per reel	%	
20	Modulus of Elasticity	Kg/sq.cm	
21	Coefficient of linear expansion	Per Deg C	

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES SPECIFIED

B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER CONTRACTOR:

C. OTHER PARTICULARS TO BE FILLED UP BY BIDDER/VENDOR/SUPPLIER/ CONTRACTOR:

	Actual Manufacturer of Material	Vendor/Supplier/ Contractor
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with date		
Official Seal/Stamp of the Company		

TECHNICAL SPECIFICATIONS

FOR

INSULATOR

"ASSOCIATED TRANSMISSION SYSTEM FOR RAPP UNIT-7 & 8"

ISSUED BY

RAPP TRANSMISSION COMPANY LTD. (RAPPTCL)
(A wholly owned subsidiary of IndiGrid Ltd.)

Address for Correspondence:

RAPP Transmission Company Ltd.,
C/o IndiGrid Ltd.,
Unit No. 101, First Floor, Windsor,
Village KoleKalyan, Off CST Road,
Vidyanagari Marg, Kalina,
Santacruz East, Mumbai 400 098
Phone: +91-7208493885; Mail: info@indigrid.com

CHAPTER - I

SPECIFICATION

FOR

COMPOSITE TYPE INSULATORS

TABLE OF CONTENTS

1. SCOPE

This Specification covers technical requirements for Design, Engineering, Manufacture, Inspection, Testing and Performance of Suspension type, Composite Insulators of Single piece design / Modular construction intended to be used as Suspension and Tension type Insulators for the following 400 kV Transmission Lines:

a) 400 KV D/C Twin ACSR Moose RAPP to Shujalpur Transmission Line

2. INSULATOR STRINGS

2.1 **Suspension/Pilot Strings for 400 KV Double Circuit Transmission Lines:** The Bidder may offer Composite insulator strings of the specified electro mechanical strength and total creepage. The bidder shall provide a corporate guarantee from the manufacturer (in favour of the Owner) for satisfactory design and performance for a minimum period of twenty five (25) years from the date of actual COD.

2.2 **Tension Strings for 400 KV Double Circuit Transmission Lines:** The Bidder may offer Composite Insulator strings of the specified electro mechanical strength and total creepage. The bidder shall provide a corporate guarantee from the manufacturer (in favour of the Owner) for satisfactory design and performance for a minimum period of twenty five (25) years from the date of actual COD.

3. CROSS REFERENCES

This Material Standard Specification shall be read in conjunction with the GCC/SCC etc as applicable and other associated Requirements for All Equipment/Materials, which shall be considered as an integral part of this Specification.

4. APPLICABLE CODES AND STANDARDS

The Composite type Suspension Insulators shall conform to the following Indian/International Standards, which shall mean latest revisions with amendments/Changes adopted and published, unless specifically stated otherwise in the Specification.

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

Sl. No.	Indian Standard	Title	International Standard
1.	IS:209-1992	Specification for zinc	BS:3436
2.	IS:406-1991	Method of Chemical Analysis of Slab Zinc	BS:3436

Sl. No.	Indian Standard	Title	International Standard
3.	IS:731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS:137- (I&II) IEC:60383
4.	IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS:2486 Part- I-1993 Part- II-1989 Part-III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	 BS:3288 IEC:60120 IEC:60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS:433-1969 ISO:1460-1973
9.	IS:8263-1990	Methods of RI Test of HV insulators	IEC:60437 NEMA Publi- cation No.07/ 1964/ CISPR
10.	IS:8269-1990	Methods for Switching Impulse test on HV insulators	IEC:60506
11.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
14.		Selection and dimensioning of high voltage insulators intended for use in polluted conditions: Polymer Insulators for AC systems	IEC:60815**-3**
15.		Tests on insulators of Ceramic material or glass or glass for overhead lines with a nominal voltage greater than 1000V	IEC:60383
16.		Composite string insulator units for overhead lines with a nominal voltage above 1000V : Standard strength classes and end fittings	IEC 61466-1
17.		Composite string insulator units for overhead lines with a nominal voltage above 1000V : Dimensional and electrical characteristics	IEC 61466-2
18		Electrical Insulating materials used under severe ambient conditions –Test methods for evaluating resistance to tracking and erosion	IEC 60587
19		Polymeric insulators for indoor and outdoor use with nominal voltage greater than 1000V- General definitions, tests, methods and acceptance criteria.	IEC 62217

Sr. No.	Standard	Title
3.1	IEC 60507	Artificial Pollution Tests on High Voltage Insulators

3.2	IEC 61109	Composite Insulators for A.C. Overhead Lines with a Nominal Voltage Greater than 1000V - Definitions, Test Methods and Acceptance Criteria
3.3	ANSI C29.1	Standard Test Methods for Electrical Power Insulators
3.4	ANSI C29.11	Standard for Composite Suspension Insulators for Overhead Transmission Line-Tests
3.5	ANSI C29.12	Insulators - Composite - Suspension Type
3.6	ANSI C29.17	Composite Line Post Insulators at Installations above 70kV A.C.
3.7	ANSI 987	IEEE Guide for Application of Composite Insulators

5. Technical Description of Composite Long Rod Insulators

5.1 Details of Composite Long Rod Insulators

5.1.1 The insulators of the suspension & tension strings shall consist of composite long rod insulators for a three phase, 50 Hz, effectively earthed 400kV D/C AC transmission system. Couplings shall be ball and socket type.

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

5.1.3 Insulators shall have sheds of the “open aerodynamic profile without any under ribs” with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

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

S.No	Type of String	Minimum Creepage Distance (mm) per unit	Electro- Mechanical Strength of Insulator Unit (kN)	Mechanical Strength of Insulator String along with Hardware Fittings (kN)
	400kV AC TRANSMISSION LINES WITH TWIN MOOSECONDUCTOR			
1.	Single ‘I’ Pilot string,	13020	120	120
2.	Single ‘I’ suspension String	13020	120	120
3.	Double Tension	13020	160	320

5.2 Pin and Cap

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

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

5.3 Ball and Socket Designation

The dimensions of the Ball and Socket shall be of 20 mm designation for 120 kN & 160kN Insulators in accordance with the standard dimensions stated in IEC:120/ IS:2486 (Part-II).

5.4 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length shall be allowed as follows:
± (0.04d+1.5) mm when d≤300 mm.
± (0.025d+6) mm when d>300 mm.

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

The tolerance in creepage distance shall be based on design dimension and their tolerances. However, no negative tolerance shall be applicable to creepage distance specified in clause 5.1.4.

5.5 Interchangeability

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

5.6 Corona and RI Performance

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

5.7 Maintenance

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

5.7.2 All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so

proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

5.8 Materials

5.8.1 Core

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

5.8.2 Housing & Weather sheds

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

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

5.8.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron spheroid graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The sealing shall stick to both housing and metal end fitting. The sealing must be humidity proof and durable with time.

End fittings shall have suitable provisions for fixing grading rings at the correct position as per design requirements.

5.8.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce radio and TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The insulator supplier shall furnish design calculations using appropriate electric field software showing electric field at surface of housing, inside housing and core and at the interface of housing and metal fittings with the proposed placement and design of corona ring. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

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

6. Workmanship

6.1 All the materials shall be of latest design and conform to the best modern practices adopted in the extra high voltage field. Bidders shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for transmission lines specified and will give continued goodservice.

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

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

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

6.5 Housing shall be uniform in quality. It shall be free from voids and impurities. It shall be clean, sound, smooth and free from gross defects and excessive flashing at parting lines.

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

6.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. and shall be in accordance with the requirement of ISO:1461 (E) and shall satisfy the tests mentioned in ISO:1460 (E). The zinc used for galvanizing shall be of purity of 99.95%. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous

and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

6.8 The supplier shall guarantee that there shall not be any failure/ decapping / breaking of insulators on line under normal operating condition. In the event of any failure/ decapping/ breaking of insulators during the first twenty-five years of service, Supplier shall supply to the owner free of cost spare insulators equal to 2 times the failed insulator quantity. Further, in case of decapping / Breaking and subsequent line drop, during the first twenty-five years of service, the supplier shall also have to pay Rs 5,00,000/ (Rs Five Lacs only) per dropped string towards expenditure to be incurred by RTCL for this line repair to compensate part of revenue loss to RTCL due to non availability of line.

7. Markings

All the individual insulators and crates shall be provided with the markings as detailed below;

7.1 Insulator Markings

Each composite insulator shall bear a marking in accordance with ANSI or IEC Standard, identifying the following :

a Manufacturer's Name
b Year of Manufacture
c Specified Mechanical Load (S.M.L.)
(for Suspension Type Insulators)
d Routine Test Load (R.T.L.)
e Country of Origin
f Owners name “INDIGRID”

The marking shall be legible and durable. Marking shall be permanently marked on one end fitting or on the uppermost shed of the insulator. The use of labels is not permitted.

7.2 Crate Markings

Each crate shall be marked with the following identifications:

a. Insulator Type and number of insulators
b. Notification of Award
c. Manufacturer’s Catalogue No.

The markings shall be legible and durable.

8. Bid Drawings

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

8.2 The Bidder shall furnish along with the bid the outline drawing of each insulator unit along with grading rings including a cross sectional view of the long rod insulator unit. The drawing shall include but not limited to the following information:

(a) Major Dimensions with manufacturing tolerances

(b) Minimum Creepage distance with positive tolerance

(c) Protected creepage distance

(d) Unit mechanical and electrical characteristics

(e) Size and weight of ball and socket parts

(f) Weight of composite long rod units

(g) Materials

8.3 After placement of award, the Supplier shall submit full dimensioned insulator drawings containing all the details as given in Clause No. 8.2 above, in three (3) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Supplier shall submit 3 more copies of the same drawing & Type Test Report to the Owner along with a soft copy for further distribution and field use at Owner's end.

8.4 After placement of award the Supplier shall also submit fully dimensioned insulator cartoon/box drawing for different type of insulators.

9. Tests and Standards

9.1 Type Tests

The following type tests shall be conducted on long rod units, components, materials or complete strings:

9.1.1 On the complete composite Long Rod Insulator String with Hardware Fittings

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

Type tests specified under Clause 9.1.1 shall not be required to be carried out if a valid test certificate is available for a similar design/Combination of hardware with same insulator design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country

where laboratory is located) or witnessed by the representative (s) of Owner. The test reports shall be submitted for the tests conducted within the last 5 (five) years prior to the date of Bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / manufacturing change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Owner.

9.1.2 On Composite Insulator Units

(a)	Tests on interfaces and connections of metal fittings	IEC: 61109-2008
(b)	Assembled core load time test	IEC: 61109-2008
(c)	Damage limit proof test and test of tightness of interface between end firings and insulator housing	IEC: 61109-2008
(d)	High Pressure washing test	Annexure-A
(e)	Brittle fracture resistance test	Annexure-A
(f)	Dye penetration test	IEC: 61109-2008
(g)	Water diffusion test	IEC: 61109-2008
(h)	Tracking and erosion test	IEC: 61109-2008
(i)	Hardness test	IEC: 61109-2008
(j)	Accelerated weathering test	IEC: 61109-2008
(k)	Flammability test	IEC: 61109-2008
(l)	Silicone content test	Annexure-A
(m)	Recovery of Hydrophobicity test	Annexure-A
(n)	Torsion test	Annexure-A

9.1.3 All the type test given in Clause No.9.1.1 shall be conducted on following insulator strings along with hardware fittings:-

- Single 'I' suspension,
- Double Tension

9.1.4 All the type tests given in Clause No.9.1.1 (a) to (f) shall also be conducted on following insulator string along with hardware fittings:-

- Single 'I' Pilot

9.1.5 Hardness test, Accelerated weathering test & Flammability test specified under Clause No. 9.1.2 above shall be conducted on housing/weather shed of either 120 kN or 160 kN composite long rod for the same type of material.

9.2 Acceptance Tests:

9.2.1 For Composite Long Rod Insulators

(a)	Verification of dimensions	IEC : 61109-2008
(b)	Galvanizing test	IEC : 60383
(c)	Verification of end fittings	IEC : 61109-2008
(d)	Verification of tightness of interface between end fittings and insulator housing and of	IEC : 61109-2008

specified mechanical load

(e)	Recovery of Hydrophobicity	Annexure-A
(f)	Following tests on interfaces and connections of metal fittings: I. Dry Power frequency Voltage Test II. Sudden load release test III. Thermal Mechanical Test IV. Water Immersion Test V. Steep front impulse voltage test VI. Dry power frequency voltage test	IEC: 61109-2008
(g)	Silicone content test	Annexure-A
(h)	Brittle Fracture Resistance Test	Annexure-A
(i)	Dye Penetration Test	IEC 61109-2008
(j)	Water Diffusion Test	IEC 61109-2008

The test 9.2.1.(f) to (j) shall be carried out as acceptance test on any one lot.

In the event of failure of the sample to satisfy the acceptance test(s) specified in 9.2 above, the retest procedure shall be as per IEC 61109-2008.

9.3 Routine Tests

9.3.1 For Composite Long Rod Insulator Units

a)	Visual Examination	As per IEC:61109-2008
b)	Mechanical routine test	As per IEC:61109-2008

9.4 Testing Expenses

9.4.1 Testing charges for the type test shall deemed to be included in the quoted price.

9.4.2 Type Tests which involves the tests on the complete insulator string with hardware fitting, the Contractor of hardware fittings shall supply the necessary number of sets of hardware fittings at the place of testing free of cost.

9.4.3 In case of failure in any type test the supplier whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 9.1 of this specifications or to repeat that particular type test at least three times successfully at his own expenses. In case of failure of the complete string in any type test, the manufacturer whose product has failed in the test shall get the test repeated at his cost. The Supplier whose material has not failed in the test shall be required to supply the requisite quantity of material (that is insulator or hardware fittings as the case may be) required for repeat testing at the place of testing and the cost of supply shall be borne by the Supplier whose material has failed in testing.

9.4.4 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

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

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

9.4.7 The Supplier shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of testing in India) and at least 6 weeks advance (in case of testing abroad) of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

9.5 Schedule of Testing

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

a) Submission of drawing for approval.

b) Submission of Quality Assurance Programme for approval.

c) Offering of material for sample selection for type tests.

d) Type testing.

9.6 Additional Tests

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

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

9.7 Guarantee

The Supplier of insulators shall guarantee overall satisfactory performance of the insulators.

9.8 Special Tests

9.8.1 The pollution test shall be performed in accordance with IEC 507.

9.8.2 The High Pressure Water Withstand Test shall be performed.

9.8.3 The Composite Insulator Suspension assembly shall be subjected to an Accelerated UV radiation tests.

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10. SAMPLE BATCH FOR TYPE TESTING

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

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

11. INSPECTION

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

11.2 The material for final inspection shall be offered by the Manufacturer only under packed condition. The Owner shall select samples at random from the packed lot for carrying out acceptance tests. Insulators shall normally be offered for inspection in lots not exceeding 2 lots. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

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

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

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

12. PACKING OF INSULATORS

12.1 All insulators shall be packed individually in cartoon tubes coated with water proof primer which should prevent water ingress & then packed in a strong seasoned wooden crates.

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

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

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

12.5 Manufacturer shall ensure that all damaged/faulty Insulators as received at site shall be replaced free of cost to the Owner.

13. DESPATCH

The Composite Insulators assembly and accessories shall be dispatched in a manner as to ensure delivery of same in the time frame approved by the Owner.

14. PERFORMANCE SCHEDULE

The bidder shall furnish the details of his performance in respect of the major works carried out by him involving supplies of Composite Insulators for 400/400 kV lines, which are in service.

15. PERFORMANCE GUARANTEE

The bidder shall furnish a corporate performance guarantee, in respect of the offered Composite insulator strings, from the manufacturer (in favour of the Owner) for a period of twenty five (25) years from the date of COD.

DATA SHEET

COMPOSITE SUSPENSION/PILOT/TENSION INSULATOR STRINGS

(To be furnished by the bidder along with his Bid)

Sl No	Description	Unit	Standard Value	Quoted Value
1.0	Power frequency withstand volt-age of string with arcing horns, corona control rings/grading rings under wet condition	kV (rms)	680	
2.0	Switching withstand voltage (dry)			
a)	Positive (Peak)	kV	1050	
b)	Negative (Peak)	kV	1050	
3.0	Impulse withstand voltage (dry)			
a)	Positive (Peak)	kV	1550	
b)	Negative (Peak)	kV	1550	
4.0	Minimum corona extinction voltage under dry condition	kV (rms)	320	
5.0	RIV at 1 MHZ when string is Energized at 305 kV (rms) under dry condition	Micro volts	1000 (max.)	
7.0	Maximum voltage distribution across any disc of line to earth voltage	%	6.5	
8.0	Combined Mechanical and Electrical (M&E) Strength	kN	120 & 160	
9.0	Tension Proof Load	-	50% of specified M&E Rating	
10.0	Residual strength after maximum loadings		70% of rated M&E	
11.0	Max. Diameter of Composite Suspension String Weather shed	mm		
12.0	Length of Suspension String	mm		
13.0	Length of pilot string	mm		
14.0	Total Creepage			
a.	120 KN	mm	13020	
b.	160 KN	mm	13020	
15.0	Weight per string			
a.	120 KN	Kg		
b.	160 KN	Kg		
c.	210 KN	Kg		
16.0	Receding water angle		80° or more	
17.0	Type of Weather shed			
a.	Coupling class/type of insulator end fitting			
b.	Insulator Weather shed material		Silicone Rubber	
18.0	Min. thickness of sheath covering over	mm	3.0	

	the core			
a.	Insulator Core Material			
b.	Core Diameter	mm		
c.	Attachment of Insulator End Fitting		Compression/ Injection mould	
d.	Water Washing Pressure Withstand	KPa	3800	

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE SPECIFIED BY OWNER

B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR:

C. OTHER PARTICULARS TO BE FILLED UP BY BIDDER/VENDOR/SUPPLIER/ CONTRACTOR:

	Actual Manufacturer of Material	Vendor/Supplier/ Contractor
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with date		
Official Seal/Stamp of the Company		

ANNEXURE-A

1.0 Tests on Complete Strings with Hardware Fittings

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV (rms) line to ground under dry condition under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC : 60383.

1.2 RIV Test (Dry)

Under the conditions as specified under (1.1) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV line to ground under dry condition. The test procedure shall be in accordance with IS: 8263/ IEC: 60437.

1.3 Mechanical Strength Test

Mechanical Strength Test for insulator strings for 400 kV line

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

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string, a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and the each sub-conductors tensioned at 25% of conductor UTS shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. All the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than $1000/f^{1.8}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated

for not less than 10 million cycles without any failure. After the test, the insulators shall be examined for looseness of pins and cap or any crack. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

1.5 Salt-fog pollution withstand test

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

2.0 Composite Longrod Insulator Units

2.1 Brittle Fracture Resistance Test

The test arrangement shall be according to Damage limit proof test with simultaneous application of 1N-HNO_3 acid directly in contact with naked FRP rod. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm.The rod shall withstand 80% of SML for 96 hours.

2.2 Recovery of Hydrophobicity Test

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

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

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

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

2.3 Silicone content test

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

2.4 High Pressure washing test

The washing of a complete insulator of each E&M rating is to be carried out at 3800kPa with nozzles of 6mm diameter at a distance of 3m from nozzles to the insulator, The washing shall be carried out for 10minutes. There shall be no

damage to the sheath or metal fitting to housing interface. The verification shall be 1 minute wet power frequency withstand test at 680kV r.m.s for 400KV.

2.5 Torsion Test

Three complete insulators of each E&M rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

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

3.2 Tests for Forgings

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

3.3 Tests on Castings

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

TECHNICAL SPECIFICATIONS

FOR

LINE HARDWARE

"ASSOCIATED TRANSMISSION SYSTEM FOR RAPP UNIT-7 & 8"

ISSUED BY

RAPP TRANSMISSION COMPANY LTD. ((RAPPTCL))
(A wholly owned subsidiary of IndiGrid Ltd.)

Address for Correspondence:

RAPP Transmission Company Ltd.,
C/o IndiGrid Ltd.,
Unit No. 101, First Floor, Windsor,
Village KoleKalyan, Off CST Road,
Vidyanagari Marg, Kalina,
Santacruz East, Mumbai 400 098
Phone: +91-7208493885; Mail: info@indigrid.com

SPECIFICATION

FOR

LINE HARDWARE

TABLE OF CONTENTS

1.0 SCOPE

This Specification covers technical requirements for Design, Engineering, Manufacture, Inspection, Testing and Performance of Line hardware intended to be used for the following 400 kV Transmission Lines:

a) 400 KV D/C Twin ACSR Moose Shujalpur to RAPP Transmission Line

2.0 CROSS REFERENCES

This Material Standard Specification shall be read in conjunction with the GCC/SCC/etc as applicable and other associated Requirements for all Equipment/Materials, which shall be considered as an integral part of this Specification.

3.0 APPLICABLE CODES AND STANDARDS

The latest revision/amendments of the following Codes and Standards shall be applicable for the equipment/material covered in this specification. In case of conflict, the vendor/manufacturer may propose equipment/material conforming to one group of Industry Codes and Standards quoted hereunder without jeopardizing the requirements of this specification.

3.1 BSI 3288/ Specification for Insulators and Conductor Fittings for Overhead Power Lines

3.2 ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3.3 ASTM A143 Standard Recommended Practice for safeguard against embrittlement of Hot-dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

3.4 ASTM A384 Standard Practice for safeguarding against warfage and distortion during Hot-dip Galvanizing of Steel Assemblies

3.5 ASTM A90 Standard Methods of Test for weight of coating on Zinc coated (Galvanized) Iron or Steel Articles.

3.6 ASTM A239 Standard Method of Test for locating the thinnest spot in Zinc (Galvanized) coating on iron or steel articles by Preece Test (Copper Sulphate dip)

3.7 IEC 61854 Overhead Lines. -- Requirements and Tests for Spacers.

3.8 Other standards to be referred:

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986

2.	IS:398-1992 Part-IV	Aluminium conductors for overhead transmission purposes: Part 4 Aluminium alloy stranded conductors	
3.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
5.	IS:2629	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
6.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
7.		Ozone test on Elastomer	ASTM- D1 171
8.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
9.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO : 1460 (E)
11.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437 NEMA:107 CISPR
12.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272

4.0 DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 General

4.1.1 The line hardware shall be of manufacturer's standard design and shall meet or exceed the requirements of this Specification in all respects.

4.1.2 All hardware associated with insulators, conductors for attachments with the structures are included in this specification. These broadly include, but are not limited to the following:

a. All hardware between the point of attachment on tower and conductor i.e., shackles, links, yoke plates, arcing horns, corona rings, grading ring, sag adjustment device, clamps, guard devices, suspension and dead-end assembly suitable for Twin ACSR Moose conductor including AGS. All the hardware shall be accordance with latest applicable standards and with highest quality of workmanship to the satisfaction of the Owner.

b. Twin Spacer dampers.

4.1.3 Manufacturer's drawings, as required in the specification, shall show the outline of the line hardware, together with all pertinent

dimensions. Any variations in these dimensions due to manufacturing tolerances shall be indicated.

4.2 Design Criteria

4.2.1 Service conditions referenced in specification shall be the basis of design criteria.

4.2.2 The line hardware shall meet requirements of applicable standards IS:2486 & IS:2121.

4.2.3 The arcing horns shall be either ball ended rod type or tubular type. The air gap shall be so adjusted to ensure effective operation under service condition.

4.2.4 The yoke plate shall be either triangular or rectangular as may be necessary. The design shall take into consideration the most severe loading conditions and dimensional tolerances of insulators and other hardware fittings. The holes provided in the plate shall conform with IS: 800. All the edges shall be rounded with least radius of 3mm. the plate shall have suitable holes for corona rings/grading rings.

4.2.5 Corona rings/Grading rings shall be provided with the hardwire fittings such that it should cover atleast one insulator in the insulator string.

4.2.6 The sag adjustment plate shall be of such that the adjustment can be done with ease, speed and safety. The sag adjustment plate is to be provided with double tension hardware fitting of three plate type and be provided with safety locking arrangement. Design calculation for deciding the dimension of the sag adjustment plate shall be furnished by Bidder.

4.2.7 The turn buckle is to be provided with the single tension hardware fitting. The threads shall be of sufficient strength for specified tensile load.

4.2.8 The Preformed Armour Rods Set suitable for Twin ACSR Moose shall be used to minimize the stress.

4.2.9 The dead end assembly shall be suitable for Twin ACSR Moose.

4.2.10 The bolts and nuts shall conform IS:6639 and shall be galvanized as per IS:1367(Part-13)/IS:2629.

4.3 Ratings

4.3.1 The ratings of line hardware shall be in conformity with the rating of corresponding equipment to which these will be connected.

4.3.2 The strength of all hardware shall be at least equal to or higher than the combined M&E rating of the insulators. In case of bundled conductors, the strength of hardware shall be increased by a factor

equal to the number of sub-conductors in the bundle or number of insulator strings, whichever is applicable.

4.3.3 The mechanical rating of all guard devices shall be at least 150kg.

4.4 Materials

4.4.1 All the materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate specifications cited herein.

4.4.2 The line hardware, except for cotter keys, shall be made of a good commercial grade of malleable iron, ductile iron, steel and aluminium / aluminium alloy. The cotter keys shall be made of stainless steel.

4.4.3 The line hardware with socket ends shall be furnished with a positive locking device of the split cotter key type. The line hardware with clevis ends shall be furnished with a positive locking device of the cotter key type or bolted type.

4.4.4 The line hardware shall be hot-dip galvanized in accordance with the standard, except that the zinc coating thickness shall be 87 micron (610gm/m²) for all items other than nuts, bolts and washers.

TABLE-1 : (Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1.	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS-1385	
2.	Arcing Horn	Mild Steel Rod/ Tube Type	Hot dip galvanised	As per IS-226 or IS-2062	
3.	Ball Fittings, Socket, all shackles links cleves	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
4.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
5.	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
6(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20 KN
6(b).	Supporting Brackets & Mounting Bolts	High Strentgth Al Alloy 7061/ 6063/ 65032/ 63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	
7.	Turn Buckle	Class-II Steel	Forged hot dip galvanized	IS:2004	
8(a).	Free centre type	High Strength Al.	Casted or forged	IS:617 or ASTM-	

TABLE-1 : (Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
	clamp/ Envelope type Clamp: Clamp Body, Keeper Piece	Alloy 4600/ LM-6 or 6061/ 65032	& Heat treated	B429	
8(b)	Envelope type Clamp: Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
8(c)	Envelope type Clamp: U Bolts	Stainless Steel or High Strength Al alloy 6061/6063 or 65032/ 63400	Forged & & Heat treated	AISI 302 or 304-L ASTM-B429	
9.	P. A. rod	High strength Al alloy type 6061 or equivalent	Heat treatment during manufacturing	ASTM:B429	Min. tensile strength of 35 kg/mm2
10.	AGS clamp (a) Supporting house	High strength corrosion resistant Al. alloy LM6, 4600 or equivalent 6061	Cast/forged heat treated.	IS:617 or equivalent	
	(b) Al insert and retaining strap	High strength Al alloy type 6061 or equivalent	Forged and Heat treated	ASTM:B429	
	(c) Elastomer cushion	Moulded on Al reinforcement			
11(a).	Dead End Assembly: Outer Sleeve	EC grade Al of purity not less than 99.50%			
11(b).	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/IS-2062	
12.	Balancing weights	Cast iron MCI/ machined Mild Steel	Hot dip galvanised	IS:226/2062 or equivalent	

Note : Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparison of material offered vis - a - vis specified in the bid or else the bids are liable to be rejected.

4.5 Fabrication

4.5.1 The contours, edges and corners of the line hardware shall be rounded to eliminate areas of high corona stress concentration.

4.5.2 The line hardware having ball and socket couplings shall be as per IS: 2486 (Part-II).

4.5.3 The line hardware for voltage application above 115kV shall be equipped with arcing horn holder, as required.

4.5.4 Workmanship and general finish shall be of the highest grade and the best modern practice to the satisfaction of Owner. All components of the same design and designation shall be identical and like components shall be interchangeable.

4.5.5 Split cotter keys shall be humped to maintain the key in the locked or unlocked positions and shall have prongs spread to prevent withdrawal from the socket. The design of the keys shall be such that their engagement and disengagement can be achieved with the use of standard transmission hot-line tools without excessive force required.

4.6 Marking

Each line hardware shall bear a marking identifying the following:

4.6.1 Manufacturer's identification mark
4.6.2 Manufacturer's Catalog number
4.6.3 Year of manufacture
4.6.4 Owners name—"INDIGRID" The

marking shall be legible and indelible.

5.0 TECHNICAL REQUIREMENTS

All energized hardware shall be corona free at this voltage. All hardware shall be designed for hot line maintenance operations.

5.1. Details of Hardware Fittings

5.1.1. The hardware fittings shall be suitable for use with Disc/Long Rod Composite insulators having ball and socket fittings. The hardware fittings shall be as per the specification. Each hardware fitting shall be supplied complete in all respects and shall include the following hardware parts:

5.1.2. Suitable arcing horn as specified in clause 5.8 hereinafter.

5.1.3. Suitable yoke plates complying with the specifications given hereinafter.

5.1.4. Corona control rings/grading ring with fittings for attachment to line side yoke plate.

5.1.5. Sag adjustment plate for Twin tension hardware fittings and turn buckle for single tension hardware fittings.

5.1.6. Suspension and dead end assembly to suit Moose conductor size.

5.1.7. Suspension clamps shall be of aluminium alloy, non-magnetic type required to support conductors.

5.1.8. Provisions shall be made on both sides of string to facilitate the replacement of insulator strings for all types of assemblies during hot line maintenance.

5.1.9. Provisions for attaching balancing weights on the line side yoke plate of single suspension pilot hardware fittings.

5.1.10. Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make the hardware fittings complete.

5.1.11. 2.5% extra fasteners.

5.2. Dimensions of Insulator String Along with Hardware Fitting

The various limiting dimensions of the insulator strings along with hardware fittings shall be as under:

S. No		Type	Insulator Length(mm)	Length of string(mm)
1	400 KV D/C Transmission Line	Single I Pilot string	3335	4125
		Single Suspension Insulator string	3335	3950
		Double Tension Insulator string	3910	5360
		Single Tension Insulator String	3910	5360

5.3. Interchangeability

5.3.1 The hardware for insulator strings with composite long rod insulators together with ball and socket fittings shall be of standard design, so that these hardware are inter- changeable with each other and suitable for use with insulators of any make conforming to relevant Indian/International Standard.

5.4. Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Contractor must give suitable assurance about the satisfactory corona and radio interference performance of the materials offered by him.

5.5. Maintenance

5.5.1 The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method. The Bidder should clearly establish in the bid, the suitability of his fittings for hot line maintenance.

5.5.2 The line side yoke plate shall have a notch & a working hole of suitable size. The design of corona control rings/grading ring shall be such that it can be easily replaced by employing hot line maintenance technique.

5.6. Designation

5.6.1 Ball and Socket Designation

The designation should be in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120. The dimensions shall be checked by the appropriate gauge after galvanising only.

5.7. Security Clips and Split Pins

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

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

5.7.3 Split pins shall be used with bolts & nuts.

5.8. Arcing Horn/Intermediate Arcing Horn

5.8.1 The arcing horn / Intermediate Arcing Horn shall be either ball ended rod type or tubular type.

5.8.2 The air gap shall be so adjusted to ensure effective operation under actual field conditions.

5.9. Yoke Plates

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/grading ring/arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS:800-1984..

5.10. Corona Control Rings/Grading Ring

5.10.1 The Corona control rings/grading ring shall be provided with hardware fittings and shall be of such design that it should cover at least one shed of insulator in composite insulator strings so that they will reduce the voltage across the insulator units. It shall also improve corona and

radio interference performance of the complete insulator string along with hardware fittings.

5.10.2 The corona control rings/grading ring shall be made of high strength heat treated aluminium alloy tube of minimum 2.5 mm wall thickness. If mild steel brackets are used then the brackets shall not be welded to the pipe but shall be fixed by means of bolts and nuts on a small aluminium plate attachment welded to the pipe. The welded center of the corona control ring/grading ring shall be grinded before buffing. Alternately, Aluminium tube/flats of suitable dimensions welded to the corona control rings/grading rings may be used for connection to yoke plate.

5.10.3 Bidder may quote for grading ring with armour grip suspension assembly. The grading ring shall be of open type design with a gap of 125 mm. The open ends shall be suitably terminated. The outside diameter of the tube shall be 60 mm for 400 KV line. The ends of grading ring tube shall be sealed with welded aluminium cap duly buffed.

5.11. Sag Adjustment Plate

5.11.1 The sag-adjustment plate to be provided with the Double tension hardware fitting shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.

5.11.2 The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.

5.11.3 Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder. The hole provided for bolts should satisfy shear edge

5.12. Suspension Assembly

5.12.1 The suspension assembly shall be suitable for the specific conductor.

5.12.2 The suspension assembly shall include free center type suspension clamp along with standard preformed armour rods or armour grip suspension clamp; except for Pilot insulator string for which only suitable Envelope type suspension clamp shall be used.

5.12.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

5.12.4 The suspension clamp along with standard preformed armour rods/armour grip suspension clamp set shall have the slip strength not less than that specified in the Standard Technical Particulars.

5.12.5 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of

hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence, which might damage the conductor.

5.12.6 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

5.12.7 The magnetic power loss shall not be more than that stipulated in the Standard Technical Particulars.

5.12.8 Free Center Type Suspension Clamp

For the Free Center Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

5.12.9 Standard Preformed Armour Rod Set

5.12.9.1 The Preformed Armour Rods Set, suitable for specific Conductor, shall be used to minimise the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs. chafing and abrasion from suspension clamp and localised heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

5.12.9.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helics shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

5.12.9.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

5.12.9.4 The length of each rod along with permissible tolerances shall be as stipulated in the Standard Technical Particulars. The end of armour rod shall be parrot billed.

5.12.9.5 The number of armour rods in each set shall as stipulated in the Standard Technical Particulars. Each rod shall be marked in the middle with paint for easy application on the line.

5.12.9.6 The armour rod shall not loose their resilience even after five applications.

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

5.12.10 Armour Grip Suspension Clamp

5.12.10.1 The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminium reinforcements and AGS preformed rod set.

5.12.10.2 Elastomer insert shall be resistant to the effects of temperature up to $95^{o}C$, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

5.12.10.3 The AGS preformed rod set shall be as detailed in clause 5.12.9.4 to 5.12.9.7 in general except for the following.

5.12.10.4 The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as detailed under clause 5.12.4 and shall not introduce unfavorable stress on the conductor under all operating conditions. However the length of AGS preformed rods shall not be less than that stipulated in the Standard Technical Particulars.

5.13. Envelope Type Suspension Clamp

5.13.1 The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.

5.14. Dead end Assembly

5.14.1 The dead end assembly shall be suitable for specific Conductor.

5.14.2 The dead end assembly shall be compression type with provision for comprising jumper terminal at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

5.14.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COM PRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead end assembly is designed for intermittent die compressions it shall bear identification marks 'COMPRESSION ZONE' AND 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensional tolerances of the cross section of aluminium and steel dead end; for dead end assembly for the specific conductor shall be as stipulated in the Standard Technical Particulars.

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

5.15. Balancing Weights

For holding the single suspension pilot insulator string used for jumper connections at the transposition towers from excessive deflection, suitable balancing weights, weighing 200 kg. are to be suspended through the line side yoke plate. It shall consist of four weights, each weighing 50 Kgs. and shall be connected to the yoke plate by means of eye bolt and shackle arrangement. The bottom weight shall be provided with recess to shield the ends of eye bolts. The same shall be suitable for use on specific transmission lines.

5.16. Fasteners : Bolts, Nuts and Washers

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

5.16.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of 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.

5.16.3 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 0.4 mm oversize on effective diameter for size up to M16.

5.16.4 Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanised. The thickness of washers shall conform to IS:2016-1967.

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

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

5.17 Spacer Damper for Twin Moose

5.17.1 Suitable spacer dampers for Twin bundle ACSR MOOSE conductor line shall be offered. The spacer damper covered by this specification shall be designed to maintain the bundle spacing of 457 mm under all normal operating conditions and to effectively control Aeolian vibrations as well as sub span oscillation and to restore conductor spacing after release of any

external extraordinary load. The nominal sub conductor spacing shall be maintained within ±5 mm.

5.17.2 The spacer damper shall restore the normal sub-conductor spacing due to displacement by wind, electromagnetic and electrostatic forces including the specified short circuit level without permanent deformation or damage either to bundle conductors or to spacer damper itself.

5.17.3 The design offered shall be presented as a system consisting of spacer dampers and their staggering scheme for spans ranging from 100 m to 1100 m. A vibration performance test shall be carried out on an experimental test line. The systems tested should be those specified by the Supplier for the 400 kV line conditions. Only systems satisfying the performance criteria under Annexure-A shall be submitted by Bidder along with bid.

5.17.4 The test line selected for the performance evaluation shall have been designed for that purpose, be adequately exposed to wind and properly instrumented.

	Description	Technical Particulars
1.	Configuration	Twin ACSR MOOSE conductor bundle per phase & all 2X3 phases in vertical configuration
2.	Span length in metres i) Ruling design span	 400 metres
	ii) Maximum span	1100 metres
	iii) Minimum Span	100 metres
3.	Tensile load in each sub-conductor	As per sag tension calculations.
4.	Armour rods used	Yes
5.	Maximum permissible dynamic strains	± 150 micro strains

5.17.5 Under the operating conditions specified, the spacer damper system shall adequately control Aeolian vibrations throughout the life of the transmission line in respective wind zone for 400KV Transmission lines in order to prevent damage to conductor at suspension clamps, dead end clamps and spacer damper clamps.

5.17.6 The spacer damper system shall also control the sub-span oscillations in order to prevent conductor damage due to chaffing and severe bending stresses at the spacer damper clamps as well as suspension and dead end clamps and to avoid wear to spacer damper components.

5.17.7 The spacer damper shall consist of a rigid central body called the frame linked to the conductor by four articulated arms terminated by suitable clamping system. The articulation shall be designed to provide elastic and damping forces under angular movement of the arms. The dynamic characteristics of the articulations shall be maintained for the whole life of the transmission line.

5.17.8 The clamping system shall be designed to provide firm but gentle and permanent grip while protecting the conductor against local static or dynamic stresses expected during normal operating conditions. The clamping system shall be designed to compensate for any reduction of conductor diameter due to creep.

5.17.9 Bolted type clamps shall allow installation without removal of the bolts or the clamps from clamp body. Locking mechanism shall be suitable to prevent bolt loosening. Clamp locking devices with small loose components shall not be accepted. Nut cracker, hinged open or boltless type clamps are acceptable provided adequate grip can be maintained on the conductor.

5.17.10 Bolts and nuts shall be of mild steel, stainless steel, or high strength steel in accordance with the design of the spacer damper.

5.17.11 Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 25 kg/mm2. The insert shall be moulded on the insert surface. The insert shall be duly heat treated and aged to retain its consistent characteristics during service. The grain flow of the forged insert shall be in the direction of the maximum tension and compression loads experienced.

5.17.12 If clamps involving preformed rods are used, these rods shall be designed for specific conductor size. They shall be made of high strength aluminium alloy of type 6061 or equivalent aluminium alloy having a minimum tensile strength of 35 kg/mm3. The rods shall be ball ended. The rods shall be heat treated and aged to achieve specified mechanical properties and to retain the same during service. The length of the rods shall be such that the ends fall inside the imaginary square whose sides are vertical and horizontal outer tangents to the conductor sections.

5.17.13 The spacer damper body shall be cast/forged from suitable high strength corrosion resistant aluminum alloy. The aluminium alloy shall be chosen in relation with the process used.

5.17.14 The rubber components involved in the design such as damping elements shall be made with rubber compound selected specifically for that particular application. The Bidder shall submit a complete list of physical and mechanical properties of the elastomer used. This list shall make reference to all applicable ASTM standards.

5.17.15 The rubber components used shall have good resistance to the effects of temperature up to 95°C and to ultraviolet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi-conductive.

5.17.16 The spacer damper involving ferrous material shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars.

5.17.17 The spacer damper assembly shall have electrical continuity. The electrical resistance between the sub-conductors across the assembly in case of spacer damper involving elastomer surfaced clamps shall be suitably selected by the manufacturer to ensure satisfactory electrical performance and avoid deterioration of elastomer under service conditions.

5.17.18 The spacer damper assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

5.17.19 The spacer damper assembly shall be capable of being installed and removed from the energized line by means of hot line techniques. The Bidder shall supply with the bid the complete description of the installation, removal and reinstallation procedure.

5.17.20 The Bidder shall recommend the staggering scheme for installation of spacer dampers on the line which shall ensure most satisfactory fatigue performance of the line as specified. The scheme shall indicate the number of spacer dampers per phase per span and the sub span lengths to be maintained between spacer dampers while installing on the twin bundle conductors.

5.17.21 The staggering scheme shall be provided for spans ranging from 100 m to 1100 m. The number of spacer dampers for a nominal ruling span of 400 m shall not be less than six.

5.17.22 No sub span shall be greater than 70 m and no end sub span shall be longer than 40 m.

5.17.23 The staggering scheme shall be such that the spacer dampers be unequally distributed along the span to achieve sufficient detuning of adjacent subs pans for oscillations of sub span mode and to ensure bundle stability for wind speeds up to 60 km/hr.

5.17.24 The Bidder shall furnish all the relevant technical documents in supports of the staggering scheme recommended for the spacer damper.

6.0 Workmanship

6.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory

and suitable for the rated transmission lines and will give continued good performance.

6.2 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

6.3 Galvanising shall he done in accordance with IS 2629 :1985/ IS 1367 (Part 13) and shall satisfy the tests mentioned in IS 2633: 1986.

6.4 Before ball fittings are galvanised all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

6.5 Pin balls shall be checked with the applicable “GO” gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90^{O} to this line. "NO GO" gauges shall not pass in any direction.

6.6 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.

6.7 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

6.8 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

6.9 All fasteners shall have suitable corona free locking arrangement to guard against vibration loosening.

7.0 Bid Drawings

7.1 The Bidder shall furnish full description and illustrations of materials offered.

7.2 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

(i) Attachment of the hanger or strain plate.

(ii) Suspension or dead end assembly.

(iii) Arcing horn attachment to the string as specified in clause 5.8 of this technical Specification.

(iv) Yoke plates

(v) Hardware fittings of ball and socket type for inter connecting units to the top and bottom Yoke plates.

(vi) Corona control rings/grading ring attachment to conductor and other small accessories.

(vii) Links with suitable fittings.

(viii) Details of balancing weights and arrangements for their attachment in the single suspension pilot insulator string.

7.3 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include :

(i) Dimensions and dimensional tolerance.

(ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.

(iii) Catalogue No.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions

(vii) Design installation torque for the bolt or cap screw.

(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.

(ix) The compression die number with recommended compression pressure.

(x) All other relevant terminal details.

7.4 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in three (3) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Contractor shall submit three (3) more copies of the tested drawings & Type Test Report to the Owner for further distribution and field use at Owner's end.

8.0 Guaranteed technical particulars

The Standard technical particulars to adhered by the contractor / manufacturer are furnished below:

A. Standard Technical Particulars of Hardware Fittings and Accessories for 400 kV D/C Line with Twin ACSR Moose Conductor

Suspension hardware fittings for ACSR MOOSE Conductor

Sl.	Description	Unit	Particulars/ Value		
			Suspension Strings		**Suspension PILOT Strings**
			Single 'I'		**Single 'I'**
			AGS clamp	**Free Centre clamp**	**Envelope clamp**
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 500 amperes	Watt	4		8
2.	Slipping strength of suspension assembly	KN	20-29		20-29
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly				
	a) No. of rods per set	No.	12		NA
	b) Direction of lay		Right hand		NA
	c) Overall length after fitting on conductor	mm	2235	2540	NA
	d) Diameter of each rod	mm	9.27		NA
	e) Tolerance in				
	i) Diameter of each rod	±mm	0.10		NA
	ii) Length of each rod	±mm	25		NA
	iii) Difference of length between the longest and shortest rod in a set	±mm	13		NA
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032		NA
	g) Minimum UTS of each rod	Kg/mm^2	35		NA
4.	**Particulars of Elastomer (For AGS Clamp only)**				
	a) Type of elastomer		Chloroprene / Neoprene Rubber	NA	NA
	b) Shore hardness of elastomer		65 to 85	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95^o C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	120 kN		120 kN
6.	Mechanical strength of suspension clamp	KN	70kN		70
7.	Purity of Zinc used for galvanising	%	99.95		99.95
8.	Min. No. of dips in standard	No.	a) Fasteners: 4 dips of 1 minute		

	preece test the ferrous parts can withstand		b) Spring washers: 3 dips of 1 minute c) All others: 6 dips of 1 minute

Tension hardware fittings for Twin ACSR MOOSE Conductor

Sl.	Description	Unit	Particulars/ Value
			Double Tension String
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	320
2.	Type of dead end assembly		Compression
3.	Compression pressure	MT	100
4.	Maximum electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	75
5.	Slip strength of dead end assembly	KN	153.2
6.	Purity of Zinc used for galvanising	%	99.95
7.	Min. No. of dips in standard preece test the ferrous parts can withstand.	Nos.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

TWIN SPACER DAMPER FOR Twin ACSR Moose CONDUCTOR

Sl.	Description	Unit	Particulars / Value		
1.	Type of Clamps		Bolted / Nut cracker / Hinged open / Boltless / Preformed rods.		
2.	Type of Damping element		Spring / Elastomer / EPDM		
3.	Material of				
	(a) Clamp		Al Alloy IS:4600 or Equivalent		
	(b) Body		Galvanised Steel / Al Alloy 4600 or Equivalent		
4.	Elastomer (*if used*)				
	(a) Shore hardness		65-80		
	(b) Temp. range for which designed	°C	Upto 95°C		
5.	Minimum ultimate tensile strength of spacer				
	(a) Compressive load	kN	15		
	(b) Tensile load	kN	7		
6.	Slipping strength of spacer clamp				
	(a) Before vibration test	kN	**Clamp type**	**Longitudinal Load (kN)**	**Maxm Slip permitted (mm)**
			Metal – Metal Bolted	6.5	1
			Rubber loaded	2.5	2.5
			Preformed rods	2.5	12

	(b) After vibration test	kN	80% of the above values
7.	Maximum magnetic power loss of at sub conductor current of 500 amperes, 50Hz AC	Watt s	Below 1 watt.
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
9.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	µV	Below 1000

9.0 Tests and Standards

9.1 Type Tests

9.1.1 On the complete Insulator String with Hardware Fittings

(a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition

(b) Switching surge voltage withstand test under wet condition

(c) Impulse voltage with-stand test under dry condition — IEC:60383

(d) Impulse voltage flash-over test under dry condition

(e) Corona and RIV test under dry condition — Annexure-A

(f) Mechanical Strength test

(g) Vibration test

(h) Salt-fog pollution withstand test) — IEC:60507

9.1.2 On Suspension Hardware Fittings only

(a) Magnetic power loss test for suspension assembly

(b) Clamp slip strength Vs torque — Annexure-A &

(c) Mechanical strength Test — IS:2486

(d) OZONE Test on elastomer

9.1.3 On Tension Hardware fittings only

(a) Electrical resistance test for dead end Assembly :

(b) Heating cycle test for dead end Assembly — IS:2486-(Part-I),

(c) Slip strength test for dead-end assembly

(d) Mechanical strength test) Annexure-A

9.1.4 Spacer Damper (For TWIN ACSR MOOSE)

(a) Chemical analysis of materials

(b) Clamp slip test

(c) Performance Test

(i) Aeolian

(ii) Sub span oscillation

(d) Magnetic power loss test — IEC:61854,

(e) Dynamic Characteristics test — Approved MQP

(f) Fatigue test — &

(g) Ozone test — Annexure-A

(h) Corona extinction voltage test (dry)

(i) Radio interference voltage test (dry)

(h) Compression and Tensile Test

9.1.5 All the type tests given under clause no. 9.1.1 above shall be conducted on Single I Suspension and Double tension insulator string along with hardware fittings for 400 kV lines.

9.1.6 The tests specified under Clause No. 9.1.1 (a) to (f) shall be conducted on single I suspension pilot Insulator string along with hardware fittings for 400 kV lines.

9.1.7 The magnetic power loss test specified under clause no. 9.1.2 (a) shall be conducted on Single suspension and Single suspension pilot assembly.

9.1.8 Heating cycle test on dead end assembly and Performance test on spacer damper shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., test conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of Owner. The test reports shall be submitted for the tests conducted within the last 5 (five) years prior to the date of Bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / manufacturing change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Owner.

9.1.9 Type tests specified under Clause 9.1.1 shall not be required to be carried out if a valid test certificate is available for a similar design/Combination of hardware with same insulator design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of Owner. The test reports shall be submitted for the tests conducted within the last 5 (five) years prior to the date of Bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / manufacturing change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Owner.

6.1 Acceptance Tests

6.1.1 On Both Suspension and Tension Hardware Fittings

	(a) Visual Examination	)IS:2486-(Part-I),)Clause 5.8 & 5.9
(b)	Verification of dimensions	))
(c)	Galvanising/Electroplating test	)
(d)	Mechanical strength test of each component (excluding corona control rings grading ring and arcing horn)	))Annexure-A))
(e)	Mechanical Strength test	)

	of welded joint	)
(f)	Mechanical strength test for corona control rings,/ grading ring and arcing horn	)BS:3288- (Part-I),))
(g)	Test on locking device for ball and socket coupling	)) IEC:372 (2)
(h)	Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forging D/Castings	))) Annexure-A

6.1.2 On Suspension Hardware Fitting only

(a)	Clamp Slip strength Vs Torque test for suspension clamp	Annexure-A,
(b)	Shore hardness test of elastomer cushion for AG suspension clamp	IS:2486
(c)	Bend test for armour rod Set	
(d)	Resilience test for armour rod set	IS:2121-(Part-I)
(e)	Conductivity test for armour rods set	

6.1.3 **On Tension Hardware Fittings Only**

(a)	Slip strength test for dead end assembly	)IS:2486 (Part-I))

6.1.4 **Spacer Damper for Conductor/Spacer**

(a)	Visual examination and dimensional verification	
(b)	Galvanising test	
(c)	Movement test (except for spacers for jumpers)	IS:2121-(Part-II)
(d)	Clamp slip test	&
(e)	Clamp bolt torque test	
(f)	Compressive and tensile test	IEC:61854
(g)	Assembly torque test	
(h)	Hardness test for elastomer(if applicable)	

6.2 Routine Tests

6.2.1 For Hardware Fittings

(a)	Visual examination	)IS:2486-(Part-I)

(b) Proof Load Test)As per practice

6.3 Tests During Manufacture

On all components as applicable

(a) Chemical analysis of Zinc used for galvanising

(b) Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings. As per practice

(c) Chemical analysis, hardness tests and magnetic particle inspection for forgings

6.4 Testing Expenses

6.4.1 Testing charges for the type test shall deemed to be included in the quoted price.

6.4.2 Testing charges for all type tests specified under clause no. 9.1.1 shall be indicated only by insulator Supplier's as the charges for these tests shall be paid to them duly by the Owner to avoid duplication and shall not be indicated by the hardware Supplier's.

6.4.3 For type tests which involve the tests on the complete insulator string with hardware fittings, the Contractor of hardware fittings shall supply the necessary number of sets of hardware fittings at the place of testing free of cost.

6.4.4 In case of failure in any type test, the Bidder whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 9.1 of this specification or to repeat that particular type test at least three times successfully at his own expenses. In case of failure of the complete string in any type test, the manufacturer whose product has failed in the test shall get the test repeated at his cost. The Supplier whose material has not failed in the test shall be required to supply the requisite quantity of material (that is, insulator discs or hardware fittings as the case may be) required for repeat testing at the place of testing and the cost of supply shall be borne by the Contractor whose material has failed in testing.

6.4.5 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

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

6.4.7 In case of failure in any type test, repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/Owner's

representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative/Inspector does not find material or test facilities to be ready for testing the expenses incurred by the Owner for re-deputation shall be deducted from contract price.

6.4.8 The Contractor shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of testing in India and at least 6 weeks advance in case of testing abroad) of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

6.5 Sample Batch For Type Testing

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

6.5.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner 's representative.

6.6 Schedule of Testing and Additional Tests

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

(a) Submission of drawing for approval.

(b) Submission of Quality Assurance programme for approval.

(c) Offering of material for sample selection for type tests.

(d) Type testing.

6.6.2 The Owner reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Contractor’s premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

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

6.7 Co-ordination for testing

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

DATA SHEET

LINE HARDWARE

(To be furnished by the bidder along with his Bid)

DESIGN AND CONSTRUCTION REQUIREMENTS

Sr.No.	Specification	Specified Value	Quoted Value
1	Type of line hardware		
2	Manufacturer's Drawing No.		
3	Material		
4	Dimensions (mm)		
5	Strength rating (kN)		
6	Thickness/Weight of coating		
7	Quantity required		

DATA SHEET

LINE HARDWARE

(To be furnished by the bidder along with his Bid)

A. ADDITIONAL TECHNICAL INFORMATION OR FEATURES TO BE SPECIFIED BY OWNER

B. ADDITIONAL SUPPLEMENTARY DATA OR FEATURES PROPOSED BY BIDDER/VENDOR/SUPPLIER/CONTRACTOR :

C. OTHER PARTICULARS TO BE FILLED UP BY BIDDER/VENDOR/SUPPLIER/ CONTRACTOR:

	Actual Manufacturer of Material	Vendor/Supplier/ Contractor
Name of Company		
Location and Office Address		
Name and Signature of Authorized Representative with date		

ANNEXURE - A

1.0 Tests on Complete Strings with Hardware Fittings

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona Extinction voltage, line to ground under dry condition shall not be less than following value for different voltage level lines. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results; shall be accordingly corrected with suitable correction factor as stipulated in IEC:60383.

SL. NO.	VOLTAGE LEVEL OF LINE	MINIMUM CORONA EXTINCTION VOLTAGE
1.	400 kV	320 kV line to ground

1.2 RIV Test (Dry)

Under the conditions as specified under (1.1) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS:8263/IEC:437.

1.3 Mechanical Strength Test

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

Notes:

- The total test load must be established gradually at a steady rate.
- Direction of Load

1. following string axis
2. following bisector of string angle.

- The insulator string must be completely unloaded and examined, then the proper direction of loading established before proceeding to the next sequential test.

The insulators string shall be deemed acceptable if, for all test loads except failure load F ,the string components do not show any visual signs of deformation or fracture, and the same components may be disassembled by hand, except for removal of cotter pins and initial loosening of the nuts. The failure load F shall be recorded and must me greater than all previous test loads.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings, with each sub conductor tensioned at 25 % of RTS of the conductor, shall be secured them with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point nearest to the string shall be measured and the same shall not be less than $1000/f^{18}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the following, tests as per relevant standards:-

Sl. No.	Test	Percentage of insulator units to be tested
		Long Rod Insulators
a)	Temperature cycle test followed by mechanical performance test	100

1.5 Assembly Test

This test shall be carried out to ensure that the cotter pins, bolts, clamps etc., fit freely and properly.

2.0 Tests on Hardware Fittings

2.1 Magnetic Power Loss Test for Suspension Assembly

2.1.1 For 400 kV line with Twin ACSR MOOSE conductor, two hollow aluminium tubes of 32 mm diameter shall be placed 457 mm apart. An alternating current over the range of 400 to 800 Amps for shall be passed through each tube. The reading of the wattmeter with and without two suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly. shall be plotted for each value of current. The value of the loss corresponding to 600 amperes shall be read off from the graph.

2.2 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS:2486-(Part-1)-1972 except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

2.3 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ultrasonic test. There shall not be any crack at the welded portion.

2.4 Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

2.5 Proof Load Test

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

2.6 Tests for Forging Casting and Fabricated Hardware

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch.

2.7 Mechanical Strength Test for Hadware fittings without insulators

The complete hardware fitting excluding insulators, arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to

disassemble them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

3.0 Tests

3.1 Test on Spacer Damper

(a) Performance Test

One very important quality of a spacer damper is its ability to control Aeolian vibrations and sub-span oscillations within acceptable limits. Performance testing shall be carried out on an experimental test line as per standard. After testing, there shall not be any slippage greater than 3mm on conductors, loosening of components or damage to conductors or spacer damper components.

i) Aeolian Vibrations

Under the specified operating conditions, the spacer damper shall control Aeolian vibrations in order to prevent damage to conductors either at suspensions clamp or at the spacer damper clamps.

For measurements and evaluation purpose, the following criteria shall apply:

- The peak to peak amplitude of any vibration cycle shall never exceed 1.5 Yb, where Yb is the safe “Bending Amplitude”.
- The RMS value of any vibration measurement sample shall be lower than 0.6 Yb/2, at 89mm from last point of contact with suspension or spacer clamp.

ii) Sub-span Oscillations

The spacer damper system shall control sub-span oscillations in order to prevent conductor damage due to clashing or to severe bending stresses at the spacer damper clamp, and avoid wear of spacer dampers elements.

In order to achieve that performance level, sub-span oscillation shall be controlled within the following limits, for any wind speed below 60 km/hr.

- In any individual sub-span, the peak to peak amplitude of each sub-conductor shall never exceed 350mm.
- In any individual sub-span, the RMS value (Y rms) of each oscillation measurement sample shall be such that:

  $f.Yrms < 80$ mm/sec.

Where

Y (rms) = anti node amplitude (mm)

f = frequency of the oscillation (cycle/sec.)

f = (1/2L) sqrt(T/m)

L = sub-span length (m)

T = Conductor tension (N)

m = conductor mass (kg/m)

For any set of 10 or more measurement samples associated with a given wind sector and a given sub-span, the Y rms value shall be such that:

f. Yrms <70 mm/sec.

The wind sector is defined as a combination of 5 km/hr wind speed range and 10º wind direction range.

Each measurement sample shall be at least one (1) minute long.

(b) Clamp Slip Test

The longitudinal slip strength shall be carried out. The test shall be carried out as per IEC 61854 (Fig 1a). The minimum slip under longitudinal pull varies with clamp type according to the following table.

CLAMP TYPE	**LONGITUDINAL LOAD (kN)**	**MAXIMUM SLIP(mm)**
Metal-Metal bolted	6.5	1
Rubber loaded Clamp using	2.5	2.5
Preformed rods	2.5	12

In order to determine the effect of conductor creep with the spacer dampers only, the conductor shall be re-tensioned to 35 of RBS of the conductor without further tightening the spacer damper clamps and the clamp slip test shall be re-performed. The minimum slip under longitudinal loads shall not be less than 80% of the values given in the above table.

Similar testing shall be performed of the other clamps of the same sample. For spacer dampers only, such clamp slip tests shall also be conducted after each of the

vibration tests mentioned in Clause 3.1 (b) but under longitudinal loading corresponding to 80% of the values given in the above table.

c) Compression and Tensile Tests

Three samples of spacer dampers shall be subjected to a tension compression test. The load shall be applied between each pair of diagonally opposed conductors. Under the compressive load, the arms shall be allowed to rotate until they reach their mechanical stops. A compressive load of 15 kN shall first be applied and held for five minutes. Then a tensile load of 7 kN shall be applied on the same pair of arms. The test shall be repeated on the other pair of arms. After the test, the spacer damper must be dismantled and the components examined. There should not be any failure of components or damage impairing the reusability of the spacer damper such as permanent deformation. The spacer geometry shall be maintained within 5% of the original dimensions.

3.2 Magnetic Power Loss Test for Spacer Damper

The sample involving ferrous parts shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. The test should be carried out at various currents ranging from 400 amperes to 800 amperes for 400 kV line and the magnetic power loss at various currents should be specified in tabulated graphical form. The difference between the power losses without and with sample at room temperature shall be limited to 1 watt for 600 amperes current (rms) for ACSR MOOSE Conductor. The losses shall be determined by averaging the observations obtained from at least four samples.

3.3 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV (rms) line to ground for 400 kV lines under dry condition for 400 kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731.

3.4 Radio Interference Voltage Test (Dry)

Under the conditions as specified under (3.3) above, the sample shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV rms line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS 8263.

3.5 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

4.0 Tests on All components (As applicable)

4.1 Chemical Analysis of Zinc used for Galvanizing

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

4.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The, sampling will be based on heat number and heat treatment batch.

4.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch.

4.4 (a) Movement Test

The spacer assembly shall be capable of the following movements without damaging the conductor, assuming one conductor is fixed and the other moving :

(i)	Longitudinal movement parallel to the conductor	± 50 mm
(ii)	Vertical movement in a vertical direction at right angle to the conductor	± 25 mm
(iii)	Torsional movement/angular movement in a vertical plane parallel to the conductor	± 5 deg.

(b) Hardness test for Elastomer

The shore hardness at different points on the elastomer surface of cushion grip clamp shall be measured by shore hardness meter. They shall lie between 65 to 80.

(c) UTS of Retaining Rods

The ultimate tensile strength of the retaining rods shall be measured. The value shall not be less than 35 kg/sq.mm.

400 KV D/C twin ACSR Moose transmission line from Shujalpur (PGCIL) to RAPP (NPCIL)

EXISTING TOWER SCHEDULE FROM LOCATION 9/10 TO AP-11/0								PROPOSED TOWER SCHEDULE FROM LOCATION 9/10 TO AP-11/0																
Sr.No	Tower No	Type of tower	Angle of Deviation	Span in (M)	Section Length (M)	Easting	Northing	Sr.No	Tower No	Type of tower	Angle of Deviation	Span in (M)	Section Length (M)	Sum of Adj Span (M)	Wind Span (M)	Weight Span (Hot)		Total	Weight Span (Cold)		Total	Easting	Northing	Remarks
																Left	Right		Left	Right				
				408.56								408.56												Cart Track & 11 kv Line
1	9/10	DB+3 (ST)	3°04'16"R			589366	2733191	1	9/10	DB+3 (ST)	3°04'16"R			833.36	416.68	203.65	191.8	395.45	203.4	184.1	387.5	589366	2733191	
				424.8								424.8												2 Nos. of cart Track
2	9/11	DA+6				589683	2732917	2	9/11	DA+6				788.85	394.43	233	198.5	431.5	240.7	204.6	445.3	589683	2732917	
				364.05								364.05												River & Nala
3	9/12	DA+0				589966	2732671	3	9/12	DA+0				679.759	339.88	165.57	152	317.57	159.5	149.9	309.4	589966	2732671	
				315.709								315.709												Road
4	9/13	DA+0				590207	2732465	4	9/13	DA+0				598.539	299	163.69	144.5	308.19	165.9	140.6	306.5	590205.98	2732473.37	Exsiting tower
				309.94								282.83												11kV line crossing
5	9/14	DA+0				590469	2732245	5	9/14	DD+0	40°36'19"R			573.34	287	148	110	258	146	124	270	590421.12	2732289.77	New tower
				380.92								290.51												11kV line crossing
6	AP-10/0	DC+0	15°15'29"R		5808.02	590731	2732025	6	AP-10/0	DC+3	25°35'43"L		2203.979	640.51	320	181	124	305	167	140	307	590466.14	2732002.77	New tower
				397.66								350												Asphalt Road and 11 kV Line crossing
								7	AP-10A/0	DD+9	59°26'14"L		350	599.95	300	227	107	334	210	115	325	590664.44	2731714.36	New tower
												249.95												Proposed expressway Delhi-Mumbai NH-148N
								8	AP-10B/0	DD+9	54°35'27"R		249.95	499.95	250	143	182	325	135	155	290	590913.8	2731731.57	New tower
												250												
7	10/1	DA+0				590964	2731708	9	10/1	DA+3				483.63	141	68	130	198	95	124	219	591072.34	2731538.27	New tower
				399.34								233.63												
8	10/2	DA+3				591203	2731387	10	10/2	DB+3	3°05'51"R			628.15	314	104	193	297	110	195	305	591220.5	2731357.63	New tower
				424.9								394.52												11kV line crossing
9	10/3	DA+3				591454	2731040	11	10/3	DA+3				793.51	397	202	0	202	201	0	201	591453.84	2731039.52	Exsiting tower
				398.99								398.99												Nala
10	10/4	DA+0				591685	2730720	12	10/4	DA+0				789.54	394.77	207.74	166	373.74	210.8	155.2	366	591685	2730720	
				390.55								390.55												
11	10/5	DA+3				591919	2730403	13	10/5	DA+3				764.59	382.3	224.52	173.7	398.22	215.2	168.8	384	591919	2730403	
				374.04								374.04												11 kv Line
12	AP-11/0	DD+0	39°52'58"R		2385.48	592130	2730107	14	AP - 11/0	DD+0	39°52'58"R		2041.73	753.46	376.73	200.29	223.2	423.49	210.8	235.6	446.4	592130	2730107	
				379.42								379.42												2 Nos. of cart Track
				4968.879								**5107.559**												