



VOLUME-II

SECTION – 2.6

**HARDWARE & ACCESSORIES FOR CONDUCTOR,
INSULATOR & EARTH WIRE**



TABLE OF CONTENTS

1.0.0	INTENT OF SPECIFICATION	3
2.0.0	CODES AND STANDARDS	3
3.0.0	TECHNICAL REQUIREMENTS.....	5
4.0.0	PARTICULARS OF HARDWARE FITTINGS	11
5.0.0	GENERAL SPECIFICATIONS	11
6.0.0	BID DRAWINGS.....	12
7.0.0	DIMENSIONS & TOLERANCES:.....	13
8.0.0	IMPORTANT CONDITIONS:.....	13
9.0.0	GALVANISING:.....	14
10.0.0	TESTS	14
11.0.0	TESTING EXPENSES.....	18
12.0.0	TEST REPORTS.....	20
13.0.0	INSPECTION	20
14.0.0	PACKING AND MARKING.....	20
15.0.0	QUALITY ASSURANCE PROGRAM	21
	ANNEXURE-2.6A TESTS ON HARDWARE FITTINGS.....	29
	ANNEXURE-2.6B ACCEPTANCE TESTS	33



SECTION – 2.6

HARDWARE & ACCESSORIES FOR CONDUCTOR, INSULATOR & EARTH WIRE

1.0.0 INTENT OF SPECIFICATION

This section provides the technical details of Hardware fittings & Accessories suitable for Insulator string, Conductor and OPGW for use on 400kV double circuit & multi circuit transmission lines and connectivity to PSS-1, PSS-2 and CTU Khavda-II GSS.

The materials covered here under this specification shall be supplied complete in all respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules.

2.0.0 CODES AND STANDARDS

Unless otherwise specified elsewhere in this specification, the rating as well as performance & testing of the Polymer Insulators shall conform but not limited to the latest revision & amendments available at the time of placement of order of all the relevant standards as listed hereunder, except as modified in this document

Sl. No.	Indian Standard	Title
1	IS:206	Tee and Strap Hinges
2	IS:209	Specification for Zinc
3	IS:1367	Technical supply conditions for threaded fasteners
4	IS:1385	Phosphor Bronze Rods & Bar Sheet and Strips and Wire
5	IS:1570 (part-I)	Schedules for wrought steels for general engineering purposes steel specified by tensile and/or yield properties
6	IS:1573	Electroplated coatings of zinc on iron and steel
7	IS:2002	Steel plates for pressure vessels for intermediate and high temperature
8	IS:2004	Specification for carbon steel forgings the general engineering purposes
9	IS 2062-2011	Specification for steel for general purpose
10	IS:2071	Method of high voltage testing
11	IS:2121 (all parts)	Specification of conductors and earthwire accessories for overhead power lines



Sl. No.	Indian Standard	Title
12	IS:2486 (all parts)	Specification for insulator fittings for overhead powerlines with nominal voltage greater than 1000V
13	IS:2629	Recommended practice for Hot Dip galvanizing of iron & steel
14	IS:2633	Methods of testing uniformity of coating on zinc coated articles
15	IS:3138	Hexagon Bolts and Nuts
16	IS:3188	Characteristic of String Insulators Units
17	IS:4759	Hot Dip Zinc Coatings on Structural Steel and other Allied Products
18	IS: 4826-1979 BS:443-1969	Hot Dip Galvanised Coating on Round Steel Wires
19	IS 6639	Specification for Hexagonal bolts for steel structures
20	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
21	IS:7814-1985	Phosphor Bronze Sheet and Strip
22	IS: 8263	Method of Radio Interference Tests on High Voltage Insulators
23	IS: 9708	Stockbridge Vibration Dampers for Overhead Power lines.
24	IS:10162	Spacers and Spacer Dampers for twin horizontal bundle Conductors.
25	BS:970 (Part-I)	General Instructions and Testing Procedures Specific Requirements for Carbon and Carbon Manganese Alloy and Stainless Steels.
26	IS 2016	Plain Washers method of impulse voltage testing
27	IS 2070	Method of Impulse voltage testing
28	IS 2551	Danger Notice Plates
29	IS 3063 DIN - 127-1970	Single Coil rectangular section spring washer for bolts, Nuts, Screws
30	IS 3138	Hexagonal bolts and Nuts
31	IS 5358 ASTM A 153, CAN/CSA G 164	Hot Dip galvanized coatings on fasteners
32	IS:4218- 1976 ISO:68-1969 R- 26-1963, R-262-	Metric Screw Threads



Sl. No.	Indian Standard	Title
	1969 R-965-1965	
33	IS:6610- 1972	Specification for heavy washers for steel structures

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 GENERAL

- 3.1.1 The Hardware fittings & Accessories shall meet the technical requirement as per standards. Hardware fittings & Accessories shall be suitable for single/double suspension Insulator and single/double tension Insulator strings.
- 3.1.2 Each Hardware fitting shall be supplied complete in all respect and shall include all components, which are required for making complete set.
- 3.1.3 The hardware fittings shall be suitable for use with Composite Long Rod insulators having ball and socket fittings.
- 3.1.4 Corona control rings/grading ring with fittings for attachment to line side yoke plate. Sag adjustment plate for Double tension hardware fittings and turn buckle for single tension hardware fittings. Suspension and dead-end assembly to suit conductor size as detailed in clause 3.5.0& 3.6.0 hereinafter.
- 3.1.5 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.
- 3.1.6 The fittings shall be suitable for attachment to suspension and tension insulator strings along with hardware fittings and shall include 2.5 % extra fasteners, Aluminium filler plugs & retaining rods. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the maximum temperature specified by them for the conductor
- 3.1.7 Composite long rod polymer insulator shall conform to IEC:61109. Composite long rod composite insulator with creepage of 31 mm per kV shall be used for both tension and suspension insulator
- 3.1.8 Insulator shall have shades of “ open aerodynamic profile without any ribs”, with good self cleaning properties. Insulator shed profile, spacing projection etc, shall be strictly in accordance with the recommendation of IEC-60815

3.2.0 INTERCHANGEABILITY

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.

3.3.0 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 Supplier shall be responsible for satisfactory corona and radio interference performance of the materials offered by him.

3.4.0 MAINTENANCE

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.

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. Split pins shall be used with bolts & nuts.

3.5.0 SUSPENSION ASSEMBLY

- 3.5.1 The suspension assembly shall be suitable for the AL59 Moose Conductor with Quad configuration
- 3.5.2 The suspension assembly shall include either free center type suspension clamp along with standard preformed armour rods or armour grip suspension clamp.
- 3.5.3 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.
- 3.5.4 The suspension clamp suitable for various type of Conductor along with standard preformed armour rods/armour grip suspension clamp set shall have slip strength between 20 to 29 KN.
- 3.5.5 The suspension clamp shall be designed for continuous operation at the temperature according to the temp of required conductor.
- 3.5.6 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.
- 3.5.7 The suspension assembly/clamp shall be designed so that it shall minimize 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.

3.5.8 Free Centre Type Suspension Clamp

For the Free Centre 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.

3.5.9 Standard Preformed Armour Rod Set

- 3.5.9.1 The Preformed Armour Rods Set shall be used to minimize 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 localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

- 3.5.9.2 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.
- 3.5.9.3 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.
- 3.5.9.4 The tolerance in length of the rods in complete set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed.
- 3.5.9.5 The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy application on the line.
- 3.5.9.6 The armour rod shall not lose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

3.5.10 Armour Grip Suspension Clamp

The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminium reinforcements and AGS preformed rod set.

Elastomer insert shall be resistant to the effects of temperature up to maximum conductor temperature guaranteed by the bidder corresponding to peak current, 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.

The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavorable stress on the conductor under all operating conditions.

3.6.0 DEAD END ASSEMBLY

- 3.6.1 The dead-end assembly shall be suitable for the AL59 Moose Conductor with Quad configuration.
- 3.6.2 The dead-end assembly shall be of compression type with provision for compressing 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.
- 3.6.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COMPRESS 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. Tapered aluminium filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead end assembly before & after compression along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

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

3.7.0 OTHER HARDWARE FITTINGS

3.7.1 BALL AND SOCKET

The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimensions of the Hardware sets to be used with 120 kN and 160 kN Electro Mechanical strength of Polymeric Insulators shall be of 20mm & 24MM respectively. The Bidder shall offer full detail of locking device in accordance with IS 2486:(Part-III) or equivalent International Standard along with test reports, gauges and adherence to Standards for Tests on Locking Devices in line with IS:2486 (Part-IV) or equivalent International Standard.

3.7.1.1 Ball fittings

Ball fittings shall be made of class IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings. Before galvanization of ball fittings, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the requirements.

3.7.1.2 Socket fittings

Socket fittings shall be made of class IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings.

3.7.1.3 Security clips for socket fittings

Socket fittings shall be provided with R-shaped security clip in accordance with IS:2486 (parts III & IV) to provide positive locking against unintentional disengagement of socket from the ball of the insulator. The security clip shall be humped to maintain the clip in the locked position and shall have both prongs spread to prevent template withdrawal from the socket. The clip end shall not project outside the recess of socket when the clip is in locked position.

The hole for the security clip shall be on the side of the socket opposite to the socket opening. The hole for the clip shall be counter sunk. The clip eye shall be of such design that the same may be engaged by a hotline clip puller to provide for disengagement under energized conditions.

The security clip shall be made of stainless steel of type AISI 302 or 304 or phosphor bronze as per IS:7814.

3.7.2 VIBRATION DAMPER FOR CONDUCTOR AND EARTHWIRE

- A) Vibration dampers of 4 R-Stock bridge type with different resonance spread with in the specified aeolian frequency bandwidth shall be used at all suspension & Tension Points on each span to damp out the aeolian vibrations of the conductors to the specified levels as mentioned here in after

Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span.

- B) The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.
- C) The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 kg/mm². It shall be of pre-formed and post- formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826-1979 for heavily coated wires.
- D) The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.
- E) The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amps at 50 Hz alternating current.
- F) The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall have to be submitted by the Bidder .
- G) The damper placement chart shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents and sample calculations.
- H) The damper placement charts shall include the following:
- a. Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor/earthwire per span.
 - b. Placement distances clearly identifying the extremities between which the distances are to be measured.
 - c. Placement recommendation depending upon type of suspension clamp (viz Free centre type, Armour grip type, etc.)
 - d. The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

3.7.3 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be of rounded that the conductor strands are not damaged during installation. The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve for owner's review. The compression pressure shall also be indicated by the Bidder

3.7.4 YOKE PLATE/LINK PLATE

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength suits to Insulators mentioned in tender document.

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 Composite 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 at least 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder.

The yoke plate/link plate shall be made of steel plate as per IS: 226 or equivalent standards. Shearing/cutting of the plate shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used. It shall be ensured that the grain flow of the yoke plate shall be in the direction of the tensile load.

Holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

3.7.5 ANCHOR SHACKLE

Anchor shackle shall be made of forged steel complete with G.I. rivets and stainless-steel split pin, minimum breaking strength shall be 240KN for double tension string.

3.7.6 BALL CLEVIS, SOCKET CLEVIS

The Ball clevis shall be made of forged steel and socket clevis from malleable cast iron complete with G.I. rivet and stainless-steel split pins. Ball and socket clevis shall be suitable for insulator string for appropriate fitting to which they are connected. All ball and clevis shall be a minimum breaking strength of 120KN.

3.7.7 CLEVIS – CLEVIS

Clevis fittings shall be made of malleable cast iron, complete with G.I. rivet and stainless-steel split pins. Clevis shall be suitable for connecting to yoke plate on sub-station structure side. Minimum breaking strength of the clevis shall be 120KN

3.7.8 TURN BUCKLE

The turn buckle is to be provided with single tension hardware fitting. The threads shall be of sufficient strength to remain unaffected under the specified tensile load.

It shall be made of forged steel. The minimum adjustment in the movement facilitated by the turn buckle shall be 175mm. The minimum breaking strength of the turn buckle shall be 160KN and requisite locking arrangement shall be provided for safe guarding shearing of threads under working conditions. The same shall be specifically indicated in the drawings.

3.7.7 SAG ADJUSTMENT PLATE

The Sag adjustment plate shall be made of steel plate as per IS:226 or equivalent standards. Shearing/cutting of the plate shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used.

Sag adjustment plate for Dead End Assembly having adjustment of upto 150mm minimum at the interval of 6 mm.

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.

Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder

3.7.8 ARCING HORN

400kV Insulator strings for transmission line shall be provided with Arcing Horns of different type at suitable position for each insulator. In case of 400kV Insulator strings, the Arcing Horn shall be provided on both line side & tower side. The dimension of the Arcing Horn shall be as per standard. However, the height of the Arcing Horn may be changed depending upon the length of Socket Eye, Yoke Plate etc. The arrangement for fixing of Arcing Horn shall be such that they do not get loose while in service. To achieve this, they should have proper seat for the Arcing Horn and heat-treated Belleville washers should be provided with the bolts.

4.0.0 PARTICULARS OF HARDWARE FITTINGS

Each Hardware fitting for the transmission line shall be complete in all respect and Bidder should furnish complete drawings and technical particulars of the items of hardware fittings. The Hardware fittings should normally comprise items mentioned below:

4.1.0 SINGLE SUSPENSION V-STRING HARDWARE FITTING

Single suspension Hardware string shall comprise of one Ball Hook, one Socket Eye Horn holder, one-line side Arcing Horn and one Suspension Clamp of AGS type with armour rod suitable for respective sizes of Conductors. The Complete string shall have ultimate breaking strength of not less than 120KN for 400kV.

4.2.0 SINGLE TENSION STRING HARDWARE FITTINGS

Single tension string Hardware shall comprise of one 'D' Shackle, one Ball Link, one Forged Steel Socket, Socket Clevis Horn holder, Arcing Horn and one TensionClamp of compression type. The Complete string shall have ultimate breaking strength of not less than 160KN for 400kV line.

4.3.0 DOUBLE TENSION STRING HARDWARE FITTINGS

The double tension string Hardware shall comprise of two 'D' shackle, one chain link one top yoke plate, two ball clevis, two socket clevis, one bottom yoke plate, Arcing horn, one clevis and a compression type dead-end Clamp. The Complete string shall have ultimate breaking strength of not less than 240KN (2 x 120KN) for 400kV line.

5.0.0 GENERAL SPECIFICATIONS

5.1.0 All the materials shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The manufacturer shall supply only such material as guaranteed by him to be satisfactory and suitable for 400kV Transmission lines.

5.2.0 The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

5.3.0 All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts

may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanised. The bolts threads shall be undercut to take care of increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS:2629-1990 or equivalent International Standard and satisfy the tests mentioned in IS:2633- 1992 or equivalent International Standard. Fasteners shall withstand four dips while spring washers shall be guaranteed to withstand at least six dips each lasting one minute under the standard preece test for galvanizing. Galvanization shall be of 910 gm/m² (minimum 126 micron at any point, averaging is not permitted)

- 5.4.0 The Zinc coating shall be perfectly adhere, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky while deposits and blisters. The Zinc used for galvanizing shall be grade Zn. 99.95 as per IS: 209-1992 or equivalent International Standard.
- 5.5.0 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blowholes, cracks etc.
- 5.6.0 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.
- 5.7.0 No item which would produce high electrical and mechanical stresses in normal working shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the Conductor in any way during erection or during continuous operation. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and no maintain good electrical contact under service conditions.
- 5.8.0 Particular care shall be taken during manufacturing and subsequent handling to ensure smooth surface free from abrasion or dents.
- 5.9.0 The fasteners shall conform to the requirement of IS: 6639-1972 or equivalent International Standard. All fasteners and clamps shall have locking arrangements to guard against vibration loosening.

6.0.0 BID DRAWINGS

- 6.1.0 The Bidder shall furnish full description and illustrations of materials offered.
- 6.2.0 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 4.8.8 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.

6.3.0 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

- (i) Dimensions and dimensional tolerance.
- (ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
- (iii) Catalogue No.
- (iv) Marking
- (v) Weight of assembly
- (vi) Installation instructions
- (vii) Design installation torque for the bolt or cap screw.
- (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.
- (ix) The compression die number with recommended compression pressure.
- (x) All other relevant terminal details.

6.4.0 After placement of award, the Contractor/Manufacturer shall submit fully dimensioned drawing including all the components in three (3) copies to the GIPCL for approval. After getting approval from the GIPCL and successful completion of all the type tests, the Contractor/Manufacturer shall submit three (03) more copies of the same drawings to the GIPCL for further distribution and field use at GIPCL's end.

7.0.0 DIMENSIONS & TOLERANCES:

- 7.1.0 The dimensions and tolerances of pin balls and socket ends shall conform to IS 2486 Part-II/IEC-120 and shall be checked by the gauge therein after galvanizing.
- 7.2.0 The 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 deg. to this line. "NO GO" gauges shall not pass in any direction.
- 7.3.0 The bearing surfaces of balls and machined sockets, before galvanizing shall not have surface roughness more than 250 micro inches.
- 7.4.0 The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contour of the socket ends shall be concentric with the axis of fittings. The axis of the bearing surface of socket ends shall be coaxial with the axis of fittings with no appreciable tilting.

8.0.0 IMPORTANT CONDITIONS:

- 8.1.0 All Hardware items shall be complete with minor items such as security clip, bolts, nuts,

washer, split pins and inners etc.

- 8.2.0 The Contractor shall be responsible for satisfying him that the Insulator fittings offered are entirely suitable for the proposed attachments and for the sizes of the Conductor specified.
- 8.3.0 All ferrous fittings (except those specified otherwise) shall be hot dip galvanized (C5-M specs, 910 g/m², minimum 126 micron at any point, averaging is not permitted.), after all machining and fitting has been completed, in accordance with relevant Indian Standard. All Hardware items (other than clamps) and those specified otherwise should be made of Drop Forged Steel. Socket items in forged steel must be forged. All forgings supplied should be stress relieved and this treatment should be done at the Contractor works. Forgings, which are not stress relieved, will not be acceptable. The items like Yoke Plate, Arcing Horn, Bolts and Nuts shall be of mild steel and rest of the items shall be of forged steel.
- 8.4.0 All Bolts, Nuts and Screw heads shall have only wide worth standard thread and of sizes indicated in the enclosed drawing. Bolts head and Nuts shall be hexagonal. Where required, nuts shall be locked in approved manner. The thread in Nuts shall be over tapped after galvanizing and shall be cut before galvanizing. The threads shall not be undercut. The Nuts should be tapped such that they are fit on the bolt threads i.e. these should not have loose fitting.

8.5.0 Compression Markings

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NONCOMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

9.0.0 GALVANISING:

- 9.1.0 Hot dip galvanizing shall conform to Indian Standard specification IS-2633 or equivalent International Standard.
- 9.2.0 Galvanizing shall be uniform, free from blisters, and shall not peel off due to abrasion, Zinc coating shall be thick enough to withstand 6 one minute dips in Copper Sulphate solution (preece test) for all ferrous parts except for threaded portions which shall withstand at least 4 one minute dips.
- 9.3.0 The Contractor must emboss/engrave their name in each forged steel item and Aluminium castings such as Ball Hook, Yoke Plate, Socket Clevis, Clevis Eye, Clevis-Clevis, Anchor Shackle/D-Shackle, Chain Link, Suspension Clamps of AGS type, Tension Clamps and Arcing Horns.
- 9.4.0 Being High Saline zone with minimum zinc deposition of 910 g/m² (minimum 126 microns at any point of the structure, averaging shall not be allowed).

10.0.0 TESTS

- 10.1.0 All the specified type tests on Hardware Fittings and Accessories for AL-59 Conductors offered by the bidder shall not be required to be carried out if valid test certificate is

available (Validity as per CEA guidelines) from an accredited laboratory or witnessed by the representative (s) of a Utility.

- 10.2.0 In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process 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 / extension of completion period to the GIPCL. The hardware fittings offered shall be type tested as per the relevant standards. Further the acceptance, routine tests and tests during manufacture shall be carried out on the conductor.
- 10.3.0 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 purpose of acceptance of that lot.
- 10.4.0 Routine tests shall mean those tests which are to be carried out on each and every product so as to check with requirements which are likely to vary during production.
- 10.5.0 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.
- 10.6.0 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 GIPCL. However, CEA MQAP guidelines are minimum requirement.
- 10.7.0 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Contractor in the "Technical Questionnaire" or the acceptance value specified in this specification, whichever is more stringent for that particular test. QAP and test (Type test, routine test etc) shall be verified with MQAP of CEA

10.8.0 Type Tests (Type tests should have been completed during last five years)

10.8.1 On Suspension Clamp

- | | | |
|---------------------------------------|---|----------------------|
| a) Magnetic power loss test | : | As per Annexure-2.6A |
| b) Clamp slip strength Vs torque test | : | As per Annexure-2.6A |
| c) Ozone Test on elastomer | : | As per Annexure-2.6A |

10.8.2 On Dead End Tension Assembly

- | | | |
|---|---|--------------------------|
| a) Electrical resistance test for dead end Assembly | : | As per IS:2486- (Part-I) |
| b) Heating cycle test for dead end Assembly | : | As per IS:2486-(Part-I) |
| c) Slip strength test for dead end assembly | : | As per IS:2486-(Part-I) |
| d) Ageing test on filler (if applicable) | : | As per Annexure-2.6A |

10.8.3 Mid Span Compression Joint for Conductor

- | | | |
|---|---|--------------------------|
| a) Chemical analysis of materials | : | As per Annexure-2.6A |
| b) Electrical resistance test | : | As per IS: 2121(Part-II) |
| c) Heating cycle test | : | As per IS: 2121(Part-II) |
| d) Slip strength test | : | As per Annexure-2.6A |
| e) Corona extinction voltage test (dry) | : | As per Annexure-2.6A |

- f) Radio interference voltage test (dry) : As per Annexure-2.6A

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

10.8.4 Repair Sleeve for Conductor

- a) Chemical analysis of materials : As per Annexure-2.6A
b) Corona extinction voltage test (dry) : As per Annexure-2.6A
c) Radio interference voltage test (dry) : As per Annexure-2.6A

10.8.5 Connector for Conductor

- a) Chemical analysis of materials : As per Annexure-2.6A
b) Electrical resistance test : As per IS: 2121 (Part-II)
Clause 6.5 & 6.6
c) Heating cycle test : As per IS: 2121 (Part-II)
d) Axial tensile load test on welded portion : As per Annexure-2.6A
e) Corona extinction voltage test (dry) : As per Annexure-2.6A
f) Radio interference voltage test (dry) : As per Annexure-2.6A

10.8.6 Vibration Damper for Conductor

- a) Chemical analysis of materials : As per Annexure-2.6A
b) Dynamic characteristics test* : As per Annexure-2.6A
c) Vibration analysis : As per Annexure-2.6A
d) Clamp slip test : As per Annexure-2.6A
e) Fatigue tests : As per Annexure-2.6A
f) Magnetic power loss test : As per Annexure-2.6A
g) Corona extinction voltage test (dry) : As per Annexure-2.6A
h) Radio interference voltage test (dry) : As per Annexure-2.6A
i) Damper efficiency test : As per IS: 9708

* Applicable for 4 R stock bridge dampers. For alternate type of vibration dampers (permitted as per clause 2.5.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/carried out by the supplier.

10.8.7 Acceptance Tests

On Both Suspension Clamp and Tension Assembly

- a) Visual Examination : As per IS: 2486-(Part-I)
b) Verification of dimensions : As per IS: 2486-(Part-I)
c) Galvanising/Electroplating test : As per IS: 2486-(Part-I)
d) Mechanical strength test of each component: As per Annexure-2.6A
e) Mechanical Strength test of welded joint : As per Annexure-2.6A f)



- Mechanical strength test for corona control ring/ grading ring and arcing horn : BS:3288 - (Part-I)
- g) Test on locking device for ball and socket coupling : As per IEC:372 (2)
- h) Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings : As per Annexure-2.6A

On Suspension Clamp only

- a) Clamp Slip Strength Vs Torque test for suspension clamp : As per Annexure-2.6A
- b) Shore hardness test of elastomer cushion for AG suspension clamp : As per Annexure-2.6A
- c) Bend test for armour rod set : As per IS: 2121(Part-I), Clause 7.5,7,10 &7.11
- d) Resilience test for armour rod set : As per IS: 2121(Part-I), Clause 7.5,7,10 & 7.11
- e) Conductivity test for armour rods set : As per IS: 2121(Part-I), Clause 7.5,7,10 & 7.11

On Tension Hardware Fittings only

- a) Slip strength test for dead end assembly : As per IS: 2486 (Part-I) Clause 5.4
- b) Ageing test on filler (if applicable) : As per Annexure-2.6A

On Mid Span Compression Joint for Conductor & Earth wire

- a) Visual examination and dimensional verification: As per IS: 2121 (Part-II), Clause 6.2, 6.3 & 6.7
- b) Galvanizing test : As per Annexure-2.6A
- c) Hardness test : As per Annexure-2.6A
- d) Ageing test on filler (if applicable) : As per Annexure-2.6A

Connector for Conductor

- a) Visual examination and dimensional verification: As per IS:2121 (Part-II)
- b) Axial tensile load test for welded portion : As per Annexure-2.6A

Repair Sleeve for Conductor

- a) Visual examination and dimensional verification: As per IS:2121(Part-II) Clause 6.2, 6.3

Vibration Damper for Conductor



- a) Visual examination and dimensional verification: As per IS: 2121(Part-II)
Clause 6.2, 6.3 7 6.7
- b) Galvanizing test : As per Annexure-2.6A
- i) On damper masses: As per Annexure-2.6A
- ii) On messenger cable : As per Annexure-2.6A
- c) Verification of resonance frequencies : As per Annexure-2.6A
- d) Clamp slip test : As per Annexure-2.6A
- e) Clamp bolt torque test : As per Annexure-2.6A
- f) Strength of the messenger cable : As per Annexure-2.6A
- g) Mass pull off test : As per Annexure-2.6A
- h) Dynamic characteristics test* : As per Annexure-2.6A
- i)

* Applicable for 4R Stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 2.5.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/ carried out by the supplier.

Routine Tests

For Hardware Fittings

- a) Visual examination : IS:2486-(Part-I)
- b) Proof Load Test : As per Annexure-2.6A

For Conductor

- a) Visual examination and dimensional verification : As per IS: 2121(Part-II)
Clause 6.2, 6.3 7 6.7

Tests During Manufacture on all components as applicable

- a) Chemical analysis of Zinc used for galvanizing: IS:2486-(Part-I)
- b) Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings : As per Annexure-2.6A
- c) Chemical analysis, hardness tests and magnetic particle inspection for forging : As per Annexure-2.6A

11.0.0 TESTING EXPENSES

- 11.1.0 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 11 of this specification or to repeat that particular type test at least three times successfully at his own expenses.



- 11.2.0 In case of type test on the complete insulator string, the Contractor/Manufacturer has to arrange similar insulators at his own cost.
- 11.3.0 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.
- 11.4.0 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.
- 11.5.0 In case of failure in any type test, repeat type tests are required to be conducted; then, all the expenses for deputation of Inspector/GIPCL's representative shall be deducted from the contract price. Also if on receipt of the Contractor/Manufacturer's notice of testing, the GIPCL's representative/Inspector does not find 'plant' to be ready for testing the expenses incurred by the GIPCL for re-deputation shall be deducted from contract price.

- 11.6.0 The Contractor/Manufacturer shall intimate the GIPCL about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of Domestic Contractor/Manufacturer and at least 6 weeks advance in case of Foreign Contractor/Manufacturer) of the scheduled date of testing during which the GIPCL will arrange to depute his representative to be present at the time of carrying out the tests.

11.7.0 Sample Batch For Type Testing

The Contractor/Manufacturer shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the GIPCL. The Contractor/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 GIPCL.

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

11.8.0 Schedule of Testing and Additional Tests

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.

The GIPCL reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Manufacturer'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 complies with the specifications.

The GIPCL 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 Manufacturer's premises or at any other test center. In case of evidence of noncompliance, it shall be binding on the part of Contractor/Manufacturer 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 GIPCL.

12.0.0 TEST REPORTS

- 12.1.0 Copies of type test reports shall be furnished in at least six copies along with one original. One copy shall be returned duly certified by the GIPCL, only after which the commercial production of the concerned material shall start.
- 12.2.0 Copies of acceptance test report shall be furnished in at least six copies. One copy shall be returned, duly certified by the GIPCL, only after which the materials will be dispatched.
- 12.3.0 Record of routine test report shall be maintained by the Manufacturer at his works for periodic inspection by the GIPCL's representative.
- 12.4.0 Test certificates of tests during manufacture shall be maintained by the Manufacturer. These shall be produced for verification as and when desired by the GIPCL.

13.0.0 INSPECTION

- 13.1.0 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured, and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub- Contractor's works raw materials. Manufacturers of all the material and for conducting necessary tests as detailed herein.
- 13.2.0 The material for final inspection shall be offered by the Contractor only under packed condition. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.
- 13.3.0 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.
- 13.4.0 Material shall not 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 all tests specified herein have been satisfactorily completed.
- 13.5.0 The acceptance of any quantity of material shall in no way relieve the Contractor 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.

14.0.0 PACKING AND MARKING

- 14.1.0 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.
- 14.2.0 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 14.3.0 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 14.4.0 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.
- 14.5.0 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer



and year of manufacture.

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

14.7.0 Each consignment shall be accompanied by a detailed packing list showing following details:

-

- (i) The name of the consignees
- (ii) Details of consignment.
- (iii) Destination.
- (iv) Total weight of consignment.
- (v) Handling and unpacking instrumentation.
- (vi) Bill of material indicating content of each package.

15.0.0 QUALITY ASSURANCE PROGRAM

The contractor shall submit the Quality Assurance Programme. A copy of the accepted Quality Assurance Plan must be available at the manufacturer's works of the Plant for reviewing by inspecting officer of the GIPCL.

(The following sets of GTP are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. Bidder shall submit comprehensive GTP during the detailed engineering along with the relevant technical brochures and drawings. The bidder shall fill in the guaranteed technical particulars in the Proforma given in this section and submit the same with his tender, without which bid will not be considered.)

SCHEDULE-1			
GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS			
Sl. No.	Description	Unit	Value guaranteed by the Bidder
1	Name & address of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed	Yes/No	



SCHEDULE-1			
GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS			
4	Maximum magnetic power loss of suspension clamp at conductor /sub conductor current of ---- amperes (at steady state conductor temperature)	Watt	
5	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	
6	Particulars of standard/AGS Standard / AGS preformed armourrod set for suspension assembly a) No. of rods per set b) Direction of lay c) Overall length after fitting on conductor d) Actual length of each rod along its helix e) Diameter of each rod f) Tolerance in i.Length of each rod ii.Diameter of each rod iii.Difference of length between the longest and shortest rod in a set g) Type of Aluminium alloy used for manufacture of PARod set h) UTS of each rod	No Mm ±mm ±mm ±mm Kg/mm ²	
7	Particulars of Elastomer (For AGS Clamp only)		
	a) Supplier of elastomer		
	b) Type of elastomer		
	c) Shore hardness of elastomer		
	d) Temperature range for which elastomer is Designed		
	e) Moulded on insert	Yes/No	
8	UTS of suspension clamp	Yes/No	
9	Purity of Zinc used for galvanising	%	
10	Maximum permissible continuous operating temperature of		
	i) Clamp body		



SCHEDULE-1			
GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS			
	ii) Standard/AGS preformed rods		

SCHEDULE-2				
GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS				
Sl.	Description	Unit	Value guaranteed by the Bidder	
1	Name of Manufacturer			
2	Address of Manufacturer			
3	Drawing enclosed		Yes / No	
4	Purity of aluminium used for aluminium sleeve	%		
			Aluminium/ Alloy	Steel
5	Outside diameter of sleeve before compression	mm		
6	Inside diameter of sleeve before compression	mm		
7	Length of sleeve before compression			
9	Dimensions of sleeve after compression			
	(a) Corner to Corner			
	(b) Surface to Surface			
10	Length of sleeve after compression			
11	Weight of sleeve			
	(a) Aluminium / Aluminium Alloy	kg		
	(b) Steel	kg		
	(c) Total	kg		

SCHEDULE-2			
GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS			
12	Electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	
13	Slip strength of dead end assembly	kN	
14	UTS of dead end assembly	kN	
15	Design calculation of yoke plates and sag adjustment plate enclosed.		Yes / No
16	Maximum permissible continuous operating temperature of dead end assembly		

SCHEDULE -3			
GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR AL59 MOOSE CONDUCTOR			
Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed	Yes / No	
4	Suitable for conductor size	mm	
5	Purity of aluminium used for aluminium sleeve	%	
6	Material for steel sleeve		
	(i) Type of material with chemical composition		
	(ii) Range of Hardness of material (Brinell Hardness)	BHN	Fromto
	(iii) Weight of zinc coating	gm/m ²	
			Aluminium/alloy
7	Outside diameter of sleeve before compression	mm	
8	Inside diameter of sleeve before compression	mm	



SCHEDULE -3			
GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR AL59 MOOSE CONDUCTOR			
9	Length of sleeve before compression		
10	Dimensions of sleeve after compression		
	(a) Corner to Corner		
	(b) Surface to Surface		
11	Length of sleeve after compression		
12	Weight of sleeve		
	(a) Aluminium	kg	
	(b) Steel	kg	
	(c) Total	kg	
13	Slip strength	kN	
14	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	
15	Maximum permissible continuous operating temperature of mid span compression joint	Deg. C	



SCHEDULE -4			
GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR AL59 MOOSE CONDUCTOR			
Sl.	Description	Unit	Particulars/ Value
1.	Material		
2.	Dimension of Aluminum sleeve <u>Before compression</u>		
	i) Inside diameter	mm	
	ii) Outside diameter	mm	
	iii) Length	mm	
3.	Dimensions of Aluminum Sleeve <u>After compression</u>		
	i) Outside dimension (Corner to corner)	mm	
	ii) Outside dimension (face to face)	mm	
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	MicroVolts (□V)	



SCHEDULE - 5			
GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR AL59 MOOSE CONDUCTOR			
Sl.	Description	Unit	Value guaranteed by the Bidder
1	Name of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed		
	(a) Design Drawing	YES / NO	
	(b) Placement Chart	YES / NO	
4	Suitable for conductor size		
5	Total weight of one damper		
			Right
6	Diameter of each damper mass	mm	
7	Length of each damper mass	mm	
8	Weight of each damper mass	kg	
9	Material of damper masses		
10	Material of clamp		
11	Material of the stranded messenger cable		
12	Number of strands in stranded messenger cable		
13	Lay ratio of stranded messenger cable		
14	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm ²	
15	Slip strength of stranded messenger cable (mass pull off)	kN	
16	Resonance frequencies		
	(a) First frequency	Hz	
	(b) Second frequency	Hz	
17	Designed clamping torque	Kg-m	



18	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	
	(b) After fatigue test	kN	
19	Magnetic power loss per vibration damper watts for -- -Amps, 50 Hz Alternating Current[average continuous operating current]	watts	
20	Maximum permissible continuous operating temperature of Vibration Damper	Deg. C	
21	Percentage variation in reactance after fatigue test in comparison with that. before fatigue Test	%	
22	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	

ANNEXURE – 2.6A
TESTS ON HARDWARE FITTINGS

1.1 Magnetic Power Loss Test for Suspension Assembly

Two hollow aluminium tubes of 32 mm diameter for the conductor shall be placed 450 mm apart respectively. An alternating current over the range of 1500 to 2000 amps shall be passed through each tube. The reading of the wattmeter with and without 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 2456 amperes per phase shall be read off from the graph and the same shall not be more than the value guaranteed by the supplier.

1.2 Mechanical Strength Test of Each Component

Each component shall be subjected to a load equal to 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. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached, and the value recorded.

1.3 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.

1.4 Mechanical Strength Test for Suspension/Tension Hardware Fittings

The complete string without insulators excluding arcing horn, corona control rings/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. This load shall be held for five minutes and then removed. After removal of the load, the string component 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 is reached and held for the 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.

1.5 Clamp Slip Strength vs. Torque Test for Suspension Clamp

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only, clamp slip strength after assembly shall be found out. The clamp

slip strength at the recommended tightening torque shall be more than 20 KN but less than 29 KN.

1.6 Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2486 (Part-I) with following modifications: -

- i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.
- ii) Number of cycle: 100 Slip strength tests shall also be carried out after heating cycle test.

1.7 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.

1.8 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.

1.9 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. The details regarding test will be as in the Quality Assurance programme.

1.10 Ozone Test for Elastomer

This test shall be performed in accordance with ASTM D-1171 by the Ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test completion, there shall be no visible crack under a 2 x magnification.

2. TESTS ON ACCESSORIES FOR CONDUCTOR

2.1 Mid Span Compression Joint for Conductor

(a) Slip Strength Test: The fitting compressed on conductor shall not be less than one meter in length. The test shall be carried out as per IS:2121 (Part-ii)-1981 clause 6-4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earth wire and retained for one minute at this load. There shall be no movement of the conductor/ earth wire relative to the fittings and no failure of the fittings during this one minute period.

2.2 Connector for Conductor

Axial Tensile Load Test for Welded Portion: - The sleeve portion of the T-Connector shall be compressed on conductor. The compressed portion shall be held rigidly on some fixtures and axial load shall be applied along with the jumper terminal the load shall be increased gradually till breaking of welded joint occurs. The breaking load should be above 30 KN.

2.3 Vibration damper for conductor

Clamp Slip and Fatigue Tests

- (i) **Test Set Up:** The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 0 deg & no wind condition and ruling span 400 from sag – tension calculation and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.
- (ii) **Clamp Slip test:** The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 KN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 KN.

2.4 Mechanical Strength Test for Earth wire Suspension/Tension Clamp

- (a) The suspension assembly/tension assembly (excluding tension clamp) 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. This load shall be held for five minutes and then removed. After removal of the load, the components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to loosen the nuts initially. The assembly 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 is reached 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.
- (b) **Clamp Slip Strength Vs Torque Test for Suspension Assembly:** The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Earth wire shall be fixed in the clamps. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the earth wire. The clamp slip strength Vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be as per the values stipulated in the Standard Technical Particulars.
- (c) **Slip Strength Test of Tension Clamp:** Tension clamps shall be compressed on a 5 m length of earth wire on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load of 50% of the specified breaking load of the earth wire shall be applied &

the sample shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the specified breaking load and maintained for one minute. There shall be no movement of the earth wire relative to the fitting during this one minute period and no failure of the fitting also.

- (d) **Electrical Resistance Test of Tension Clamp:** The tension clamp and the jumpers shall be compressed on two suitable lengths of earth wire. The electrical resistance shall be measured between points on earth wire near the clamp and near the jumper mouth keeping 25 mm clearance of the fitting and should not exceed 75% of the measured resistance of equivalent length of earth wire. The test shall be conducted with direct current. The current connections shall be at a distance not less than 50 times the diameter of earth wire from the fitting and shall be made so that effective contact is ensured with all those strands of the earth wire which would be taken into account in calculating its equivalent resistance. The test shall be repeated with the polarity reversed and the average of the two results considered as the measured value.

2.5 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.

3. 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 Contractor 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 Contractor and Owner in Quality Assurance Programme.



ANNEXURE-2.6 B
ACCEPTANCE TESTS

1 Mid Span Compression Joint for Conductor

Hardness Test: - The Brinell hardness at various points on the sleeve of conductor core and tension clamp shall be measured.

2 Connector for Conductor

Axial Tensile Load Test for Welded Portion: - Same as clause 2.2 of Annexure – 2.6A

3 Vibration Damper for Conductor

- a) Verification of Resonance Frequencies: - The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of ± 0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.
- b) Clamp Slip Test: - Same as Clause 2.3 (ii) of Annexure – 2.6A.
- c) Clamp Bolt Torque Test: - The clamp shall be attached to a section of the conductor/earth wire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.4 (c), Annexure-2.6A.
- d) Strength of the Messenger Cable: - The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor
- e) Mass Pull off Test: - Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.