SECTION-VI A

HARDWARE FITTINGS & ACCESSORIES FOR CONDUCTOR & EARTHWIRE

(Applicable for all hardware fittings and accessories for conductor and earthwire of transmission line with all type of conductors except Suspension clamp, dead end clamp and accessories for HTLS conductor)

TECHNICAL SPECIFICATIONS

SECTION-VI A

HARDWARE FITTINGS & ACCESSORIES FOR CONDUCTOR & EARTHWIRE

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TECHNICAL SPECIFICATIONS

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CONTENTS

Clause	Description	Page No.
1.0	Technical Description of Hardware Fitting	1
2.0	Technical Description of Accessories for Conductor	14
3.0	Technical Description of Accessories for GS Earthwire	26
4.0	Type Tests & Standards	30
Annexure-A	Type Test Procedures	49
Annexure-B	Standard Technical Particulars of Hardware Fittings and Accessories for Conductor & Earthwire	78
Annexure-C	Typical Placement Chart for spacer Damper	132

TECHNICAL SPECIFICATIONS

SECTION- VI A

HARDWARE FITTINGS &

ACCESSORIES FOR CONDUCTOR & EARTHWIRE

1.0 Technical Description of Hardware Fittings

1.1 Details of Hardware Fittings

1.1.1 The hardware fittings shall be suitable for use with disc insulators, porcelain longrod insulators and composite long rod insulators having ball and socket fittings.

For hardware fittings for transmission line upto 765kV voltage level (including ±320kV HVDC, ±500 kV HVDC, ±800 kV HVDC and special fittings for coastal areas), the suppliers may develop hardware components in line with the standard drawings enclosed with the section of drawings of the specification and submit their drawing for approval of POWERGRID prior to testing and manufacturing.

Standard lengths of insulators have been considered in the above specification drawings for indicative purpose only. The actual length of insulator string shall be based on the insulators being supplied for the package.

Alternatively, Supplier can also offer other suitable hardware designs meeting the requirements of Technical Specification and length & general arrangement of Hardware strings specified in the standard hardware drawings for various transmission lines enclosed in the drawing section. However, for Jumper pad of dead-end clamps for 220 KV & above voltage level lines, bolting arrangement in line with 'Dead End Assembly jumper bolting arrangement' drawing enclosed with the drawing section shall be provided.Design calculations i.e. bearing, shear and tensile strength etc. of the components shall be furnished by the Contractor. Proper fitment of Hardware Fittings with towers shall be ensured by the contractor.

Employer may accept hardware components having better performance such as higher mechanical strength at no extra cost to POWERGRID.

1.1.2 Each hardware fitting shall be supplied complete in all respects and shall include the following hardware parts:

1.1.2.1 Suitable arcing horn as specified in clause 1.8 hereinafter.

1.1.2.2 Suitable yoke plates complying with the specifications given hereinafter.

1.1.2.3 Corona control rings/ grading ring with fittings for attachment to line side yoke plate.

1.1.2.4 Sag adjustment plate for double/ triple/ quad tension hardware fittings and turn buckle for single tension hardware fittings.

1.1.2.5 Suspension and dead-end assembly to suit conductor type and size as covered in the scope.

1.1.2.6 Provisions for attaching balancing weights on the line side yoke plate of single suspension pilot hardware fittings.

1.1.2.7 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.

1.1.3 For owner supplied fittings 2.5% extra fasteners (excluding factory fitted fasteners) & retaining rods shall be provided to the Contractor to take care of losses during erection. No payment shall be admissible for these extra supplies. For fittings included in the scope of the Contractor, the contractor is permitted to get inspected and supply upto 2.5% extra fasteners & retaining rods to take care of losses during erection. No payment shall be admissible for these extra supplies.

1.2 **Dimensions of Insulator String Along with Hardware Fitting**

The various limiting dimensions of the insulator strings along with hardware fittings shall be as per the specification drawings enclosed at section of drawings of this specification.

1.2.1 For every set of tension hardware fitting for quad/ hexa bundle conductor configuration one no. 250 mm rigid spacer suitable for twin conductor shall also be provided to ensure that there is no fouling of conductors or any component of the fittings while bringing down top two conductors through bottom two conductors of quad/ hexa bundle, at the jumper location.

1.3 **Interchangeability**

1.3.1 The hardware for insulator strings with disc insulators/ porcelain long rod/ composite long rod insulators together with ball and socket fittings shall be of standard design, so that this hardware is inter-changeable with each other and suitable for use with insulators of any make conforming to relevant Standard.

1.4 **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.

1.5 **Maintenance**

1.5.1 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.

1.5.2 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.

1.6 **Designation**

1.6.1 **Ball and Socket Designation**

The dimensions of the ball and socket are furnished in the Standard Technical Particulars enclosed with this section of the specification. The designation should be in accordance with the standard dimensions stated in IS 2486 (Part-II). The dimensions shall be checked by the appropriate gauge after galvanising only.

1.7 **Security Clips and Split Pins**

1.7.1 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). 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

1.7.2 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).

1.7.3 Split pins shall be used with bolts & nuts.

1.8 **Arcing Horn/Intermediate Arcing Horn**

1.8.1 The arcing horn/ Intermediate Arcing Horn shall be either ball ended rod type or tubular type**,** based on the drawings enclosed with the specifications.

1.8.2 The arcing horn shall be provided as shown in the drawing of the hardware fittings, enclosed in this specification.

1.8.3 The air gap shall be so adjusted to ensure effective operation under actual field conditions.

1.9 **Yoke Plates**

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.

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 maintenance holes and 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 contractor. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS 800.

1.10 **Corona Control Rings/ Grading Ring**

1.10.1 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-disc insulator/ equivalent length in insulator strings. It shall also improve corona and radio interference performance of the complete insulator string along with hardware fittings.

1.10.2 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.

1.10.3 The Corona control rings/ grading ring should have a smooth finish. No blemish should be seen or felt when rubbing a hand over the metal.

1.10.4 The limiting dimensions of corona control ring/ grading ring shall be as per the specification drawings.

1.10.5 The grading ring shall be of open type design with a gap of 125 mm for voltage up to 765 kV AC lines and 150 mm for $\pm$500 kV & $\pm$800 kV HVDC lines. The open ends shall be suitably terminated. The outside diameter of the tube of corona control rings/ grading ring shall be minimum 75 mm for voltage above 400 kV

and minimum 60 mm for 400 kV and below voltage lines. The ends of grading ring tube shall be sealed with welded aluminium cap duly buffed.

1.11 **Sag Adjustment Plate**

1.11.1 The sag-adjustment plate to be provided with the double/ triple/ quadruple/ 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.

1.11.2 The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 330 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.

1.11.3 Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by Contractor. The hole provided for bolts should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS 800.

1.12 **Turn Buckle**

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

1.12.2 The maximum length of the turn buckle from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing. An adjustment of 150 mm minimum shall be possible with turn buckle.

1.13 **Suspension Assembly**

1.13.1 The suspension assembly shall be suitable for the specific Conductor type and size as covered in the scope.

1.13.2 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.

1.13.3 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.

1.13.4 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.

1.13.5 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.

1.13.6 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.

1.13.7 The magnetic power loss shall not be more than that stipulated in the Standard Technical Particulars.

1.13.8 **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.

1.13.9 **Standard Preformed Armour Rod Set**

1.13.9.1 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.

1.13.9.2 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.

1.13.9.3 The pitch length of the rods shall be determined by the Contractor 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.

1.13.9.4 The length of each rod along with permissible tolerances shall be as stipulated in the Standard Technical Particulars. The ends of armour rods should be ball ended for voltage upto 220kV and parrot billed for voltage above 220kV.

1.13.9.5 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.

1.13.9.6 The armour rod shall not loose their resilience even after five applications.

1.13.9.7 The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS) & Minimum tensile strength shall not be less than 35kg/mm^2.

1.13.10 **Armour Grip Suspension Clamp**

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

1.13.10.2 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.

1.13.10.3 The AGS preformed rod set shall be as detailed in the relevant clause of the specifications. The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as specified in the Standard Technical Particulars 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.

1.14 **Envelope Type Suspension Clamp**

1.14.1 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.

1.15 **Dead end Assembly**

1.15.1 The dead-end assembly shall be suitable for specific Conductor.

1.15.2 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.

1.15.3 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. 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.

1.15.4 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.

1.16 **Balancing Weights**

For holding the single suspension pilot insulator string used for jumper connections at transposition towers or when used with Composite Insulators, from excessive deflection, suitable balancing weights, weighing 200 kg (25x8) for 400kV and above voltage lines and 100 kg (25kg x 4) for 220kVshall be provided.

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

1.17.1 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.

1.17.2 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.

1.17.3 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.

1.17.4 Fully threaded bolts shall not be used for parts/ components requiring shear/ tensile strength. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts. Bolts & Nuts

for these parts/ components shall be of minimum 5.6 grade conforming to IS 1367 or equivalent International standards.

1.17.4.1 For parts/ components requiring grip strength viz. arcing horn, corona rings & dead-end jumper assembly, fully threaded bolts can be used as an alternative. Bolts & nuts for these parts/ components shall be of minimum 4.6 grade conforming to IS 6639 or equivalent International standards

1.17.4.2 In case of fasteners of other materials viz. stainless steel, aluminium alloy, etc. are proposed to be used by the supplier, these shall conform to relevant Indian/ International standards and complete details shall be submitted by the supplier for review & approval by the Employer.

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

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

1.17.7 The Supplier shall indicate the size & length of various bolts in the drawings, based on thickness of components connected, the nut and the washer, the length of shank, the threaded portion of bolts, etc. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

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

1.17.9 To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc., in-house. The manufacturer should also have proper Quality Assurance system, which should be in line with the requirement of this specification and ISO 9001 services Quality System standard.

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

1.18 **Materials**

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

1.18.1 The details of materials for different component are listed as in Table-I

TABLE-1 (Details of Materials)

Sl. No.	Name of item	Material	Process of treatment	Reference Standard
1	Security Clips	Stainless Steel (AISI 304)/ Phosphor Bronze	-	ASTM A240/ IS-7811
2	Arcing Horn	Mild Steel Rod/ Tubular Type	Hot dip galvanised	IS 2062
3	Ball Fittings, Socket,	Class-IV forged steel/ EN8D/ EN19	Drop forged & normalized Hot dip galvanised	IS 2004/ BS970
4	Shackles, links, clevis	Class-IV forged steel	Drop forged & normalized Hot dip galvanised	IS 2004
5	Yoke Plate, Sag Adjustment plate	Mild Steel /High Tensile Steel	Hot dip galvanized	IS 2062
6(a)	Corona Control ring/ Grading ring	Mild Steel/High Strength Al. Alloy tube 65032/ 63400 Type)	Heat treated (for Al) & Hot Dip Galvanized (for MS)	IS 2062/ IS 733
6(b)	Supporting Brackets & Mounting Bolts	High Strentgth Al Alloy 65032/ 63400 Type) or Mild Steel	Heat treated (for Al) / Hot dip galvanized	IS 733 IS2062
7	Turn Buckle	Class-IV forged steel	Forged hot dip galvanized	IS 2004
8(a)	Free centre type clamp/ Envelope type Clamp: Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ 65032	Casted or forged & Heat treated	IS 617/ IS 733
8(b)	Envelope type Clamp: U Bolts	Stainless Steel (AISI 304 or High Strength	Heat treated (Al Alloy)	ASTM A240/ IS 733

Sl. No.	Name of item	Material	Process of treatment	Reference Standard
		Al alloy 65032/ 63400		
9	P. A. rod	High strength Al alloy type 65032	Heat treatment during manufacturing	IS 733
10	AGS clamp (a) Supporting house	High strength Al. alloy 4600/ 65032	Casted or forged & heat treated.	IS 617, IS 733
	(b) Al insert and retaining strap	High strength Al alloy type 65032 or equivalent	Forged and Heat treated	IS 733
	(c) Elastomer cushion	Neoprene/ Moulded on Al reinforcement		
11(a)	Dead End Assembly: Outer Sleeve	Aluminium Alloy 19500		IS 733
11(b)	Steel Sleeve	Forged Steel Class II	Hot Dip Galvanised	IS 2004
		Mild Steel		IS 2062
12	Balancing weights	Mild Steel/ Cast iron MCI	Hot dip galvanised	IS 210/ IS 2062

1.19 **Workmanship**

1.19.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the High Voltage field. The Contractor 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.

1.19.2 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.

1.19.3 All ferrous parts including fasteners shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanised. The bolt threads shall be undercut to take care of the increase in diameter due to galvanising. Galvanising shall be done in accordance with IS 2629/ IS 1367 (Part 13) and shall satisfy the tests mentioned in IS 2633.

1.19.4 Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

1.19.5 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanising shall be as per STP.

1.19.6 Ball ends 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.

1.19.7 Socket ends, before galvanising, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS 2486.

The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.

1.19.8 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.

1.19.9 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

1.19.10 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.

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

1.19.11 All fasteners shall have suitable corona free locking arrangement to guard against vibration loosening.

1.19.12 Welding of aluminum shall be by inert gas shielded tungsten arc or inert gas shielded metal arc process. Welds shall be clean, sound, smooth, uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions. Porosity shall be minimised so that mechanical properties of the aluminum alloys are not affected. All welds shall be properly finished as per good engineering practices.

1.20 **Drawings & Approvals**

1.20.1 Drawings:

1.20.2 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components, as described below, to the Employer for approval. After submission of valid type test reports or successful completion of type tests and getting approval from the Employer, the Contractor shall submit the same drawings to the Employer for further distribution and field use at Employer 's end.

1.20.3 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following shall be submitted for approval. 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 1.8 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.

1.20.4 All drawings shall be identified by a drawing number and contract number and 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.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions, if any.

(vii) Design installation torque for the bolt or cap screw.

(ix) The compression die number with recommended compression pressure.

(x) All other relevant terminal details.

2.0 Accessories for Conductor

2.1 General

2.1.1 This portion (under clause 2.0) details the technical particulars of the accessories for Conductor.

2.1.2 For owner supplied accessories, 2.5 % extra fasteners (excluding factory fitted fasteners) & retaining rods shall be provided to the Contractor to take care of losses during erection. No payment shall be admissible for these extra supplies. For accessories included in the scope of the Contractor, Supplier is permitted to get inspected and supply upto 2.5% extra fasteners and retaining rods to take care of losses during erection. No payment shall be admissible for these extra supplies.

2.2 Mid Span Compression Joint

2.2.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The resistance of the joint when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor. The joint shall not permit slipping off, 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.

2.2.2 The joint shall be made of steel and aluminium sleeves for jointing the steel core and aluminium wires respectively. The steel sleeve should not crack or fail during compression. The steel sleeve shall be hot dip galvanised. The aluminium sleeve shall have aluminium of purity not less than 99.5%. The dimensions and dimensional tolerances of mid span compression joint shall be as per Standard Technical Particulars.

2.3 T-Connector

T-Connector of compression type shall be used for jumper connection at transposition tower. It shall be manufactured out of 99.5% pure aluminium and shall be strong enough to withstand normal working loads. The T-connector 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 so rounded that the conductor strands are not damaged during installation. The resistance of the connector when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor. The T-connector shall not

permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of T-connector should be kept at an angle of 15 deg. from vertical and horizontal plane of the conductor in order to minimise jumper pull at the welded portion. The dimensions and dimensional tolerances of T-connector shall be as per Standard Technical Particulars.

2.4 **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 so rounded that the conductor strands are not damaged during installation. The dimensions and dimensional tolerances of repair sleeve shall be as per Standard Technical Particulars.

2.5 Vibration Damper

2.5.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified Aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s shall be used at suspension and tension points on each conductor in each span along with bundle spacers to damp out Aeolian vibration as mentioned hereinafter.

2.5.2 Alternate damping systems or “Dogbone” dampers offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

2.5.3 One damper minimum on each side per Conductor/Sub-conductor for suspension points and two dampers minimum on each side per conductor/sub-conductor for tension points shall be used upto ruling design span as given in relevant clause of section–I.

2.5.4 In case more dampers are recommended by the supplier, the payment shall be restricted to the number of dampers indicated above.

2.5.5 The clamp of the vibration damper shall be made of high strength aluminium alloy of grade 4600 as per IS 617. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap

shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

2.5.6 The messenger cable shall be made of high strength galvanised steel/ stainless steel with a minimum strength of 135 kg/sq mm. It shall be of preformed and post formed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the 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 for heavily coated wires.

2.5.7 The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.

2.5.8 The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

2.5.9 The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.

2.5.10 The vibration damper shall be capable of being installed and removed from energised line by means of hot line technique. In addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

2.5.11 The supplier must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. 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.

2.5.12 The vibration damper shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars.

2.5.13 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be

submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	Description	Technical particulars
1.	Span length	
i)	Ruling design span	As given in section-I
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters
2.	Configuration	As per Section-I of this Specification
3.	Conductor/ sub-conductor tension	25% of UTS of conductor
4.	Armour rods used	Standard preformed armour rods/ AGS
5.	Maximum permissible dynamic strain	+/- 150 micro strains

2.5.14 The damper placement chart for spans ranging from 100 m to 1100 m shall be submitted by the contractor/ supplier. Placement charts should be duly supported with relevant technical documents and sample calculations.

2.5.15 The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/ Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

2.6 Bundle Spacer (for twin Bundle Conductors)

2.6.1 Armour grip bundle spacers shall be used to maintain the spacing of 450 mm between the two sub-conductors of each bundle under all normal working conditions.

2.6.2 Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the Specification.

2.6.3 The offer shall include placement charts recommending the number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the twin bundle conductors.

2.6.3.1 The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 30 km/hr and to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operating conditions.

2.6.3.2 The placement chart shall be provided for spans ranging from 100 m to 1100m. The number of spacers recommended for a ruling design span of 400m shall however be seven with no sub-span greater than 70m and no end sub-span longer than 40m. In case more spacers are recommended by the supplier, the payment shall be restricted to the number of spacers indicated above.

2.6.4 The spacer offered by the Bidder shall satisfy the following requirements: -

2.6.4.1 Spacer shall restore normal spacing of the sub conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor

2.6.4.2 For spacer requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The preformed rods shall be made of high strength, special aluminium alloy of type 65032 or equivalent aluminium alloy and shall have minimum tensile strength of 35 kg/sq.mm. The ends of retaining rods should be ball ended**.** The rods shall be heat-treated to achieve specified mechanical properties and give proper resilience and retain the same during service.

2.6.4.3 Four number of rods shall be applied on each clamp to hold the clamp in position. The length and diameter of preformed retaining rod shall be decided by suppliers as per design of the Bundle spacer. However, diameter and length of the rods shall be as per the STP.

2.6.4.4 Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.

2.6.4.5 The clamp grooves shall be in uniform contact with the conductor over the entire surface, except for rounded edges. The groove of the clamp body and

clamp cap shall be smooth and free of projections, grit or other material, which cause damage to the conductor when the clamp is installed.

2.6.4.6 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.

2.6.4.7 No rubbing, other than that of the conductor clamp hinges, shall take place between any parts of the spacer. Joint incorporating a flexible medium shall be such that there is no relative slip between them.

2.6.4.8 The spacer shall be suitably designed to avoid distortion or damage to the conductor or to themselves during service.

2.6.4.9 The spacer shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance.

2.6.4.10 The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep.

2.6.4.11 The spacer assembly shall not have any projections, cuts, abrasions etc. or chattering parts which might cause corona or RIV.

2.6.4.12 The spacer tube shall be made of aluminium alloy of type 65032 or 63400.

2.6.4.13 Elastomer, if used, shall be resistant to the effects of temperature up to 95^0C, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characteristics. The physical properties of the elastomer shall be of approved standard.

2.6.4.14 The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.

2.6.4.15 The spacer assembly shall have complete ease of installation and shall be capable of removal/ reinstallation without any damage.

2.6.4.16 The spacer assembly shall be capable of being installed and removed from the energised line by means of hot line technique.

2.5 **Spacer Damper**

2.5.1 Suitable spacer dampers for bundle conductor configuration for line (stipulated in relevant clause of section–I) 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.

2.5.2 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.

2.5.3 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 test line selected for the performance evaluation shall have been designed for that purpose, be adequately exposed to wind and properly instrumented.

Sl.	Description	Technical Particulars
1	Configuration	Refer to Section-I for configuration of lines & mechanical properties of the conductor
1.	Span length	
i)	Ruling design span	As given in section-I
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters
3	Tension in each sub-conductor	25% of UTS of Conductor
4	Armour rods used	Yes
5	Maximum permissible dynamic strains	± 150 micro strains

2.5.4 Under the operating conditions specified, the spacer damper system shall adequately control Aeolian vibrations throughout the life of the transmission line with wind velocity ranging from 0 to 30 km per hour in order to prevent damage to conductor at suspension clamps, dead end clamps and spacer damper clamps.

2.5.5 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.

2.5.6 The spacer damper shall consist of a rigid central body called the frame linked to the conductor by articulated arms. terminated by elastomer lined or elastomer covered clamps and securely held by preformed retaining helical, factory-formed rods. 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.

2.5.7 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.

2.5.8 Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp.

2.5.9 Four number of rods shall be applied on each clamp to hold the clamp in position. The retaining rods shall be designed for specific conductor size. They shall be made of high strength aluminium alloy of type 65032 or equivalent aluminium alloy having a minimum tensile strength of 35 kg/sq.mm. The end of armour rod shall be parrot billed. The rods shall be heat treated and aged to achieve specified mechanical properties and to retain the same during service. Each rod shall be marked in the middle with paint for easy application on the line. The length and diameter of preformed retaining rod shall be decided by suppliers as per design of the Spacer Damper. However, diameter and length of the rods shall be as per the STP.

2.5.10 The spacer damper body and clamps shall be cast/ forged from suitable high strength corrosion resistant aluminum alloy. The aluminium alloy shall be chosen in relation with the process used.

2.5.11 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.

2.5.12 The rubber components used shall have good resistance to the effects of temperature indicated in the Standard Technical Particulars and to ultraviolet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi conductive.

2.5.13 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.

2.5.14 The spacer damper assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

2.5.15 The spacer damper assembly shall be capable of being installed and removed from the energized line by means of hot line techniques. The Supplier shall

submit complete description of the installation, removal and reinstallation procedure.

2.5.16 A typical placement chart of spacer dampers for spans ranging from 100m to 1100m is indicated in table at ***Annexure-D***. Sub span spacing indicated in ***Annexure-D*** may be varied as per the manufacturer requirement, provided total no. of Spacer Damper in sub-span shall not be less than indicated in table at ***Annexure-D***. In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead-end clamp.

In case more Spacer dampers are recommended by the supplier, the payment shall be restricted to the number of Spacer dampers indicated in table at ***Annexure-D*** for different spans and one additional in case of tension towers.

2.5.17 The staggering scheme shall be such that no sub span shall be greater than 65 m and no end sub span shall be longer than 40 m and that the spacer dampers be unequally distributed along the span to achieve sufficient detuning of adjacent sub spans for oscillations of sub span mode and to ensure bundle stability for wind speeds up to 60 km/hr.

2.6 **Rigid Spacer**

2.6.1 Jumpers at tension points shall also be fitted with Rigid spacers so as to limit the length of free conductor to 3.65 m and to maintain the sub conductor spacing of 450mm for twin conductor line and 457 mm for Triple/ Quad/ Hexa bundle lines. Supplier shall quote for rigid spacer for jumper. It shall meet all the requirements of spacer used in line except for its vibration performance. Rigid spacers requiring retaining rods shall not be quoted for jumpers.

2.6.2 The spacer offered by the Bidder shall satisfy the following requirement: -

2.6.2.1 Rigid spacer shall restore normal spacing of the sub conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor

2.6.2.2 Any nut used shall be locked in an approved manner to prevent vibration loosening. The ends of bolts and nuts shall be properly rounded for specified corona performance or suitably shielded.

2.6.2.3 Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.

2.6.2.4 The clamp grooves shall be in uniform contact with the conductor over the entire surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free of projections, grit or other material. which cause damage to the conductor when the clamp is installed.

2.6.3 For the rigid spacer involving bolted clamps, 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 5 kN. 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.

2.6.4 Universal type bolted clamps, covering a range of conductor sizes, will not be permitted.

2.6.5 No rubbing, other than that of the conductor clamp hinges or clamp swing bolts, shall take place between any parts of the spacer. Joint incorporating a flexible medium shall be such that there is no relative slip between them.

2.6.6 The spacer shall be suitably designed to avoid distortion or damage to the conductor or to themselves during service.

2.6.7 Rigid spacers shall be acceptable only for jumpers.

2.6.8 The Rigid spacer shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance.

2.6.9 The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep.

2.6.10 The Rigid spacer assembly shall not have any projections, cuts, abrasions etc. or chattering parts which might cause corona or RIV.

2.6.11 The spacer tube shall be made of extruded aluminium alloy of type 65032 or 63400. If fasteners of ferrous material are used, they shall conform to and be galvanised conforming to relevant Indian Standards. The spacer involving ferrous fasteners shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars.

2.6.12 Elastomer, if used, shall be resistant to the effects of temperature up to 95^0C, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characteristics. The physical properties of the elastomer shall be of approved standard.

2.6.13 The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.

2.6.14 The spacer assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

2.6.15 The spacer assembly shall be capable of being installed and removed from the energised line by means of hot line technique.

2.7 Material and Workmanship

2.7.1 All the equipment shall be of the latest proven design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for transmission line applications of the rated voltage with bundle conductors and will give continued good performance.

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

2.7.3 All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanised as per grade 4 of IS 1573. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS 2629/ IS 1367 (Part-13) and satisfy the tests mentioned in IS 2633. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall have a minimum overall coating of Zinc equivalent to 610 gm/sqm and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Preece test for galvanising unless otherwise specified.

2.7.4 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be as per STP.

2.7.5 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes cracks etc.

2.7.6 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localised heating phenomenon is averted.

2.7.7 No equipment 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 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 all service conditions.

2.7.8 Particular care shall be taken during manufacture and subsequent handling to ensure smooth surface free from abrasion or cuts.

2.7.9 The fasteners shall conform to the requirements of IS 6639. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

2.8 **Compression Markings**

2.8.1 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 'NON-COMPRESSION 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.

2.9 **Drawings**

2.9.1 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components, as described below, to the Employer for approval. After submission of valid type test reports or successful completion of type tests and getting approval from the Employer, the Contractor shall submit the same drawings to the Employer for further distribution and field use at Employer 's end

2.9.2 The Contractor shall furnish detailed dimensioned drawings of the equipment and all component parts. Each drawing shall be identified by a drawing number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.

2.9.3 The drawings shall include: -

i. Dimensions and dimensional tolerances

ii. Material. fabrication details including any weld details and any specified finishes and coatings. Regarding material, designations and reference of standards are to be indicated.

iii. Marking

iv. Weight of assembly

v. Installation instructions, if any

vi. Design installation torque for the bolt or cap screw

vii. The compression die number with recommended compression pressure.

viii. All other relevant technical details

3.0 G.S. Earth wire Accessories

3.1 General

3.1.1 This portion specifies the details of the technical particulars of the accessories for Galvanised Steel Earth wire.

3.1.2 For owner supplied accessories, 2.5 % extra fasteners (excluding factory fitted fasteners) & retaining rods shall be provided to the Contractor to take care of losses during erection. No payment shall be admissible for these extra supplies. For accessories included in the scope of the Contractor, supplier is permitted to get inspected and supply upto 2.5% extra fasteners to take care of lossess during erection. No payment shall be admissible for these extra supplies.

3.2 Mid Span Compression Joint

3.2.1 Mid Span Compression Joint shall be used for joining two lengths of earth wire. The joint shall be made of mild steel with aluminium encasing. The steel sleeve should not crack or fail during compression. The Brinnel Hardness of steel should not exceed the value as stipulated in the Standard Technical Particulars. The steel sleeve shall be hot dip galvanised. The aluminium sleeve shall have aluminium of purity not less than that stipulated in the Standard Technical Particulars. Filler aluminium sleeve shall also be provided at the both ends. The joints shall not permit slipping off, damage to or failure of the complete earth wire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earth wire. The joint shall have resistance less than 75% of resistance of equivalent length of earth wire. The dimensions and the dimensional tolerances of the joint shall be as stipulated in the Standard Technical Particulars.

3.3 Vibration Damper

3.3.1 Vibration dampers of 4R-Stockbridge type with four (4) different frequencies spread within the specified aeolian frequency band-width corresponding to wind speed of 1m/s to 7 m/s shall be used for suspension and tension points on each earth wire in each span to damp out aeolian vibrations as mentioned herein after.

3.3.2 Alternate damping systems or “Dogbone” dampers offering equivalent or better performance also shall be acceptable provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Supplier along with the bid.

3.3.3 One damper minimum on each side per earth wire at suspension points and two dampers on each side per earth wire at tension points shall be used upto ruling design span as given is relevant clause of Section-I.

3.3.4 Incase more number of dampers per ruling design span are recommended by the supplier, the payment shall be restricted to the number of dampers specified in clause 3.3.3.

3.3.5 The clamp of the vibration damper shall be made of aluminium alloy. It shall be capable of supporting the damper during installation and prevent damage or chaffing of the earth wire during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the earth wire without damaging the strands or causing premature fatigue failure of the earth wire under the clamp. The clamp groove shall be in uniform contact with the earth wire over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or materials which could cause damage to the earth wire when the clamp is installed. Clamping bolts shall be provided with self locking nuts designed to prevent corrosion of the threads or loosening during service.

3.3.6 The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 Kg/sq.mm. It shall be of preformed and post formed quality in order to prevent subsequent drop of weights and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion.

3.3.7 The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkages, inclusions and blow holes etc. The inside and outside surfaces of the damper masses shall be smooth.

3.3.8 The vibration analysis of the system, with and without damper, dynamic characteristic of the damper as detailed under ***Annexure-A***, shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the system are as follows: -

Sl. No.	Description	Technical particulars
1.	Span length in meters	
i)	Ruling design span	As given in section-I
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters
2.	Configuration	As per Section-I of this Specification
3.	Tension of earthwire	25% of UTS of earthwire
4.	Armour rods used	Standard preformed armour rods/ AGS
5.	Maximum permissible dynamic strain	+/- 150 micro strains

3.3.9 The damper placement chart for spans ranging from 100 m to 1100 m shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents.

3.3.10 The damper placement charts shall include the following:

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating number of dampers to be installed per earth wire per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz, free center type/ trunion type etc.)

(4) The influence of mid span compression joints in the placement of dampers.

3.4 **Flexible Aluminium Bond**

The flexible aluminium bond shall be manufactured from multi strand multi wire fatigue resistant Aluminium alloy, conforming to IS 398 (Part 4) with a minimum cross-sectional area of 95 sq.mm and not less than 750 mm in length.

The bond shall be flexible so as not to interfere with the clamp movement, shall be terminated with compressed lugs. One lug shall be suitable for 12 mm dia. bolt and the other for 16 mm dia bolt. The complete assembly shall also include one 16 mm dia., 40 mm long HRH (Hex Round Hex) MS Bolt hot dip galvanised with nut and lock washer.

3.5 **Suspension Clamp**

3.5.1 Standard anchor shackle/ twisted shackle for earth wire suspension clamp shall be supplied for attaching to the hanger plate of tower.

3.5.2 At all suspension towers, suitable suspension clamps shall be used to support the required earth wire. The clamps shall be of either free center type or trunnion type and shall provide adequate area of support to the earth wire. The groove of the clamp shall be smooth, finished in a uniform circular or oval shape and shall slope downwards in a smooth curve to avoid edge support and hence to reduce the intensity of bending moment on earth wire.

3.5.3 There shall be no sharp point in the clamps coming in contact with earth wire. There shall not be any displacement in the configuration of the earth wire strands nor shall the strands be unduly stressed in final assembly during working conditions.

3.5.4 The clamping piece and the clamp body shall be clamped by at least two U-bolts of size not less than 10 mm diameter having one nut and one 3 mm thick lock nut with washer on each of its limbs. Suspension clamps shall be provided with inverted type U-bolts. One limb of the U-bolt shall be long enough to accommodate the lug of the flexible Aluminium bond.

3.5.5 The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pin etc. The total drop of the suspension assembly from the center point of the attachment to the center point of the earth wire shall not exceed 150 mm. The design of the assembly shall be such that the direction of run of the earth wire shall be same as that of the conductor.

3.5.6 The complete assembly shall be guaranteed for slip and breaking strength of values indicated in the Standard Technical Particulars.

3.6 **Tension Clamp**

3.6.1 At all tension towers suitable compression type tension clamps shall be used to hold the required galvanised steel earth wire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates.

3.6.2 The clamps shall have adequate area of bearing surface to ensure positive electrical and mechanical contact and shall not permit any slip to the earth wire under working tension and vibration conditions. The angle of jumper terminal to be mounted should be 30 deg. with respect to the vertical line.

3.6.3 The clamps shall be made of mild steel with aluminium encasing. The steel should not crack or fail during compression. The Brinnel hardness of steel sleeve shall not exceed 200. The steel sleeve shall be hot dip galvanised. The aluminium encasing shall have aluminium of purity not less than 99.5%. Filler aluminium sleeve shall also be provided at the end.

3.6.4 The complete assembly shall be so designed as to avoid undue bending in any part of the clamp and shall not produce any hindrance to the movements of the clamps in horizontal or vertical directions.

3.6.5 The slip strength of the assembly shall not be less than 95% of the ultimate strength of the earth wire.

3.6.6 The clamps shall be complete with all the components including anchor shackle, bolts, nuts, washers, split pin, jumper arrangement etc.

3.7 **Material and Workmanship**

Same as Clause 2.7 of this section

3.8 **Compression Marking**

Same as Clause 2.8 of this section

3.9 **Drawings**

Same as Clause 2.9 of this section

4.0 **Tests and Standards**

4.1 **Type Tests**

4.1.1 **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 *(for AC transmission line & DMR for HVDC line only*)	As per IEC 60383/ IEC60060-1
b)	DC voltage withstand test without corona control rings/ grading ring and arcing horns under wet condition *(for DC transmission line only)*	Annexure-A
c)	Switching surge voltage withstand test under wet condition *(for 400 kV & above voltage level line only)*	As per IEC 60383
d)	Impulse voltage withstand test under dry condition	As per IEC 60383
e)	Voltage distribution test *(for Disc Insulator string only)*	Annexure-A
f)	Corona and RIV test under dry condition *(for 400 kV & above voltage level line only)*	Annexure-A
g)	Mechanical Strength test	Annexure-A
h)	Vibration test	Annexure-A

Note: Applicability of above type tests on hardware fittings covered under BPS shall be as follows: -

a) 765 kV double circuit transmission line with Hex ZEBRA conductor

i)	Double 'I' suspension	All type test as per clause no. 4.1.1
ii)	Quadruple tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g)
iv)	Single tension	
v)	Double 'I' suspension (River Crossing)	Type test as per clause no. 4.1.1 (g)

vi)	Quadruple Tension (River Crossing)	

b) 765 kV single circuit transmission line with Quad BERSIMIS conductor

i)	Double 'I' suspension	All type test as per clause no. 4.1.1
ii)	Single 'V' suspension	
iii)	Double 'V' suspension	
iv)	Quadruple tension	
v)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g)
vi)	Single 'V' suspension pilot	
vii)	Single tension	
viiI)	Double 'I' suspension (River Crossing)	Type test as per clause no. 4.1.1 (g)
ix)	Quadruple Tension (River Crossing)	

c) 400 kV transmission line with quad MOOSE conductor

i)	Double 'I' suspension	All type test as per clause no. 4.1.1
ii)	Quadruple tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g)
iv)	Single tension	
v)	Double 'I' suspension (River Crossing)	Type test as per clause no. 4.1.1 (g)
vi)	Quadruple Tension (River Crossing)	

d) 400 kV transmission line with triple SNOWBIRD conductor

i)	Double 'I' suspension	All type test as per clause no. 4.1.1
ii)	Double tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g)
iv)	Single tension	

e) 400 kV transmission line with twin LAPWING/ MOOSE/ HTLS conductor

i)	Single 'I' suspension	All type test as per clause no. 4.1.1
ii)	Double tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g)
iv)	Single tension	
v)	Double 'V' suspension (River Crossing)	Type test as per clause no. 4.1.1 (g)
vi)	Triple Tension (River Crossing)	

f) 220 kV transmission line with single ZEBRA conductor

i)	Single 'I' suspension	All type test as per clause no. 4.1.1 except c) & f)
ii)	Single tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g) except c) & f)
iv)	Double 'I' suspension	
v)	Double tension	

g) 220 kV transmission line with twin MOOSE conductor

i)	Single 'I' suspension	All type test as per clause no. 4.1.1 except c) & f)
ii)	Double tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g) except c) & f)
iv)	Double 'I' suspension	

h) 132 kV transmission line with single PANTHER/ ZEBRA conductor

i)	Single 'I' suspension	All type test as per clause no. 4.1.1 except c) & f)
ii)	Single tension	
iii)	Single 'I' suspension pilot	All type test as per clause no. 4.1.1(a) to (g) except c) & f)
iv)	Double 'I' suspension	
v)	Double tension	

i) ±500 kV HVDC transmission line with quad BERSIMIS/ LAPWING conductor

i)	Single 'V' suspension	All type test as per clause no. 4.1.1
ii)	Quadruple tension	
iii)	Double 'V' suspension	All type test as per clause no. 4.1.1(a) to (g)

j) ±800 kV HVDC transmission line with hexa LAPWING conductor

i)	Single 'Y' suspension	All type test as per clause no. 4.1.1
ii)	Triple tension	
iii)	Single 'I' suspension Pilot	All type test as per clause no. 4.1.1(a) to (g)

k) ±800 kV HVDC transmission line (DMR)

i)	Single 'I' suspension	All type test as per clause no. 4.1.1 except c) & f)
ii)	Double tension	

4.1.2 **On Suspension Hardware Fittings only**

a)	Visual Examination	IS 2486 (Part-I)
b)	Verification of Dimensions	IS 2486 (Part-I)
c)	Chemical Analysis of Materials	Annexure-A
d)	Magnetic power loss test for suspension assembly (for AC line only), if applicable	Annexure-A
e)	Slip Strength test on clamp	Annexure-A
f)	Mechanical Strength test on Suspension hardware fitting except clamp	Annexure-A
g)	Vertical damage load & Failure load test on suspension clamp	IEC 61284
h)	OZONE resistance Test on elastomer	IEC 61854, Clause 7.6.3
i)	Galvanising/ electroplating tests	Annexure-A

4.1.3 **On Tension Hardware fittings only**

a)	Visual Examination	IS 2486 (Part-I)
b)	Verification of Dimensions	IS 2486 (Part-I)
c)	Chemical Analysis of Materials	Annexure-A
d)	Electrical resistance test for dead end assembly	IS 2486-(Part-I)
e)	Heating cycle test for dead end Assembly	IS 2486 (Part-I)
f)	Mechanical strength test on hardware fitting except clamps	Annexure-A
g)	Slip strength test for dead end assembly	Annexure-A
h)	Galvanising/ electroplating tests	Annexure-A

4.1.4 **Mid Span Compression Joint for Conductor and Earth wire**

a)	Visual Examination	IS 2121(Part-II)
b)	Dimensional Verification	IS 2121(Part-II)
c)	Chemical Analysis of Materials	Annexure-A
d)	Electrical resistance test	IS 2121(Part-II)
e)	Heating cycle test	IS2121 (Part-II)
f)	Failing load test	Annexure-A
g)	Corona extinction voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure - A
h)	Radio interference voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure – A
i)	Galvanising test	Annexure-A

Note: 'Heating cycle', 'Corona extinction voltage', 'Radio interference voltage' tests are not applicable to Mid span compression joint for Earthwire

4.1.5 **T-Connector for Conductor**

a)	Visual Examination	IS 2121(Part-IV)
b)	Verification of Dimensions	IS 2121(Part-IV)
c)	Chemical Analysis of Materials	Annexure-A
d)	Electrical resistance test	IS 2121(Part-II)
e)	Heating cycle test	IS 2121 (Part-IV)
f)	Tensile test	IEC 61284; Clause 11.6.2
g)	Axial tensile load test on welded portion	Annexure-A
h)	Corona extinction voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure-A
i)	Radio interference voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure-A
i)	Galvanising test	Annexure-A

4.1.6 **Repair Sleeve for Conductor**

a)	Visual Examination	IS 2121(Part-II)
b)	Dimensional Verification	IS 2121(Part-II)
c)	Chemical Analysis of Materials	Annexure-A
d)	Failing load test	Annexure-A
e)	Corona extinction voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure-A
f)	Radio interference voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure–A

4.1.7 **Flexible Aluminium Bond**

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Slip Strength Test	Annexure–A
e)	Galvanising test	Annexure–A

4.1.8 **Vibration Damper for Conductor and Earth wire**

a)	Visual Examination	IS 9708
b)	Verification of Dimensions	IS 9708
c)	Chemical Analysis of Materials	Annexure–A
d)	Resonance frequency test	IS 9708
e)	Dynamic characteristics test	Annexure–A
f)	Vibration analysis	Annexure–A
g)	Clamp slip test	Annexure-A
h)	Clamp bolt torque test	IS 9708
i)	Fatigue test	Annexure-A
j)	Mass pull off test	IS 9708
k)	Attachment of clamp to messenger cable	IEC 61897, Clause 7.9
l)	Damping efficiency test	IS 9708
m)	Magnetic power loss test (for AC line only), if applicable	Annexure-A
n)	Corona extinction voltage test (dry) *(for 400 kV & above voltage level line only)*	Annexure-A
o)	Radio interference voltage test (dry) (*(for 400 kV & above voltage level line only)*	Annexure-A
p)	Galvanising/Electroplating test	Annexure-A
NOTE: 'Magnetic Power Loss, 'Corona extinction voltage', 'Radio interference voltage' tests are not applicable to Vibration damper for Earthwire		

4.1.9 **Spacer Damper**

a)	Visual examination & verification of dimension, materials and mass	IEC:61854; Clause 7.1 & 7.2
b)	Clamp slip test	Annexure-A
c)	Performance Test*	
	(i) Aeolian	Annexure-A
	(ii) Sub span Oscillation	Annexure-A
d)	Magnetic power loss test (if applicable)	Annexure-A
e)	Characteristics of the Elastic & damping Properties	Annexure-A
f)	Fatigue (sub – oscillation) test	IEC 61854; Clause 7.5.7.2
g)	Corona extinction voltage test (dry)	Annexure-A
h)	Radio interference voltage test (dry)	Annexure-A
i)	Compression & Tension test	Annexure-A
j)	Ozone Resistance test on Elastomer	IEC 61854; Clause 7.6.3

4.1.10 **Bundle Spacer/Rigid Spacer**

a)	Visual examination & verification of dimension, materials and mass	IEC 61854; Clause 7.1 & 7.2
b)	Clamp slip test	Annexure-A
c)	Clamp bolt tightening test (if applicable)	IEC 61854; Clause 7.5.3
d)	Vibration test	Annexure-A
	i) Vertical Vibration	
	ii) Longitudinal Vibration	
	iii) Sub span oscillation	
e)	Magnetic power loss test (if applicable)	Annexure-A
f)	Compression & Tension test	Annexure-A
g)	Corona extinction voltage test (dry) (for 400 kV & above voltage level line only)	Annexure-A
h)	Radio interference voltage test (dry) (for 400 kV & above voltage level line only)	Annexure-A
i)	Ozone test	IEC 61854; Clause 7.6.3
NOTE: 'Vibration Test' & 'Ozone Test' are not applicable to Rigid Spacers.		

4.1.11 **Earth wire Suspension Clamp Assembly**

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Mechanical Strength test	Annexure-A
e)	Slip strength test for suspension clamp	Annexure-A
f)	Galvanising test	Annexure–A

4.1.12 **Earth wire Tension Clamp Assembly**

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Mechanical Strength test (excluding clamp)	Annexure-A
e)	Slip strength test for dead-end clamp	Annexure–A
f)	Electrical Resistance test	IS 2121 (Part-III)
g)	Galvanising test	Annexure–A

4.1.13 Type tests specified under Clause 4.1.1 to 4.1.12 shall not be required to be carried out if the same has been carried out if a valid test certificate is available for a similar design.

The test certificate shall be considered valid if,

i. Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/ 17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and

ii. Type test reports contain validity details of Calibration reports of the relevant testing equipment and information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/relevant standards (IS/ IEC) and compliance to the same and

iii. The Equipment (i.e. Hardware Fittings and accessories for conductor & earthwire) shall be supplied from the same manufacturing works, where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint Venture (JV) for the initial period of 03 years from the date of establishment of manufacturing plant.

In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:

a) the relevant standard does not bar the same,
b) the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
c) the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/ practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
d) Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).

iv. The Type test report(s) of the equipment shall not be older than 10 (ten) years as on the originally scheduled last date of bid submission (Soft Copy).

v. While submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is:
   a) No change in the Design
   b) No change in the material,
   c) No change in manufacturing process, and
   d) No amendment/ revision in the relevant standard as regard to type test conditions, since the type test.

Further, test certificates shall also be considered valid, if the same has already been approved/ accepted by POWERGRID & tests have been conducted within the above-mentioned validity period

Also, in case, hardware components of previously type tested hardware fittings are modified as per the attached standardized drawing, the suppliers shall be required to carry out Mechanical strength test of the entire string (without insulators) as per Clause 4.1.2 & 4.1.3 at no extra cost to the Employer

In case the tests have been conducted earlier than the above stipulated period or in case of revision/ amendment in the provisions/ test procedure of the IS/ IEC as referred in the TS or in the event of any discrepancy in the test report (i.e., due to non-inclusion of validity details of calibration certificate, desired information etc. or any test 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 Specifications), the tests shall be conducted by the supplier at no extra cost to the Purchaser.

Further, in-case of non–availability of valid type test reports for 'Performance test' on Spacer Dampers, the type test shall not be required to be carried out if the spacer damper design offered under the package has been in successful operation for at least 3 years as on date of NOA on a transmission line having same conductor bundle configuration. Documentary evidence including supply record, performance certificate, etc. from respective utilities shall be submitted by the supplier in this regard.

**The performance tests conducted on Spacer Dampers as well as operational experience (in lieu of performance test) stipulated above with same Central Frame and damping system but with different clamping system shall also be considered valid.*

4.2 Acceptance Tests

4.2.1 On Both Suspension and Tension Hardware Fittings

a)	Visual Examination	IS 2486 (Part-I)
b)	Verification of Dimensions	IS 2486 (Part-I)

c)	Galvanising/Electroplating test	Annexure-A
d)	Mechanical strength test of each component (excluding corona control rings gradingring and arcing horn)	Annexure-A
e)	Mechanical Strength test of welded joint	Annexure-A
f)	Mechanical strength test for corona control rings/ grading ring and arcing horn	BS 3288 (Part-I), Clause 7.3.2
g)	Test on locking device for ball and socket coupling	IS 2486 (Part-IV)
h)	Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings	Annexure-A

4.2.2 **On Suspension Hardware Fitting only**

a)	Clamp Slip strength test	Annexure-A
b)	Shore hardness test of elastomer cushion for AG suspension clamp	
c)	Bend test for armour rod set	IS 2121 (Part-I), Clause 7.10
d)	Resilience test for armour rod set	Annexure-A
e)	Electrical Resistance test for armour rods set	Annexure-A

4.2.3 **On Tension Hardware Fittings Only**

(a)	Slip strength test for dead end assembly	Annexure-A

4.2.4 **Mid Span Compression Joint for Conductor and Earth wire**

a)	Visual Examination	IS 2121(Part-II)
b)	Dimensional Verification	IS 2121(Part-II)
c)	Chemical Analysis of Materials	Annexure-A
d)	Galvanising test	Annexure-A
e)	Failing load test	Annexure-A
f)	Hardness test	Annexure-A

4.2.5 **T-Connector for Conductor**

a)	Visual Examination	IS 2121(Part-IV)
b)	Verification of Dimensions	IS 2121(Part-IV)
c)	Chemical Analysis of Materials	Annexure-A

d)	Axial tensile load test for welded portion	Annexure-A
e)	Tensile test	IEC 61284; Clause 11.6.2
f)	Galvanising test	Annexure-A

4.2.6 Repair Sleeve for Conductor

a)	Visual Examination	IS 2121(Part-II)
b)	Dimensional Verification	IS 2121(Part-II)
c)	Chemical Analysis of Materials	Annexure-A
d)	Failing load test	Annexure-A

4.2.7 Flexible Aluminium Bond

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Slip Strength Test	Annexure-A

4.2.8 Vibration Damper for Conductor and Earthwire

a)	Visual Examination	IS 9708
b)	Verification of Dimensions	IS 9708
c)	Chemical Analysis of Materials	Annexure-A
d)	Galvanising/ Electroplating test	Annexure-A
e)	Clamp slip test	Annexure-A
f)	Clamp bolt torque test	IS 9708
g)	Resonance frequency test	IS 9708
h)	Strength of messenger cable	Annexure-A
i)	Dynamic characteristics test	Annexure-A
j)	Mass pull off test	IS 9708
k)	Attachment of clamp to messenger cable	IEC 61897, Clause 7.9

4.2.9 Spacer Damper/ Bundle Spacer/ Rigid Spacer

a)	Visual examination & verification of dimension, materials and mass	IEC 61854; Clause 7.1 & 7.2
b)	Galvanising test	Annexure–A
c)	Movement test (except for spacers for jumpers)	Annexure–A
d)	Clamp slip test	Annexure–A
e)	Clamp bolt tightening test (if applicable)	IEC 61854; Clause 7.5.3
f)	Compression and tension test	Annexure–A

g)	Assembly torque test	Annexure–A
h)	Characteristics of the Elastic & damping Properties	Annexure-A
i)	Hardness test for elastomer (if applicable)	Annexure–A
j)	UTS of retaining rods (if applicable)	Annexure–A

4.2.10 **Earth wire Suspension Clamp Assembly**

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Galvanising test	Annexure–A
e)	Mechanical Strength Test	Annexure-A
f)	Slip strength test for suspension clamp	Annexure-A

4.2.11 **Earth wire Tension Clamp Assembly**

a)	Visual Examination	IS 2121(Part-III)
b)	Dimensional Verification	IS 2121(Part-III)
c)	Chemical Analysis of Materials	Annexure-A
d)	Galvanising test	Annexure–A
e)	Mechanical Strength test (excluding clamp)	Annexure-A
f)	Slip strength test for dead-end clamp	Annexure-A

4.3 **Routine Tests**

4.3.1 **For Hardware Fittings**

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

4.3.2 **For conductor and earthwire accessories**

a)	Visual examination	IS 2121(Part-II/ III/ IV, as applicable)
b)	Dimensional verification	IS 2121(Part-II/ III/ IV, as applicable)

4.4 **Tests During Manufacture**

on all components as applicable

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

4.5 **Testing Expenses**

4.5.1 In the event of type testing, bidders shall ensure that adequate facilities are available in the proposed laboratories and the tests can be completed in these laboratories within the time schedule.

4.5.2 In case of type test on the complete insulator string, the Contractor has to arrange similar insulators at his own cost.

4.5.3 In case of failure in any type test, the supplier is either required to modify the design of the material & repeat all the type tests once or to repeat that particular type test at least three times successfully at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

If repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/Employer's representative shall be deducted from the contract price. Also, if on receipt of the Contractor's notice of testing, the Employer's representative/Inspector does not find 'plant' to be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

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

4.5.5 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, except for the expenses of the inspector/ Purchaser's representative.

4.6 **Sample Batch for Type Testing**

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

4.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Employer's representative. However, those acceptance tests, which are also required to be carried out afresh as the type test, shall not be required to be carried out.

4.7 **Schedule of Testing and Additional Tests**

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

(a) Submission of drawing for approval.

(b) Submission of Quality Assurance programme for approval.

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

(d) Type testing.

4.7.2 The Employer 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 complies with the specifications.

4.7.3 The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at 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 Employer.

4.8 **Test Reports**

4.8.1 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 Employer, only after which the commercial production of the concerned material shall start.

4.8.2 Copies of acceptance test report shall be furnished in at least six copies. One copy shall be returned, duly certified by the Employer, only after which the materials will be dispatched.

4.8.3 Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Employer's representative.

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

4.9 **Inspection**

4.9.1 The Employer '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.

4.9.2 The material for final inspection shall be offered by the Contractor only under packed condition as detailed in clause 4.10 of this part of the Specification. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

4.9.3 The Contractor shall keep the Employer 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.

4.9.4 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 Employer in writing. In the latter case also, the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

4.9.5 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.

4.10 **Packing and Marking**

4.10.1 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.

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

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

4.10.4 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.

4.10.5 Each component of Hardware fittings and accessories shall be legibly and indelibly marked with trade mark of the manufacturer. However, in such type

of component/ item, which consists of many parts and are being supplied in assembled condition (suspension clamp, vibration damper, spacer/ rigid spacer, spacer damper etc.), the complete assembly shall be legibly and indelibly marked on main body/on one of the parts. The symbol  alongwith the word 'TOP' shall be marked on the main body of the spacer damper for installing spacer damper in correct position.

4.10.6 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.

4.11 **Standards**

4.11.1 The Hardware fittings and accessories for conductor and earth wire shall conform to the following Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

4.11.2 In the event of the supply of hardware fittings; conductor and earth wire accessories 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	Specification for zinc	
2	IS 398 (Part 2)	Aluminium Conductor for overhead transmission purpose-Specification: Aluminium Conductor, Galvanised Steel-Reinforced	
3	IS 398 (Part 4)	Aluminium Conductor for overhead transmission purpose: Aluminium Alloy Stranded Conductor (Aluminium-Magnesium-Silicon type)-Specification	
4	IS 398 (Part-5)	Aluminium Conductor for overhead transmission purpose-Specification: Aluminium Conductor, Galvanised Steel-	

		Reinforced for Extra High voltage (400 kV and above)	
5	IS 398 (Part-6)	Aluminium Conductor for Overhead Transmission Purpose: High Conductivity Aluminium Alloy Stranded Conductors-Specification	
3	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4	IS 2121 (Part-I)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Armour Rods, Binding wires & Tapes for Conductors	
5	IS 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	
6	IS 2121 (Part 3)	Conductors and Earthwire Accessories for Overhead Lines: Accessories for Earthwire: Accessories for Earhwire-Specification	
7	IS 2121 (Part 4)	Conductors and Earthwire Accessories for Overhead Lines: Non-Tension Joints-Specification	
8	IS 2486 (Part-I)	Metal Fittings of Insulators for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
9	IS 2486 (Part-II)	Insulator Fittings for Overhead Power Lines with Nominal Voltage greater than 1000 V-Specification: Dimensional Requirements	
10	IS 2486 (Part III)	Specification for Insulator Fittings for Overhead Power Lines with a Nominal Voltage greater than 1000 volts: Locking Devices	
11	IS 2486 (Part IV)	Specification for Insulator Fittings for Overhead Power Lines with a	

		Nominal Voltage greater than 1000V: Tests for Locking Devices	
12	IS 2629	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
13	IS 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
14	IS 4826	Galvanised Coating on Round Steel Wires	
15	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	
16	IS 6639	Hexagonal Bolts for Steel Structures	
17	IS 9708	Specification for Stock Bridge Vibration Dampers for Overhead Power Lines	
18	IS 10162	Specification for Spacers Dampers for Twin Horizontal Bundle Conductors	
19	IS 8263	Method of Radio Interference Tests on High Voltage Insulators	
20		Ozone test on Elastomer	IEC 61284
21		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC 383-1993

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N 19-ND UK
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe. Geneva SWITZERLAND
BIS/ IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001 INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017 U.S.A.

Annexure–A

1.0 Tests on Complete Strings with Hardware Fittings

1.1 D.C Voltage Withstand test (Wet)

The procedure for this test be the same as specified in BS 137 (Part-I) Clause 3.4 and 3.5 except that the insulator string shall be tested without the Corona Control rings.

1.2 Voltage Distribution Test

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed as per table given below for different transmission line configuration: -

Transmission line configuration	Suspension string	Tension string
765 kV line	6.5%	6.5%
400 kV line	9%	10%
220 kV line	13%	14%
132 kV line	20%	20%

1.3 Corona Extinction Voltage Test (Dry)

The sample assembly consisting of complete insulator string when subjected to power frequency (for ac line) / DC voltage (for dc line) shall have a corona extinction voltage of not less than the requirement stipulated in the table below: -

Voltage Level	Maximum Height of the conductor above ground (m)	Minimum Corona extinction voltage (kV)
400 kV	8.84	320 (305 for RIV test)
765 kV	15	510
±500kV HVDC	Such that voltage gradient is not less than 22 kV/cm	550
±800kV HVDC	Such that voltage gradient is not less than 22 kV/cm	880

There shall be no evidence of corona on any part of the sample. The test shall be carried out as per IEC 61284. 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.

1.4 **Radio Interference Voltage Test (Dry)**

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz. The test procedure shall be in accordance with IS 8263.

1.5 **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 loaded to reproduce design conditions. The testing programme varies with string and tower types according to following table:

String Type	Total Test Load* (kN)	Direction** of Load	Duration of Load (Min.)	Sequence of Testing ***
132kV (SINGLE PANTHER)				
Double I Suspension (2X70kN)	94	1	5	1
	140	1	1	2
	F****	1	-	3
Single I Suspension (90kN)	60	1	5	1
	90	1	1	2
	F****	1	-	3
Single Tension (90 kN)	60	1	5	1
	90	1	1	2
	F****	1	-	3
Double Tension (2X90kN)	120	1	5	1
	180	1	1	2
	F****	1	-	3
220 kV (SINGLE ZEBRA)				
Double I Suspension (2X70kN)	94	1	5	1
	140	1	1	2
	F****	1	-	3
Single I Suspension (70kN)	47	1	5	1
	70	1	1	2
	F****	1	-	3
Single I Suspension Pilot (70kN)	47	1	5	1
	70	1	1	2
	F****	1	-	3

Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Double Tension (2X120kN)	160	1	5	1
	240	1	1	2
	F****	1	-	3
220 kV (TWIN MOOSE)				
Single I Suspension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Double Tension (2X160kN)	214	1	5	1
	320	1	1	2
	F****	1	-	3
400 kV (TWIN MOOSE/ HTLS)				
Single V (2x90kN)	80	2	5	1
	60	3	5	2
	60	4	5	3
	90	3	1	4
	F****	3	_	5
Single I Suspension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single I Suspension (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single I Suspension Pilot (160 KN)	107 160 F****	1 1 1	5 1 -	1 2 3

Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single Tension (160 KN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Double Tension (2X160kN)	214	1	5	1
	320	1	1	2
	F****	1	-	3
Double Tension (2X210kN)	281	1	5	1
	420	1	1	2
	F****	1	-	3
400kV (TWIN LAPWING)				
Single I Suspension (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Single I Suspension Pilot (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Single Tension (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Double Tension (2 X210kN)	281	1	5	1
	420	1	1	2
	F****	1	-	3
400kV (TRIPLE SNOWBIRD)				
Double I Suspension (2X120kN)	161	1	5	1
	240	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Double Tension (2 X210kN)	281	1	5	1
	420	1	1	2

	F****	1	-	3
400kV (QUAD MOOSE)				
Double I Suspension (2X160kN)	161	1	5	1
	240	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Quad Tension (4X160kN)	429	1	5	1
	640	1	1	2
	F****	1	-	3
±500kV HVDC (QUAD BERSIMIS)				
Single V (2x210kN)	155	2	5	1
	130	3	5	2
	130	4	5	3
	210	3	1	4
	F****	3	-	5
Double V (2x2x210kN)	320	2	5	1
	280	3	5	2
	280	4	5	3
	420	3	1	4
	F****	3	-	5
Quadruple Tension (4X160 kN)	429	1	5	1
	640	1	1	2
	F****	1	-	3
±500kV HVDC (QUAD LAPWING)				
Single V (2x210kN)	155	2	5	1
	130	3	5	2
	130	4	5	3
	210	3	1	4
	F****	3	-	5
Double V (2x2x210kN)	320	2	5	1
	280	3	5	2
	280	4	5	3

	420	3	1	4
	F****	3	-	5
Quadruple Tension (4X210 kN)	560	1	5	1
	840	1	1	2
	F****	1	-	3
765kV S/C (QUAD BERSIMIS)				
Double I (2X160kN)	160	1	5	1
	240	1	1	2
	F****	1	1	3
Single V (2X210kN)	155	2	5	1
	130	3	5	2
	130	4	5	3
	210	3	1	4
	F****	3	_	5
Double V (2X2X210kN)	280	2	5	1
	260	3	5	2
	260	4	5	3
	420	3	1	4
	F****	3	_	5
Single Tension (120kN)	80	1	5	1
	120	1	1	2
	F****	1	-	3
Quadruple Tension (4X210kN)	540	1	5	1
	840	1	1	2
	F****	1	_	3
Single I Pilot (120kN) & Single V Pilot (2X120kN)	80	1	5	1
	120	1	1	2
	F****	1	_	3
765kV D/C (HEXA ZEBRA)				
Double I Suspension (2X160kN)	214	1	5	1
	320	1	1	2
	F****	1	-	3
Double I Suspension (2X210kN)	280	1	5	1
	420	1	1	2
	F****	1	-	3
Single I Suspension Pilot (160kN)	107	1	5	1
	160	1	1	2

	F****	1	-	3
Single I Suspension Pilot (1 x 210 kN)	140 210 F****	1 1 1	5 1 -	1 2 3
Single Tension (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Single Tension (1 x 210 kN)	140 210 F****	1 1 1	5 1 -	1 2 3
Quad Tension (4X210kN)	560	1	5	1
	840	1	1	2
	F****	1	-	3
Quad Tension (4X320kN)	856	1	5	1
	1280	1	1	2
	F****	1	-	3
±800kV HVDC (HEXA LAPWING)				
Single 'Y' suspension String for Pole conductor	340	2	5	1
	250	3	5	2
	250	4	5	3
	420	3	1	4
	F*****	3	-	5
Triple Tension String for Pole conductor	845	1	5	1
	1260	1	1	2
	F*****	1	-	3
Single I Pilot String for Pole conductor (160kN)	108	1	5	1
	160	1	1	2
	F*****	1	-	3
Single I Suspension for DMR (160kN)	108	1	5	1
	160	1	1	2
	F*****	1	-	3
Single I Suspension for DMR (210kN)	141	1	5	1
	210	1	1	2
	F*****	1	-	3
Double Tension String for DMR (2x210kN)	281	1	5	1
	420	1	1	2
	F*****	1	-	3

Notes:

* : The total test must be established gradually at a steady rate.

**: Direction of load

1. following string axis
2. following bisector of string angle.
3. Following with respect to vertical, half the string angle, along the axis of one of the arm of the V-string
4. Following with respect to vertical, half the string angle +15 deg, along the axis of one of the arm of the V-string

*** The insulator string must be completely unloaded and examined, then the proper direction of loading established before proceeding to the next sequential test.

****: F denotes Failure load

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.

1.6 **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 sub conductors each tensioned at 25% of 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. 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 $1000/f^{1.8}$ 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 disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test.

2.0 Tests on Hardware Fittings

2.1 Magnetic Power Loss Test for Suspension Assembly

The sample shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. This test shall be carried out as per Clause 12.0 of IEC 61284. An alternating current over the range as stipulated below (per sub-conductor) shall be passed through a suitable length of conductor and the power losses shall be measured both with and without the fittings assembled on the conductor. Armour rods shall be applied to the conductor if they are used in service. The reading of the wattmeter with and without five suspension clamps shall be recorded and tabulated graphical form. The test is passed if the average power loss for suspension clamp at given ampere is less than or equal to the value indicated in the Standard Technical Particulars.

Conductor name	Alternating current range
PANTHER	200 amps to 500 amps
ZEBRA/ MOOSE/ SNOWBIRD/ BERSIMIS/LAPWING	400 amps to 800 amps

2.2 Slip Strength Test for Suspension Clamp

The Clamp slip strength test shall be carried out as per Clause no. 11.1.1 of IS 2486 (Part-1) by keeping the clamp at minimum specified slip strength for one minute and considering slip strength as specified in the Standard Technical Particular (STP).

2.3 Mechanical Strength Test for Suspension/Tension Hardware Fittings except clamp

The complete string excluding insulator, arcing horn, corona control ring, grading ring and suspension assembly/ dead end assembly shall be loaded to reproduce design conditions. The testing programme varies with string and tower types according to following table:

String Type	Total Test Load* (kN)	Direction** of Load	Duration of Load (Min.)	Sequence of Testing ***
132kV (SINGLE PANTHER)				
Double I Suspension (2X70kN)	94	1	1	1
	140	1	1	2
	F****	1	-	3
Single I Suspension (~~70~~90kN)	60	1	1	1
	90	1	1	2
	F****	1	-	3
Single Tension	60	1	1	1

(90 kN)	90	1	1	2
	F****	1	-	3
Double Tension (2X90kN)	120	1	1	1
	180	1	1	2
	F****	1	-	3
220 kV (SINGLE ZEBRA)				
Double I Suspension (2X70kN)	94	1	1	1
	140	1	1	2
	F****	1	-	3
Single I Suspension (70kN)	47	1	1	1
	70	1	1	2
	F****	1	-	3
Single I Suspension Pilot (70kN)	47	1	1	1
	70	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Double Tension (2X120kN)	160	1	1	1
	240	1	1	2
	F****	1	-	3
220kV (TWIN MOOSE)				
Single I Suspension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Double Tension (2X160kN)	214	1	1	1
	320	1	1	2
	F****	1	-	3
400kV (TWIN MOOSE/HTLS)				
Single V (2x90kN)	80	2	1	1
	90	2	1	2

	F****	2	_	3
Single I Suspension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single I Suspension (160kN)	107	1	5	1
	160	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single I Suspension Pilot (160 KN)	107 160 F****	1 1 1	5 1 -	1 2 3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single Tension (160 KN)	107 160 F****	1 1 1	5 1 -	1 2 3
Double Tension (2X160kN)	214	1	1	1
	320	1	1	2
	F****	1	-	3
Double Tension (2X210kN)	281	1	5	1
	420	1	1	2
	F****	1	-	3
400kV (TWIN LAPWING)				
Single I Suspension (160kN)	107	1	1	1
	160	1	1	2
	F****	1	-	3
Single I Suspension Pilot (160kN)	107	1	1	1
	160	1	1	2
	F****	1	-	3
Single Tension (160kN)	107	1	1	1
	160	1	1	2
	F****	1	-	3
Double Tension (2 X210kN)	281	1	1	1
	420	1	1	2
	F****	1	-	3

400kV (TRIPLE SNOWBIRD)				
Double I Suspension (2X120kN)	161	1	1	1
	240	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Double Tension (2 X210kN)	281	1	1	1
	420	1	1	2
	F****	1	-	3
400kV (QUAD MOOSE)				
Double I Suspension (2X160kN)	161	1	1	1
	240	1	1	2
	F****	1	-	3
Single I Suspension Pilot (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Quad Tension (4X160kN)	429	1	1	1
	640	1	1	2
	F****	1	-	3
±500kV HVDC (QUAD BERSIMIS)				
Single V (1x210kN)	176	2	1	1
	263	2	1	2
	F****	2	-	3
Double V (2x210kN)	352	2	1	1
	525	2	1	2
	F****	2	-	3
Quadruple Tension (4X160 kN)	482	1	1	1
	720	1	1	2
	F****	1	-	3
±500kV HVDC (QUAD LAPWING)				

Single V (1x210kN)	176	2	1	1
	263	2	1	2
	F****	2	-	3
Double V (2x210kN)	352	2	1	1
	525	2	1	2
	F****	2	-	3
Quadruple Tension (4X210 kN)	616	1	1	1
	920	1	1	2
	F****	1	-	3
765kV S/C (QUAD BERSIMIS)				
Double I (2X160kN)	181	1	1	1
	270	1	1	2
	F****	1	1	3
Single V (2X210kN)	188	2	1	1
	280	2	1	2
	F****	2	_	3
Double V (2X2X210kN)	332	2	1	1
	495	2	1	2
	F****	2	_	3
Single Tension (120kN)	80	1	1	1
	120	1	1	2
	F****	1	-	3
Quadruple Tension (4X210kN)	616	1	1	1
	920	1	1	2
	F****	1	-	3
Single I Pilot (120kN)	80	1	1	1
	120	1	1	2
	F****	1	_	3
Single V Pilot (2X120kN)	140	2	1	1
	208	2	1	2
	F****	2	_	3
765kV D/C (HEXA ZEBRA)				
Double I Suspension (2X160kN)	235	1	1	1
	350	1	1	2
	F****	1	-	3
Double I Suspension (2X210kN)	280	1	5	1
	420	1	1	2

	F****	1	-	3
Single I Suspension Pilot (160kN)	107	1	1	1
	160	1	1	2
	F****	1	-	3
Single I Suspension Pilot (1 x 210 kN)	140 210 F****	1 1 1	5 1 -	1 2 3
Single Tension (160kN)	107	1	1	1
	160	1	1	2
	F****	1	-	3
Single Tension (1 x 210 kN)	140 210 F****	1 1 1	5 1 -	1 2 3
Quad Tension (4X210kN)	616	1	1	1
	920	1	1	2
	F****	1	-	3
Quad Tension (4X320kN)	856	1	5	1
	1280	1	1	2
	F****	1	-	3
±800kV HVDC (HEXA LAPWING)				
Single 'Y' suspension String for Pole conductor	340	2	1	1
	505	2	1	2
	F*****	2	-	3
Triple Tension String for Pole conductor	884	1	1	1
	1320	1	1	2
	F*****	1	-	3
Single I Pilot String for Pole conductor (160kN)	108	1	1	1
	160	1	1	2
	F*****	1	-	3
Single I Suspension for DMR (160kN)	108	1	1	1
	160	1	1	2
	F*****	1	-	3
Single I Suspension for DMR (210kN)	141	1	1	1
	210	1	1	2
	F*****	1	-	3
Double Tension String for DMR (2x210kN)	281	1	1	1
	420	1	1	2
	F*****	1	-	3

Notes:

* : The total test must be established gradually at a steady rate.

**: Direction of load
1. following string axis
2. following bisector of string angle.

*** : The hardware assembly must be completely unloaded and examined, then the proper direction of loading established before proceeding to the next sequential test.

****: F denotes Failure load

The hardware components 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.

2.4 **Galvanising /Electroplating Test on clamp & fittings**

The test shall be carried out as per Clause no. 9.4 of IS 2486 (Part-1) 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.

2.5 **Slip Strength Test of dead end assembly**

The fitting compressed on conductor/earth wire shall not be less than one meter in length. The test shall be carried out as per IS 2486 (Part-I) except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor and retained for one minute at this load. There shall be no movement of the conductor relative to the fittings and no failure of the fittings during this one minute period.

2.6 **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.

2.7 **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.

2.8 **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 the values indicated in the Standard Technical Particulars.

2.9 **Proof Load Test (Routine 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.

2.10 **Mechanical Strength Test of Each Component (Acceptance Test)**

Each component shall be subjected to a load equal to 50 % 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.

2.11 **Resilience test for armour rod set**

The test shall be carried out as per Clause no. 7.11 of IS 2121 (Part-1) except slip strength after resilience shall be carried out as per clause 2.2 above.

2.12 **Electrical resistance test for armour rod set**

The test shall be carried out as per Clause no. 7.5 of IS 2121 (Part-1) except the conductivity of the armour rods shall be as specified in the STP.

3.0 Tests on Conductor and Earth wire Accessories

3.1 Mid span compression joint for conductor/ earthwire & Repair sleeve for conductor

a) Failing load Test of Mid span compression joint for conductor/ earthwire & Repair sleeve for conductor

The test shall be carried out as per IS 2121 (Part-II), clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor and retained for one minute at this load. There shall be no movement of the conductor relative to the fittings and no failure of the fittings during this one-minute period.

b) Galvanising Test on Mid span compression joint

The test shall be carried out as per Clause no. 6.7 of IS 2121 (Part-II) except that standard preece test shall also be carried out and the results obtained shall satisfy the requirements of this specification.

c) Hardness Test

The Brinnel hardness at various points on the steel sleeve of conductor core and of the earthwire compression joint and tension clamp shall be measured.

3.2 T-Connector for Conductor

a) **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 the value indicated in the Standard Technical Particulars.

b) **Galvanising Test**

The test shall be carried out as per Clause no. 6.7 of IS: 2121- (Part-IV) except that standard preece test shall also be carried out and the results obtained shall satisfy the requirements of this specification.

3.3 Flexible Aluminum Bond

a) Slip Strength Test

On applying a load of 3 kN between the two ends, stranded flexible aluminium cable shall not come out of the connecting lugs and none of its strands shall be

damaged. After the test, the lugs shall be cut open to ascertain that the gripping of cable has not been affected.

b) Galvanising Test

The test shall be carried out as per Clause no. 5.7 of IS: 2121- (Part-III) except that standard preece test shall also be carried out and the results obtained shall satisfy the requirements of this specification.

3.4 **Vibration Damper for conductor and Earth wire**

(a) Dynamic Characteristics Test (As Type test)

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for aeolian vibration frequency band range from 0.18/d to 1.4/d, where d is the conductor/ Earthwire diameter in meters. The damper assembly shall be vibrated vertically with a $\pm$ 1 mm amplitude upto 15 Hz frequency and beyond 15 Hz at ± 0.5mm to determine following characteristics with the help of suitable recording instruments:

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the aeolian vibration frequency-band between the lower and upper dangerous frequency, limits determined by the vibration analysis of conductor/earth wire without dampers.

Acceptance criteria for vibration damper.

(i) The above dynamic characteristics test on five dampers shall be conducted.

(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

(iii) The above mean reactance response curve should lie within following limits:

Conductor name	**Range of mean reactance**
LAPWING	0.227 f to 0.908 f
MOOSE	0.191 f to 0.762 f
ZEBRA	0.135 f to 0.540 f
PANTHER	0.0991 f to 0.495 f
7/3.66 mm GS EARTHWIRE	0.060 f to 0.357 f
7/3.15 mm GS EARTHWIRE	0.050 f to 0.300 f

7/4.5 mm GS EARTHWIRE	0.084 f to 0.504 f

(iv) The above mean phase angle response curve shall be between 25^{o} to 130^{o} within the frequency range of interest.

(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.

(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the conductor/earthwire shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis:

(i) The analysis shall be borne for single conductor/earthwire without armour rods as per the parameters given under clause 2.5.13 and 3.3.8 of this part of the Specification. The tension shall be taken as 25% of RTS of conductor/ earth wire for a span ranging from 100 m to 1100 m.

(ii) The self-damping factor and flexural stiffness (EI) for conductor and earthwire shall be calculated on the basis of experimental results. The details of experimental analysis with these data should be furnished.

(iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.

(iv) Examine the aeolian vibration level of the conductor/earthwire with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of conductor/ earthwire without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of conductor/earthwire with damper/dampers installed at the recommended location, the dynamic strain level, at the clamped span extremities, damper attachment points and the antinodes on the conductor/earthwire shall be determined. In addition to above damper clamp vibration amplitude and antinode vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper

vibration amplitude shall not be more than that of the specified fatigue limits.

c) Clamp Slip and Fatigue Tests

(i) Test Set Up

The fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor/earthwire shall be tensioned at 25% of RTS of conductor/earthwire 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/earthwire has been tensioned, clamps shall be installed to support the conductor/earthwire 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/earthwire. 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 stepless speed control as well as stepless 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 test shall be carried out as per Clause 7.9 of IS 9708. Further, the load at which the clamp slips shall not be more than 5 kN.

(iii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ± 25/f mm, where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the, test if resonance shift is observed the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned hereinabove shall be repeated after fatigue test without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from conductor/ earthwire and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristic of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The conductor/earthwire under clamp shall also be free from any damage.

For the purpose of acceptance, the following criteria shall be applied.

i) There shall not be any resonant frequency shift before and after the test by more than ± 20 %.

ii) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20 %.

iii) Power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Contractor. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

d) Magnetic Power Loss Test for Vibration Damper

The sample shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. This test shall be carried out as per Clause 12.0 of IEC:61284. An alternating current over the range as stipulated below (per subconductor) shall be passed through a suitable length of conductor and the power losses shall be measured both with and without the fittings assembled on the conductor. The reading of the wattmeter with and without five units shall be recorded and tabulated graphical form. The test is passed if the average power loss for vibration damper at given ampere is less than or equal to the value indicated in the Standard Technical Particulars.

Conductor name	Alternating current range
Panther	200 amps to 500 amps
Zebra/ Moose/ Lapwing	400 amps to 800 amps

e) Galvanising/ Electroplating test on Vibration damper

The test shall be carried out as per Clause no. 7.11 of IS: 9708 except that standard preece test shall also be carried out and the results obtained shall satisfy the requirements of this specification.

f) **Dynamic Characteristics Test (Acceptance Test)**

The test will be performed as acceptance test with the procedure mentioned for type test with sampling mentioned below

Vibration Damper of Conductor	-	1 Sample for 1000 Nos. & below
	-	3 Samples for lot above 1 000 & up to 5000 nos.
	-	Additional 1 sample for every additional 1500 pieces above 5000.

The acceptance criteria will be as follows

(i) The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of ranging from 0.18/d to 1.4/d-where d is the conductor diameter in meters. The damper assembly shall be vibrated vertically with a $\pm$ 1 mm amplitude upto 15 Hz frequency and beyond 15 Hz at ± 0.5mm

(ii) If all the individual curve for dampers are within the envelope as already mentioned for type test for reactance & phase angle, the lot passes the test.

(iii) If individual results do not fall within the envelope, averaging of characteristics shall be done.

(a) Force of each damper corresponding to particular frequency shall be taken & average force of three dampers at the frequency calculated.

(b) Similar averaging shall be done for phase angle.

(c) Average force Vs frequency and average phase Vs frequency curves shall be plotted on graph paper. Curves of best fit shall be drawn for the entire frequency range.

(d) The above curves shall be within the envelope specified.

g) **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 message caste 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 caste. The load shall be not less than the value guaranteed by the Contractor

3.5 Spacer Damper, Bundle spacer & Rigid Spacer

(a) Performance Test

One very important quality of a spacer damper is its ability to control Aeolian vibrations and subspan oscillations within acceptable limits. Performance testing shall be carried out on an experimental test line, as described in *Clause 2.5, Section-VI*. 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) Subspan Oscillations

The spacer damper system shall control subspan 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, subspan oscillation shall be controlled within the following limits, for any wind speed below 60 km/hr.

- In any individual subspan, the peak to peak amplitude of each subconductor shall never exceed 350mm.
- In any individual subspan, the RMS value (Y rms) of each oscillation measurement sample shall be such that:

f.Yrms < 80 mm/sec.

Where

Y (rms) = antinode amplitude (mm)

f = frequency of the oscillation (cycle/sec.)

f = (1/2L) sqrt (T/m)

L = subspan 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 subspan, 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 (for Spacer Damper, Bundle Spacer & Rigid Spacer)**

The Longitudinal slip test shall be carried out. The spacer damper assembly shall be installed as per conductor bundle configuration (as stipulated in relevant *clause of section -I*) at a tension of 20% of its rated tensile strength for Zebra/Moose/snowbird/Bersimis & 54 kN for ACSR Lapwing conductor. In case of spacer for jumper, the clamp of sample shall be tightened with a specified tightening torque. One of the sample clamps, when subjected to a longitudinal pull parallel to the conductor axis for a minimum duration of one minute. The minimum slip under longitudinal pull varies with clamp type as per the values stipulated in the Standard Technical Particulars.

In order to determine the effect of conductor creep with the spacer dampers only, the conductor shall be re-tensioned to 35% of RTS (in case of ACSR Lapwing conductor shall be re-tensioned to 81 kN) 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 Standard Technical Particulars.

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 3.4 (a)

but under longitudinal loading corresponding to 80% of the values given in the Standard Technical Particulars.

(c) Characteristic of the Elastic and Damping Properties Test

The test shall be carried out by stiffness-damping method as per clause 7.5.5(A) of IEC: 61854. The purpose of this test is to obtain quantitative information regarding the dynamic characteristic of the spacer damper. The values obtained during this test will serve as references to evaluate the behaviour of the same spacer damper under the fatigue test.
The test frequency shall not be higher than 3 Hz. The test shall be performed at five different displacement amplitudes. The amplitudes shall be selected to reproduce 10, 20, 40, 60 and 90 percent of the maximum displacement permitted by the spacer damper design.

The test shall be performed on three samples.

d) **Compression and Tension Tests (for Spacer Damper, Bundle Spacer & Rigid spacers)**

The test shall be carried out as per clause 7.5.4.2 of IEC: 61854. Three samples of spacer/spacer dampers shall be subjected to a compression and tension test. A compressive load as specified in the Standard Technical Particulars shall first be applied and held for five minutes. Then a tensile load as specified in the Standard Technical Particulars shall be applied on the same pair of arms. The test shall be repeated on the other pair of arms. The acceptance criteria shall be as per IEC:61854.

e) Magnetic Power Loss Test (for Spacer Damper, Bundle Spacer & Rigid spacers)

The sample shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. This test shall be carried out as per Clause 12.0 of IEC:61284. An alternating current over the range of 400 amps to 800 amps (per subconductor) shall be passed through a suitable length of conductor and the power losses shall be measured both with and without the fittings assembled on the conductor. The reading of the wattmeter with and without five units shall be recorded and tabulated graphical form. The test is passed if the average power loss for spacer damper/ spacer at given ampere is less than or equal to the value indicated in the Standard Technical Particulars.

f) Galvanising Test on Spacer damper, Bundle spacer & Rigid spacer

The test shall be carried out as per Clause no. 5.16 of IS: 10162 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.

g) **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.

h) Assembly Torque Test

The spacer assembly shall be installed on conductor. The same shall not rotate on either clamp on applying a torque of 0.04 kN in clockwise or anti-clockwise direction.

i) 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 the values indicated in the Standard Technical Particulars.

j) 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.

k) Vibration Tests on Bundle Spacer

The test set up shall be as per Clause No. *3.3 (c) (i) of Annexure-A*. The spacer assembly shall be clamped to conductor. During the vibration tests the axis of the clamp of sample shall be maintained paralleled to its initial static position by applying a tension 25% of RTS of the conductor. The spacer assembly shall be free to vibrate and shall not be re-torqued or adjusted between the tests.

All the vibration tests mentioned hereunder shall be conducted on the same sample on the same test span. The samples shall withstand the vibration tests without slipping on the conductor. loosening, damage or failure of component parts. After each vibration test, clamp slip test shall be carried out as per the procedure given in Clause No. 3.4 (b).

(i) Longitudinal Vibration Test

The stationary conductor and the vibrating conductor/equivalent diameter of aluminum alloy tube shall be restrained by fixed clamps. The displacement of the vibrating conductor shall be 25mm minimum on either side. The longitudinal movement shall be parallel to the conductor at frequency not less than 2 Hz for minimum one million cycles.

(ii) Vertical Vibration Test

The spacer/spacer damper shall be installed in the middle of the test span and the frequency chosen so as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimen to allow free movement of the conductor close to the test specimen. One conductor shall be connected to the shaker and vibrated to an amplitude such that.

$$f^{1.8}\ Ymax > 1000\ mm/sec.$$

Where Ymax being the antinode displacement (mm) and f is the test frequency (Hz). The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 million.

(iii) Sub-span Oscillation Test

The test shall be conducted for oscillation in horizontal plane at frequency higher than 3 Hz for minimum one million cycles. The amplitude for oscillation shall be kept equivalent to an amplitude of 150 mm for a full sub-span of 80m. Both the conductor shall be vibrated 180 deg. out of phase with the above minimum amplitude.

3.6 Corona Extinction Voltage Test (Dry) on conductor accessories

same as clause 1.3 of Annexure A.

3.7 Radio Interference Voltage Test (Dry) on conductor accessories

same as clause 1.4 of Annexure A.

3.8 Earthwire Suspension/Tension Clamp Assembly

a) **Mechanical Strength Test for Suspension/ Tension Clamp Assembly**

The suspension/ tension clamp 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 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 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 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) Slip Strength Test for Suspension Clamp Assembly

The Clamp slip strength test shall be carried out as per Clause no. 5.4a) of IS: 2121 (Part-III) by keeping the clamp at minimum specified slip strength for one minute and considering slip strength as specified in the Standard Technical Particular (STP) enclosed with this specification at Annexure C.

c) **Slip Strength Test of dead end assembly**

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

4 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.

5 Tests on All components (As applicable)

a) 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%.

b) 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 Purchaser in Quality Assurance Programme.

c) 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 Purchaser in Quality Assurance Programme.

Annexure-B

A) Standardized Technical Particulars of Hardware Fittings 765 kV D/C Transmission Line with ACSR ZEBRA conductor

1. Suspension hardware fittings for ACSR Zebra Conductor

Sl.	Description	Unit	Particulars/ Value		
			Double 'I'		Single 'I' PILOT
			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	16 - 24		16 - 24
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	2080	2540	NA
	d) Diameter of each rod	mm	7.87		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 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95^o C	NA	NA

	d) Moulded on insert		Yes	NA	NA
5.	Minimum Mechanical strength of suspension fitting (excluding suspension clamp)	KN	350 kN		160 kN
6.	Mechanical strength of suspension clamp	KN	70 kN		70 kN
7.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute		

2. Tension hardware fittings for ACSR Zebra Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**
			Tension String
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	Single Tension: 160kN Quadruple Tension: 920 kN
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	123.8
6.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

B) Standardized Technical Particulars of Hardware Fittings 765 kV S/C Transmission Line with ACSR BERSIMIS conductor

1. Suspension hardware fittings for ACSR BERSIMIS Conductor

Sl.	Description	Unit	Particulars/ Value		
			Suspension Strings		**Suspension PILOT Strings**
			Single 'V' / Double 'V' / Double 'I'		**Single 'I' / Single 'V'**
			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.	13		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/m m^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 80	NA	NA

	c) Temperature range for which elastomer is designed		Upto 95° C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	Single 'V': 235 kN Double 'V': 470 kN Double 'I': 270 kN		130 kN
6.	Mechanical strength of suspension clamp	KN	Single 'V': 70kN Double 'V': 120 kN Double 'I': 70 kN		70kN
7.	Purity of Zinc used for galvanising	%	99.95		99.95
8.	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) All others: 6 dips of 1 minute		

2. Tension hardware fittings for Quad ACSR BERSIMIS Conductor

Sl.	Description	Unit	Particulars/ Value
			Quadruple Tension String
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	920
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	146.3
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

C) Standardized Technical Particulars of Hardware Fittings for 400 kV Transmission Line with Quad ACSR MOOSE Conductor

1.	**Suspension hardware fittings for Quad ACSR MOOSE conductor**				
Sl.	**Description**	**Unit**	**Particulars / Value**		
			Double 'I'		**Single 'I' Pilot**
			AGS clamp	**Free centre clamp**	**Envelope clamp**
1.	Maximum magnetic power loss of suspension assembly at sub conductor current of 600 amperes, 50Hz AC	Watt	4		8
2.	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	20-29		
3.	Particulars of standard/AGS 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				NA
	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
	g) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032		NA
	h) UTS of each rod	Kg/mm^2 (Min)	35		NA
4.	**Particulars of Elastomer (For AGS Clamp only)**				
	a) Type of elastomer		Chloroprene / Neoprene	NA	NA
	b) Shore hardness of elastomer		65 - 80	NA	NA
	c) Temperature range for which elastomer is designed	°C	Upto 95°C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5.	Mechanical Strength of Suspension fitting (excluding suspension clamp)	KN	240		120
6.	Mechanical Strength of suspension clamp.		70	70	70

7.	Purity of Zinc used for galvanising	%	As per IS:209 / IS 13229
8.	Min. No. of dips in standard preece test the ferrous parts can withstand	No	a) Fasteners: 4 dips of 1 min b) Spring washers: 3 dips of 1 min c) All others: 6 dips of 1 min

2.	**Tension hardware fittings for Quad ACSR MOOSE conductor**			
Sl.	**Description**	**Unit**	**Particulars / Value**	
			Single Tension	**Quad Tension**
1.	Mechanical Strength of Tension fittings (excluding dead end clamp)	kN	120	640
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	%	As per IS:209 / IS 13229	
7.	Min. No. of dips in standard preece test the ferrous parts can withstand.	Nos	a) Fasteners: 4 dips of 1 min b) Spring washers: 3 dips of 1 min c) All others: 6 dips of 1 min	

D) Standardized Technical Particulars of Hardware Fittings for 400 kV Transmission Line with twin ACSR MOOSE Conductor

1.	**Suspension hardware fittings for twin ACSR MOOSE conductor**							
Sl.	**Description**	**Unit**	**Particulars/ Value**					
			Single "I" Suspension Fittings with		**Double "V" Suspension Fittings with *(AACSR MOOSE Conductor)***		**Single suspension Pilot Fitting with**	
			AGS clamp	**Free Centre clamp**	**AGS clamp**	**Free Centre clamp**	**Envelope clamp**	
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 600 amperes	Watt	4		4		8	
2.	Slipping strength of suspension assembly	KN	20-29		20-29		20-29	
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly							
	a) No. of rods per set	No.	12		12		NA	
	b) Direction of lay		Right hand		Right hand		NA	
	c) Overall length after fitting on conductor	mm	2235	2540	2235	2540	NA	
	d) Diameter of each rod	mm	9.27		9.27		NA	
	e) Tolerance in							
	i) Diameter of each rod	±mm	0.10		0.10		NA	
	ii) Length of each rod	±mm	25		25		NA	
	iii) Difference of length between the longest and shortest rod in a set	±mm	13		13		NA	
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032		6061/ 65032		NA	
	g) Minimum UTS of each rod	Kg/mm^2	35		35		NA	
4.	**Particulars of Elastomer (For AGS Clamp only)**							
	a) Type of elastomer		Chloroprene/ Neoprene	NA	Chloroprene /Neoprene	NA	NA	

			Rubber		Rubber		
	b) Shore hardness of elastomer		65 to 80	NA	65 to 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA	Upto 95° C	NA	NA
	d) Moulded on insert		Yes	NA	Yes	NA	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	120		2 x160 (along one limb)		120
6.	Mechanical strength of suspension clamp	KN	70		120		70
7.	Galvanising						
a)	Minimum weight of Zinc coating for steel parts	gm/m2	610				
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)				
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute				

1.	**Tension hardware fittings for twin ACSR MOOSE conductor**				
Sl.	**Description**	**Unit**	**Particulars/ Value**		
			Single Tension	**Double Tension**	**Triple Tension *(AACSR MOOSE Conductor)***
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	120	2x160	3x160
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		214 (AACSR 'MOOSE' to be used)
6.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m2	610		

b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5(IS 13229)
c)	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

E) Standardized Technical Particulars of Hardware Fittings for 400 kV Transmission Line with triple ACSR SNOWBIRD Conductor

Sl.	Description	Unit	Particulars / Value		
			Double 'I'		Single 'I' Pilot
			AGS clamp	Free centre clamp	Envelope clamp
1.	Maximum magnetic power loss of suspension assembly at sub conductor current of 600 amperes, 50Hz AC	Watt	4		8
2.	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	20-29		
3.	Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension assembly				
	a) No. of rods per set	No.	11		NA
	b) Direction of lay		Right Hand		NA
	c) Overall length after fitting on conductor	mm	2083	2083	NA
	d) Diameter of each rod	mm	7.87		NA
	e) Tolerance in				NA
	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
	g) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032		NA
	h) UTS of each rod	Kg/mm^2 (Min)	35		NA
4.	**Particulars of Elastomer (For AGS Clamp only)**				
	a) Type of elastomer		Chloroprene / Neoprene	NA	NA
	b) Shore hardness of elastomer		65 – 80	NA	NA
	c) Temperature range for which elastomer is designed	°C	Upto 95°C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5.	Mechanical Strength of Suspension fitting (excluding suspension clamp)	KN	240		120
6.	Mechanical Strength of suspension clamp.	kN	70		70

7.	Purity of Zinc used for galvanising	%	As per IS:209 / IS 13229
8.	Min. No. of dips in standard preece test the ferrous parts can withstand	No	a) Fasteners: 4 dips of 1 min b) Spring washers: 3 dips of 1 min c)All others: 6 dips of 1 min

TENSION HARDWARE FITTINGS TRIPLE ACSR SNOWBIRD CONDUCTOR

Sl.	**Description**	**Unit**	**Particulars / Value**	
			Single Tension	**Double Tension**
1.	Mechanical Strength of Tension fittings (excluding dead end clamp)	kN	120	420
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	112	
6.	Purity of Zinc used for galvanising	%	As per IS:209 / IS 13229	
7.	Min. No. of dips in standard preece test the ferrous parts can withstand.	Nos	a) Fasteners: 4 dips of 1 min b) Spring washers: 3 dips of 1 min c)All others: 6 dips of 1 min	

F) Standardized Technical Particulars of Hardware Fittings for 220 kV Transmission Line with ACSR ZEBRA conductor

1. Suspension hardware fittings for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value				
			Single "I" Suspension Fittings with		Double "I" Suspension Fittings with		Single suspension Pilot Fitting with
			AGS clamp	Free Centre clamp	AGS clamp	Free Centre clamp	Envelope clamp
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 500 amperes	Watt	2	2	2	2	4
2.	Slipping strength of suspension assembly	KN	16-24	16-24	16-24	16-24	16-24
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly						
	a) No. of rods per set	No.	12	12	12	12	NA
	b) Direction of lay		Right hand	Right hand	Right hand	Right hand	NA
	c) Overall length after fitting on conductor	mm	2080	2540	2080	2540	NA
	d) Diameter of each rod	mm	7.87	7.87	7.87	7.87	NA
	e) Tolerance in						
	i) Diameter of each rod	±mm	0.10	0.10	0.10	0.10	NA
	ii) Length of each rod	±mm	25	25	25	25	NA
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	13	13	13	NA
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	6061/ 65032	6061/ 65032	6061/ 65032	NA
	g) Minimum UTS of each rod	Kg/mm^2	35	35	35	35	NA
4.	**Particulars of Elastomer (For AGS Clamp only)**						
	a) Type of elastomer		Chloroprene/ Neoprene	NA	Chloroprene /Neoprene	NA	NA

			Rubber		Rubber		
	b) Shore hardness of elastomer		65 to 80	NA	65 to 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA	Upto 95° C	NA	NA
	d) Moulded on insert		Yes	NA	Yes	NA	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	70		2 x 70		70
6.	Mechanical strength of suspension clamp	KN	70		70		70
7.	Galvanising						
a)	Weight of Zinc coating for steel parts	gm/m^2	610				
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209: 1992) or 98.5 (IS 13229:1991)				
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				

2. Tension hardware fittings for ACSR ZEBRA Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Single Tension	**Double Tension**
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	120	2x120
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	123.80	
6.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanising	%	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	

G) Standardized Technical Particulars of Hardware Fittings for 132 kV Transmission Line with ACSR PANTHER Conductor

1. Suspension hardware fittings for ACSR PANTHER Conductor

Sl.	Description	Unit	Particulars/ Value			
			Single "I" Suspension Fittings with		Double "I" Suspension Fittings with	
			AGS clamp	Free Centre clamp	AGS clamp	Free Centre clamp
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 350 amperes	Watt	2	2	2	2
2.	Slipping strength of suspension assembly	KN	11-16	11-16	11-16	11-16
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly					
	a) No. of rods per set	No.	11	11	11	11
	b) Direction of lay		Right hand	Right hand	Right hand	Right hand
	c) Overall length after fitting on conductor	mm	1760	1930	1760	1930
	d) Diameter of each rod	mm	6.35	6.35	6.35	6.35
	e) Tolerance in					
	i) Diameter of each rod	±mm	0.10	0.10	0.10	0.10
	ii) Length of each rod	±mm	16	16	16	16
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	13	13	13
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	6061/ 65032	6061/ 65032	6061/ 65032
	g) Minimum UTS of each rod	Kg/ mm^2	35	35	35	35
4.	**Particulars of Elastomer (For AGS Clamp only)**					
	a) Type of elastomer		Chloroprene/Neoprene Rubber	NA	Chloroprene /Neoprene Rubber	NA
	b) Shore hardness of elastomer		65 to 80	NA	65 to 80	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA	Upto 95° C	NA
	d) Moulded on insert		Yes	NA	Yes	NA

5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	70	2 x 70
6.	Mechanical strength of suspension clamp	KN	70	70
7.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanising	%	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	

2. Tension hardware fittings for ACSR PANTHER Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Single Tension	**Double Tension**
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	90	2 X 90
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	85.2	
6.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanising	%	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	

H) Standardized Technical Particulars of Hardware Fittings for ±800 kV HVDC Transmission Line with ACSR LAPWING conductor

1. Suspension hardware fittings for ACSR LAPWING Conductor

Sl.	Description	Unit	Particulars/ Value		
			Suspension Strings		
			Single 'Y'		
			AGS clamp	Free Centre clamp	Single I PILOT
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 500 amperes	Watt	NA		NA
2.	Slipping strength of suspension assembly	KN	20-29		20-29
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly				NA
	a) No. of rods per set	No.	14		NA
	b) Direction of lay		Right hand		NA
	c) Overall length after fitting on conductor	mm	2235	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 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	Single 'Y' : 505 kN		160kN

6.	Mechanical strength of suspension clamp	KN	Single 'Y' : 130kN	70kN
7.	Purity of Zinc used for galvanising	%	99.95	
8.	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) All others: 6 dips of 1 minute	

2. Tension hardware fittings for Hexa ACSR LAPWING Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**
			Triple Tension String
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	1320
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	178.6
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

I) Standardized Technical Particulars of Hardware Fittings for metallic return Conductor with ACSR LAPWING conductor

1. Suspension hardware fittings for Metallic Return Conductor

Sl.	Description	Unit	Particulars/ Value	
			Single "I" Suspension Fittings with	
			AGS clamp	Free Centre clamp
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 350 amperes	Watt		
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.	14	14
	b) Direction of lay		Right hand	Right hand
	c) Overall length after fitting on conductor	mm	2235	2385
	d) Diameter of each rod	mm	9.27	9.27
	e) Tolerance in			
	i) Diameter of each rod	±mm	0.10	0.10
	ii) Length of each rod	±mm	25	25
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	13
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	6061/ 65032
	g) Minimum UTS of each rod	Kg/mm^2	35	35
4.	**Particulars of Elastomer (For AGS Clamp only)**			
	a) Type of elastomer		Chloroprene/Neoprene Rubber	NA
	b) Shore hardness of elastomer		65 to 80	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA
	d) Moulded on insert		Yes	NA
5.	Mechanical strength of suspension fitting (excluding suspension clamp)	KN	160	
6.	Mechanical strength of suspension clamp	KN	120	
7.	Galvanising			

a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

2. Tension hardware fittings for Metallic Return Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**
			Double Tension
1.	Mechanical strength of Tension fitting (excluding dead end clamp)	KN	420
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	178.6
6.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

J) Accessories for ACSR ZEBRA conductor for 765 kV transmission line with Hexa ZEBRA conductor

1. Repair sleeve for ACSR Zebra 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	31.00 ± 0.5
ii)	Outside diameter	mm	48.00 ± 1.0
iii)	Length	mm	275.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve After compression**		
i)	Outside dimension (Corner to corner)	mm	47.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	Micro Volts (μV)	1000

2. Mid span compression Joint for ACSR Zebra Conductor

Sl.	Description	Unit	Particulars/ Value	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of 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	31.00 ± 0.5	10.00 ± 0.2
ii)	Outside diameter	Mm	48.00 ± 1.0	20.00 ± 0.5
iii)	Length	Mm	710 ± 5	241 ± 5
4.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension (Corner to corner)	Mm	47.00 ± 0.5	19.00 ± 0.5
ii)	Outside dimension (face to face)	Mm	41.00 ± 0.5	16.00 ± 0.5
5.	Slip strength	KN	123.8	

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	510
8.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 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 galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute

3. T-connector for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value
1.	**Material**		Aluminium of purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
	i) Inside diameter	mm	31.00 ± 0.5
	ii) Outside diameter	mm	48.00 ± 1.0
	iii) Length	mm	400.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
	i) Outside dimension (Corner to corner)	mm	47.00 ± 0.5
	ii) Outside dimension (face to face)	mm	41.00 ± 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	510
7.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	Micro Volts	1000

4. HEX SPACER DAMPER FOR ACSR ZEBRA CONDUCTOR for 765kV Trans.Lines					
Sl.	**Description**	**Unit**	**Particulars / Value**		
1.	Type of Clamps		Preformed rods.		
2.	Type of Damping element		Spring / Elastomer / EPDM		
3.	Material of				
	(a) Clamp		Al Alloy IS:4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)		
	(b) Body		Al Alloy 4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)		
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	14		
	(b) Tensile load	kN	7.0		
6.	Slipping strength of spacer clamp				
	(a) Before vibration test	kN	**Clamp type**	**Longitudinal Load (kN)**	**Maxm Slip permitted (mm)**
			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	Watts	Below 1 watt.		
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510		
9.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) Microvolts under dry condition	µV	Below 1000		
10.	Galvanising				

a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

5.HEX RIGID SPACER FOR ACSR ZEBRA CONDUCTOR for 765kV Trans.Lines					
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	14		
	(b) Tensile load	kN	7.0		
4.	Slipping strength of spacer clamp	kN	**Clamp type**	**Longitudinal Load (kN)**	**Maxm Slip permitted (mm)**
			Metal – Metal Bolted	6.5	1
			Rubber loaded	2.5	2.5
5.	Maximum magnetic power loss of at sub conductor current of 500 amperes, 50Hz AC	Watts	Below 1 watt.		
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510		
7.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) Microvolts under dry condition	µV	Below 1000		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m2	610		

b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

K) Accessories for ACSR BERSIMIS conductor for 765 kV transmission line with Quad BERSIMIS conductor

1. Mid span compression Joint for ACSR BERSIMIS Conductor

Sl.	Description	Unit	Particulars/ Value	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of 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 for steel sleeve	gm/m^2	610	
4.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	37.40 ± 0.5	8.10 ± 0.2
ii)	Outside diameter	mm	58.4 ± 1.01.0	20.70 ± 0.5
iii)	Length	mm	865 ± 5	220 ± 5
5.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension (Corner to corner)	mm	57.40 ± 0.5	20.20 ± 0.5
ii)	Outside dimension (face to face)	mm	49.70 ± 0.5	17.50 ± 0.5
iii)	Length	mm	938 (approx)	250 (approx)
5.	Slip strength	KN	146.3	
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	510	
8.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	Micro Volts	1000	

2. Repair sleeve for ACSR BERSIMIS 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	37.40 ± 0.5
ii)	Outside diameter	Mm	58.4 ±1.1.
iii)	Length	Mm	530 ± 5
3.	**Dimensions of Aluminum Sleeve After compression**		
i)	Outside dimension (Corner to corner)	Mm	57.40 ± 0.5
ii)	Outside dimension (face to face)	Mm	949.70 ± 0.5
iii)	Length	Mm	570 (approx)
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	Micro Volts (μV)	1000

3. **QUAD SPACER DAMPER FOR QUAD ACSR BERSIMIS CONDUCTOR**

Sl.	Description	Unit	Particulars / Value
1.	Type of Clamps		Preformed rods.
2.	Type of Damping element		Spring / Elastomer / EPDM
3.	Material of		
	(a) Clamp		Al Alloy IS:4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)
	(b) Body		Al Alloy 4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)
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	7.5
6.	Slipping strength of spacer clamp		

	(a) Before vibration test	kN	**Clamp type**	**Longitudinal Load (kN)**	**Maxm Slip permitted (mm)**
			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	Watts	Below 1 watt.		
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510		
9.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) Microvolts under dry condition	µV	Below 1000		
10.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m2	610		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute		

4. QUAD RIGID SPACER FOR QUAD ACSR BERSIMIS 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	7.5

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
5.	Maximum magnetic power loss of at sub conductor current of 500 amperes, 50Hz AC	Watts	Below 1 watt.		
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	510		
7.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) Microvolts under dry condition	µV	Below 1000		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute		

L) Accessories for ACSR MOOSE conductor for 400 kV transmission line

1. Mid span compression Joint for ACSR MOOSE Conductor

Sl.	Description	Unit	Particulars/ Value	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of 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 for steel sleeve	gm/m^2	610	
4.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	34.00 ± 0.5	11.10 ± 0.2
ii)	Outside diameter	mm	54.00 ± 1.0	21.00 ± 0.5
iii)	Length	mm	735 ± 5	250 ± 5
5.	**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
iii)	Length	mm	785 (approx)	286 (approx)
6.	Slip strength	KN	153.2	
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320	
9.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000	

2. 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
iii)	Length	mm	330.00(Approx.)
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

3. 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

4. Vibration Damper for ACSR MOOSE conductor (For twin bundle conductor line only)

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 hot 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/m m^2	135
5.	Slip strength of stranded messenger cable (mass pull off)	KN	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	5 to 40
8.	Maximum magnetic power loss per vibration damper watts for 600 amps, 50 Hz Alternating Current	Watts	1
9.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
10.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000
11.	Percentage variation in reactance after fatigue test in comparison with that. before fatigue test	%	+/-40 (Maximum)
12.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
13.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5(IS 13229)
c)	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

5. Bundle Spacer for ACSR MOOSE conductor (For twin bundle conductor line only)

Sl.	**Description**	**Unit**	**Particulars/ Value**		
1.	Type of Bundle Spacer		Armour grip type		
2.			**Insert**	**Main body**	**Retaining rods (if any)**
(i)	Materials of components		Aluminum alloy 6061/ 65032	Tube Aluminum alloy 6063/63400; 6061/ 65032	Aluminum alloy 6061/65032

(ii)	Manufacturing process of component parts		Forged	Tube-extrusion	Heat treatment during manufacturing
3.	**Retaining rods (if used)**				
	(a) Number of retaining rods used for each spacer	no.	8		
	(b) Diameter	mm	7.87-0.1		
	(c) Length	mm	1100+15		
	(d) Minimum UTS of rods	Kg/mm^2	35		
4.	**Elastomer**				
	(a) Type		Chloroprene/Neoprene		
	(c) Moulded on insert		Yes		
	(d) Shore hardness		65 to 80		
	(e) Thickness on insert	mm	5(Average)		
	(f) Temp. range for which designed	°C	95		
5.	**Minimum ultimate tensile strength of spacer**				
	(a) Compressive load	kN	14		
	(b) Tensile load	kN	7		
6.	Slipping strength of spacer clamp				
	a) Before vibration test	KN	2.5		
	b) After vibration test	KN	2		
7.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320		
8.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro volts	1000		

6. Rigid Spacer for Jumper for ACSR MOOSE conductor (For twin bundle conductor line only)

Sl.	Description	Unit	Particulars/ Value
1.	**Material of component parts**		
	(a) Clamp		Aluminum alloy (4600)
	(b) Main 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	14

	(b) Tensile load	kN	7.0
4.	Slipping strength of spacer clamp	kN	2.5
5.	Maximum Magnetic power loss per spacer for 600 Amps, 50 Hz Alternating Current	Watts	1
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
7.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro volts	1000

7. Quad Spacer Damper for ACSR MOOSE conductor

Sl.	**Description**	**Unit**	**Particulars / Value**		
1.	Type of Clamps		Preformed rods.		
2.	Type of Damping element		Spring / Elastomer / EPDM		
3.	Material of				
	(a) Clamp		Al Alloy IS:4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)		
	(b) Body		Al Alloy 4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)		
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	14		
	(b) Tensile load	kN	7.0		
6.	Slipping strength of spacer clamp				
	(a) Before vibration test	kN	**Clamp type**	**Longitudnal Load (kN)**	**Maxm Slip permitted (mm)**
			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 600 amperes, 50Hz AC	Watt	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
10.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

8. Quad Rigid Spacer for Jumper for 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	14		
	(b) Tensile load	kN	7.0		
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

5.	Maximum magnetic power loss of at sub conductor current of 600 amperes, 50Hz AC	Watts	Below 1 watt.
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
8.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute

M) Accessories for ACSR Snowbird Conductor for 400 kV transmission line

Mid span compression Joint

Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of 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 for steel sleeve	gm/m^2	610	
4.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	33.00 ± 0.5	7.00 ± 0.2
ii)	Outside diameter	mm	54.00 ± 1.0	19.20 ± 0.5
iii)	Length	mm	735 ± 5	250 ± 5
5.	**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
iii)	Length	mm	785 (approx)	286 (approx)
6.	Slip strength	KN	112	

7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
9.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

Repair sleeve

Sl.	Description	Unit	Particulars/ Value
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter	mm	33.00 ± 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
iii)	Length	mm	330.00(Approx.)
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

TRIPLE SPACER DAMPER FOR TRIPLE ACSR SNOWBIRD CONDUCTOR

Sl.	Description	Unit	Particulars / Value
1.	Type of Clamps		Preformed rods.
2.	Type of Damping element		Spring / Elastomer / EPDM
3.	Material of		
	(a) Clamp		Al Alloy IS:4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)
	(b) Body		Al Alloy 4600 or Equivalent for Casting & Al Alloy 6061 or Equivalent (for Forging)

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	14		
	(b) Tensile load	kN	7.0		
6.	Slipping strength of spacer clamp				
	(a) Before vibration test	kN	**Clamp type**	**Longitudnal Load (kN)**	**Maxm Slip permitted (mm)**
			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 600 amperes, 50Hz AC	Watt	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		
10.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/ m2	610		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute		

TRIPLE RIGID SPACER FOR TRIPLE ACSR SNOWBIRD 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	14		
	(b) Tensile load	kN	7.0		
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
5.	Maximum magnetic power loss of at sub conductor current of 600 amperes, 50Hz AC	Watts	Below 1 watt.		
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		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m 2	610		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute c) all others: 6 dips of 1 minute		

T-connector

Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		Aluminium of purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
	i) Inside diameter	mm	33.00 ± 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

N) Accessories for ACSR ZEBRA conductor for 220 kV transmission line

1. Mid span compression Joint

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	31.00 ± 0.5	10.00 ± 0.2
ii)	Outside diameter	mm	48.00 ± 1.0	20.00 ± 0.5
iii)	Length	mm	710 ± 5	241 ± 5
4.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension (Corner to corner)	mm	47.00 ± 0.5	19.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5	16.00 ± 0.5
5.	Slip strength	KN	123.8	
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
7.	Galvanising			

a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

2. Repair sleeve

Sl.	Description	Unit	Particulars/ Value
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter	mm	31.00 ± 0.5
ii)	Outside diameter	mm	48.00 ± 1.0
iii)	Length	mm	275.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
i)	Outside dimension (Corner to corner)	mm	47.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5

3. Vibration Damper

Sl.	Description	Unit	Particulars/ Value
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc alloy
	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	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	5 to 45

8.	Maximum magnetic power loss per vibration damper watts for 500 amps, 50 Hz Alternating Current	Watts	1
9.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
10.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
11.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

O) Accessories for ACSR PANTHER conductor for 132 kV transmission line

1. Mid span compression Joint for ACSR PANTHER Conductor

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	23.00 ± 0.5	9.50 ± 0.2
ii)	Outside diameter	mm	38.00 ± 1.0	18.00 ± 0.5
iii)	Length	mm	610 ± 5	203 ± 5
4.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension (Corner to corner)	mm	37.00 ± 0.5	17.40 ± 0.5

ii)	Outside dimension (face to face)	mm	32.00 ± 0.5	15.10 ± 0.5
5.	Slip strength	KN	85.2	
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
7.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanising	%	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	

2. Repair sleeve for ACSR PANTHER 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	23.00 ± 0.5
ii)	Outside diameter	mm	38.00 ± 1.0
iii)	Length	mm	241.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
i)	Outside dimension (Corner to corner)	mm	37.00 ± 0.5
ii)	Outside dimension (face to face)	mm	32.00 ± 0.5

3. Vibration Damper for ACSR PANTHER Conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc alloy
	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	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	5 to 45
8.	Maximum magnetic power loss per vibration damper watts for 350 amps, 50 Hz Alternating Current	Watts	1
9.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
10.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
11.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

P) Accessories for ACSR Lapwing conductor for ±800 kV HVDC Transmission Line.

Mid span compression Joint for ACSR Lapwing				
Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of purity 99.5%	Mild Steel (Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 120 to 200	
3.	Weight of Zinc coating for steel sleeve	gm/m^2	610	

4.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter: Nominal Tolerance	mm mm	41 ± 0.5	10 ± 0.5
ii)	Outside diameter: Nominal Tolerance	mm mm	64 ± 1.0	21 ± 0.5
iii)	Length	mm	As per design*	As per design*
	*As per design to meet specified strength requirement (Min. Length- Al-Sleeve-860mm, Steel Sleeve-225mm)			
5.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension (Corner to corner)	mm	As per design	As per design
ii)	Outside dimension (face to face)	mm	As per design	As per design
iii)	Length	mm	As per design	As per design
5.	Slip strength	KN	178.6	
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 a voltage gradient of 22 kV/cm on conductor under dry condition	kV	880	
8.	Maximum Radio Interference Voltage at 1 MHz when subjected to conductor surface gradient of 22 kV/cm (positive) under dry condition	Micro Volts	1000	

Repair sleeve for ACSR LAPWING Conductor

Sl.	Description	Unit	Particulars/ Value
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter: Nominal Tolerance	mm mm	41 ± 0.5
ii)	Outside diameter: Nominal Tolerance	mm	64 ±1.0
iii)	Length	mm	As per design
	*As per design to meet specified strength requirement (Min. Length- 495mm)		
3.	**Dimensions of Aluminum Sleeve After compression**		

i)	Outside dimension (Corner to corner)	Mm	As per design
ii)	Outside dimension (face to face)	Mm	As per design
iii)	Length	Mm	As per design
4.	Minimum corona Extinction voltage kV (rms) under a voltage gradient of 22 kV/cm on conductor under dry condition	kV	880
5.	Maximum Radio Interference Voltage at 1 MHz when subjected to conductor surface gradient of 22 kV/cm (positive) under dry condition	Micro Volts (μV)	1000

Q) Accessories for 7/3.66 mm GS Earthwire for 400 kV and 765 kV transmission line

1. Mid span compression Joint for 7/3.66 mm GS Earthwire

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	%	75		

	percentage of the resistance of equivalent length of bare Earthwire		

2. Flexible AL Bond for 7/3.66 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Stranding		19(12+6+1)/dia2.54
2.	Cross sectional area	Sq.mm	95
3.	Length of aluminium cable	mm	750+5
4.	Material of lugs		Aluminum alloy
5.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

3. Vibration Damper for 7/3.66 mm GS Earthwire

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)

4. Suspension Clamp for 7/3.66 mm GS Earthwire

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
5.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

5. Tension Clamp for 7/3.66 mm GS Earthwire

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%		
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	120-200		
3.	**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
4.	**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	
5.	Slip strength	KN	65		
6.	Minimum Breaking strength of assembly (excluding clamp)	KN	70		
7.	Compression Pressure	Ton	100		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/ m^2	610		
b)	Purity of Zinc used for galvanising	%	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		

R) Accessories for 7/3.15 mm GS Earthwire for 220 kV and 132 kV transmission line

1. Mid span compression Joint for 7/3.15 mm GS Earthwire

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.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 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	315 ± 5	230 ± 5	25 ± 2
4.	**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	
5.	Slip strength	KN	53.20		
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75		
7.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610		
b)	Purity of Zinc used for galvanising	%	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		

2. Flexible AL Bond for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Stranding		19(12+6+1)/dia2.54
2.	Cross sectional area	Sq.mm	95
3.	Length of aluminium cable	mm	750+5
4.	Material of lugs		Aluminum alloy
5.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

3. Vibration Damper for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc alloy
	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)
10.	Galvanising		

a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

4. Suspension Clamp for 7/3.15 mm GS Earthwire

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 (Fe 410, IS 2062)
2.	Total Drop (Maximum)	mm	150
3.	Breaking Strength (Minimum)	kN	25
4.	Slipping Strength	kN	9 to 14
5.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

5. Tension Clamp for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value		
1.	**Material of components**				
	(i) Anchor Shackle		Forged Steel		
	(ii) Compression Clamp				
	a) Steel Sleeve		Mild Steel (Fe 410, IS 2062)		
	b) Aluminium sleeve		Aluminium of purity 99.5%		
	c) Aluminium Filler sleeve		Aluminium of purity 99.5%		
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	100-200		
3.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 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	220 ± 5	180 ± 5	25 .0±2
4.	**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
5.	Slip strength	KN	53.20	
6.	Minimum Breaking strength of assembly (excluding clamp)	KN	70	
7.	Compression Pressure	Ton	100	
8.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610	
b)	Purity of Zinc used for galvanising	%	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	

S) Accessories for 7/4.5 mm GS Earthwire for ±800 kV transmission line

Mid span compression Joint for 7/4.5 mm GS Earthwire					
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: Nominal Tolerance	mm mm	24-28 ± 0.5	14-15 ± 0.5	14-15 ± 0.5
ii)	Outside diameter: Nominal Tolerance	Mm mm	32-38 ± 0.5	24-27 ± 0.5	24-27 ± 0.5
iii)	Length	mm	As per design*	As per design*	As per design*
	* As per design to meet specified strength requirement (Minimum length-Al-Sleeve-525mm, Steel sleeve-345mm, Alu filler tube-50mm)				
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension (Corner to Corner)	mm	As per design	As per design	

ii)	Outside dimension (face to face)	mm	As per design	As per design
iii)	Length	mm	As per design	As per design
6.	Slip strength	KN	100.9	
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75	

2.	**Flexible AL Bond for 7/4.5 mm GS Earthwire**		
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Stranding		19(12+6+1)/dia2.54
2.	Cross sectional area	Sq.mm	95
3.	Length of aluminium cable	mm	750+5
4.	Material of lugs		Aluminum alloy
5.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40
3.	**Vibration Damper for 7/4.5 mm GS Earthwire**		
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	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	%	+/-25(Maximum)
9.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-25 (Maximum)

4. Suspension Clamp for 7/4.5 mm GS Earthwire			
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	45
4.	Slipping Strength	kN	19 to 27
5.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	610
b)	Purity of Zinc used for galvanising	%	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

Tension Clamp for 7/4.5 mm GS Earthwire					
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: Nominal Tolerance	mm mm	24-28 ± 0.5	14-14.5 ± 0.5	14-14.5 ± 0.5
ii)	Outside diameter: Nominal Tolerance	mm mm	32-38 ± 0.5	24-28 ± 0.5	24-28 ± 0.5
iii)	Length	mm	As per design	As per design	As per design
5.	**Dimensions of Sleeve after compression**				

			Aluminium Sleeve	Steel Sleeve
i)	Outside dimension (Corner to Corner)	mm	As per design	As per design
ii)	Outside dimension (face to face)	mm	As per design	As per design
6.	Slip strength	KN	100.9	
7.	Minimum Breaking strength of assembly (excluding clamp)	KN	120	
8.	Compression Pressure	Ton	100	

Annexure-C

TYPICAL PLACEMENT CHART FOR SPACER DAMPER																					
Span in Meter	No.	Sub Span In meter																			
100	2	34	31	35																	
105	2	34	40	31																	
110	2	34	45	31																	
115	2	34	50	31																	
120	2	34	55	31																	
125	2	34	60	31																	
130	2	34	65	31																	
135	2	39	65	31																	
140	2	39	65	36																	
145	3	34	39	44	28																
150	3	35	40	45	30																
155	3	36	41	47	31																
160	3	37	43	48	32																
165	3	39	44	49	33																
170	3	40	45	50	35																
175	3	40	47	53	35																
180	3	40	50	55	35																
185	3	40	52	58	35																
190	3	40	55	60	35																
195	3	40	57	63	35																
200	3	39	65	58	38																
205	4	37	50	40	46	32															
210	4	38	51	41	47	33															
215	4	36	53	42	50	34															
220	4	39	45	55	44	37															
225	4	39	45	55	49	37															
230	4	39	50	55	49	37															
235	4	39	49	57	52	38															
240	4	39	55	59	50	37															
245	4	39	55	65	49	37															
250	4	39	65	50	58	38															
255	4	40	65	54	61	35															
260	5	40	48	44	52	41	35														
265	5	40	49	45	54	42	35														
270	5	37	52	45	50	47	39														
275	5	36	56	45	55	44	39														
280	5	38	60	46	54	43	39														
285	5	38	60	49	55	44	39														
290	5	38	62	50	56	45	39														

Note: In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead end clamp.

295	5	38	64	51	57	46	39														
300	5	38	62	53	57	51	39														
305	5	38	64	56	60	48	39														
310	5	38	62	55	60	56	39														
315	5	40	62	54	59	65	35														
320	6	40	45	55	49	43	53	35													
325	6	40	46	56	50	44	54	35													
330	6	40	47	57	51	45	55	35													
335	6	38	55	50	45	51	57	39													
340	6	38	57	51	46	52	57	39													
345	6	38	57	52	44	55	60	39													
350	6	38	59	52	44	55	63	39													
355	6	38	58	52	45	60	63	39													
360	6	40	53	62	57	52	61	35													
365	6	40	54	63	58	53	62	35													
370	6	40	55	65	59	54	62	35													
375	7	40	56	47	52	43	48	54	35												
380	7	40	57	47	53	44	49	55	35												
385	7	40	58	48	54	44	50	56	35												
390	7	40	58	49	55	45	51	57	35												
395	7	38	52	57	50	55	45	59	39												
400	7	40	60	51	56	47	53	58	35												
405	7	40	61	52	57	47	54	59	35												
410	7	40	62	52	58	48	55	60	35												
415	7	40	62	54	59	50	55	60	35												
420	7	40	63	54	60	50	57	61	35												
425	7	40	56	62	58	53	57	60	39												
430	7	40	57	64	58	52	57	63	39												
435	7	40	59	63	60	55	58	61	39												
440	7	40	59	64	61	56	59	62	39												
445	8	40	46	56	50	58	54	49	57	35											
450	8	40	48	56	51	59	54	49	58	35											
455	8	40	48	57	52	60	55	50	58	35											
460	8	39	58	55	52	49	53	56	61	37											
465	8	39	59	56	53	50	54	57	60	37											
470	8	39	60	57	54	51	54	57	61	37											
475	8	39	63	60	54	47	55	58	62	37											
480	8	40	52	61	55	64	58	53	62	35											
485	8	40	53	61	56	64	59	54	63	35											
490	9	40	58	48	43	51	56	47	53	59	35										
495	9	40	58	48	44	52	57	48	54	59	35										
500	9	40	59	49	44	52	58	48	55	60	35										

Note: In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead end clamp.

505	9	40	59	50	45	53	59	48	55	61	35										
510	9	40	60	51	45	54	59	49	55	62	35										
515	9	40	61	51	46	54	59	51	56	62	35										
520	9	40	61	51	46	55	60	52	57	63	35										
525	9	40	62	52	47	56	61	51	57	64	35										
530	9	39	62	56	59	53	57	51	55	60	38										
535	9	39	65	56	59	53	57	51	55	62	38										
540	9	40	64	54	49	57	63	54	59	65	35										
545	9	40	65	55	49	59	63	54	60	65	35										
550	10	40	53	58	48	55	45	52	60	48	56	35									
555	10	40	53	58	49	56	46	52	60	49	57	35									
560	10	40	54	59	50	56	47	53	60	49	57	35									
565	10	40	55	60	51	57	47	53	60	50	57	35									
570	10	40	55	61	51	57	48	54	61	51	57	35									
575	10	40	55	61	51	59	49	54	62	51	58	35									
580	10	37	59	52	58	51	56	61	54	60	53	39									
585	10	37	62	52	59	51	56	61	55	60	53	39									
590	10	37	64	52	59	51	56	61	55	63	53	39									
595	10	37	65	53	59	52	56	62	55	64	53	39									
600	10	37	65	54	59	53	57	61	56	64	55	39									
605	10	37	65	55	60	53	57	61	56	64	58	39									
610	10	37	65	56	63	54	57	60	56	64	59	39									
615	10	39	65	59	62	54	57	61	56	64	58	40									
620	11	40	58	51	61	54	49	59	52	45	55	61	35								
625	11	40	58	52	61	55	49	60	52	45	56	62	35								
630	11	40	59	52	62	56	49	60	53	46	56	62	35								
635	11	40	59	53	62	56	50	61	53	46	57	63	35								
640	11	39	54	61	55	60	52	58	53	57	51	60	40								
645	11	39	54	62	56	61	52	59	53	58	51	60	40								
650	11	39	55	62	57	61	53	59	54	58	52	60	40								
655	11	39	55	63	57	62	53	60	54	59	52	61	40								
660	11	39	56	63	58	62	54	60	55	59	53	61	40								
665	11	39	57	65	58	62	54	62	55	59	53	61	40								
670	11	39	57	65	58	64	54	62	55	60	53	63	40								
675	11	39	58	65	59	64	55	62	56	60	54	63	40								
680	11	39	60	64	62	63	55	62	57	60	56	62	40								
685	12	40	60	50	57	62	53	58	49	54	60	50	57	35							
690	12	40	61	51	58	62	53	59	49	55	60	50	57	35							
695	12	40	61	51	58	63	54	59	50	55	61	50	58	35							
700	12	40	61	51	58	63	55	60	50	56	61	51	59	35							
705	12	39	62	55	63	54	61	52	59	53	57	60	50	40							
710	12	39	62	56	63	55	61	53	59	54	57	60	51	40							

Note: In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead end clamp.

715	12	39	63	56	64	55	62	53	60	54	57	61	51	40							
720	12	39	63	57	64	56	62	54	60	55	59	53	58	40							
725	12	39	64	57	65	56	63	54	61	55	60	53	58	40							
730	12	39	64	58	65	57	63	55	61	56	60	54	58	40							
735	13	40	56	61	53	48	56	62	53	47	57	52	60	55	35						
740	13	40	56	61	54	48	57	62	54	47	57	52	61	56	35						
745	13	40	57	63	54	49	57	62	54	47	57	52	62	56	35						
750	13	40	58	63	55	50	57	62	54	48	58	53	61	56	35						
755	13	40	58	63	55	50	58	63	54	48	58	53	63	57	35						
760	13	40	58	65	55	50	59	64	55	48	58	53	63	57	35						
765	13	40	59	65	56	51	59	64	55	49	59	53	63	57	35						
770	13	40	60	65	56	51	59	64	56	49	59	54	64	58	35						
775	13	40	60	65	56	52	59	64	56	50	60	55	65	58	35						
780	13	40	65	58	53	59	54	60	55	61	56	62	55	63	39						
785	14	40	61	55	49	58	53	47	56	61	51	58	48	53	60	35					
790	14	40	61	56	49	59	53	47	56	63	51	59	48	53	60	35					
795	14	40	62	56	50	59	53	47	56	63	52	59	49	54	60	35					
800	14	40	63	56	50	59	54	48	57	63	52	59	49	55	60	35					
805	14	40	63	57	51	60	54	48	57	63	52	59	50	55	61	35					
810	14	40	63	57	51	60	55	48	57	63	54	61	50	55	61	35					
815	14	40	64	57	52	60	55	49	58	63	54	61	51	55	61	35					
820	14	40	64	58	52	61	55	49	58	64	54	61	51	56	62	35					
825	14	40	64	58	52	61	56	49	59	64	55	61	52	57	62	35					
830	14	40	65	58	53	62	56	49	59	64	55	62	52	57	63	35					
835	15	40	53	61	56	50	46	54	61	57	51	60	54	45	51	61	35				
840	15	40	53	62	56	51	46	54	61	57	51	61	55	45	52	61	35				
845	15	40	54	62	57	51	46	54	62	57	52	61	55	46	52	61	35				
850	15	40	54	62	58	51	46	54	63	57	52	61	56	46	53	62	35				
855	15	40	54	62	58	52	46	55	63	58	52	61	56	47	53	63	35				
860	15	40	55	63	58	52	47	55	63	58	53	62	56	47	53	63	35				
865	15	40	55	64	59	52	47	55	64	58	53	62	57	47	54	63	35				
870	15	40	56	64	59	53	47	56	64	59	53	62	57	47	54	64	35				
875	15	40	56	64	59	53	48	56	65	59	54	63	57	48	54	64	35				
880	15	40	56	65	60	53	48	56	65	60	54	63	58	48	54	65	35				
885	15	40	56	65	60	53	48	56	65	60	55	64	58	50	55	65	35				
890	15	40	65	55	64	57	63	59	49	60	50	61	51	62	52	63	39				
895	15	40	65	55	64	58	63	59	50	60	51	61	52	62	53	63	39				
900	16	40	58	51	61	56	51	61	55	49	60	52	63	57	51	45	55	35			
905	16	40	58	52	62	57	52	61	55	49	60	52	63	57	52	45	55	35			
910	16	40	58	52	62	57	52	62	56	50	60	53	63	57	52	46	55	35			
915	16	40	59	52	63	58	53	62	56	50	60	54	63	57	52	46	55	35			
920	16	40	60	52	63	58	53	62	56	51	60	54	63	58	53	46	56	35			

Note: In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead end clamp.

925	16	40	60	53	63	58	53	63	57	51	61	54	64	58	53	46	56	35			
930	16	40	60	53	64	59	53	63	57	51	61	55	64	58	53	48	56	35			
935	16	40	61	53	64	59	54	64	57	51	61	55	65	58	53	48	57	35			
940	16	40	61	54	64	59	54	64	57	52	62	55	65	59	54	48	57	35			
945	17	40	53	47	56	51	61	56	50	60	53	48	57	62	51	46	57	62	35		
950	17	40	53	47	56	51	61	56	51	60	54	48	57	63	52	47	57	62	35		
955	17	40	54	47	57	51	62	57	51	61	54	48	57	63	52	47	57	62	35		
960	17	40	54	48	57	52	62	57	51	61	54	49	57	63	53	48	57	62	35		
965	17	40	54	48	57	52	62	57	52	61	55	49	58	63	53	48	58	63	35		
970	17	40	55	48	58	53	63	58	52	61	55	49	58	63	53	48	58	63	35		
975	17	40	55	49	58	53	63	58	52	61	55	49	59	64	53	48	59	64	35		
980	17	40	55	49	58	53	63	58	52	62	56	50	59	64	54	49	59	64	35		
985	17	40	55	49	59	54	64	58	53	62	56	50	59	64	54	49	59	65	35		
990	17	40	55	49	59	54	64	58	53	63	56	51	59	65	55	49	60	65	35		
995	17	40	56	50	59	54	64	59	53	63	56	51	60	65	55	50	60	65	35		
1000	18	40	45	50	59	52	62	57	52	62	57	48	53	61	56	51	44	54	62	35	
1005	18	40	45	50	60	53	63	57	52	63	58	48	53	61	56	51	44	54	62	35	
1010	18	40	45	50	60	53	63	57	52	63	58	49	53	62	57	51	45	54	63	35	
1015	18	40	46	51	60	54	63	57	52	63	58	49	54	62	57	51	45	55	63	35	
1020	18	40	46	51	61	54	64	58	53	63	58	49	54	62	57	52	45	55	63	35	
1025	18	40	47	51	61	54	64	59	53	63	58	49	55	62	58	52	45	56	63	35	
1030	18	40	47	51	61	54	64	59	54	64	59	50	55	62	58	53	45	56	63	35	
1035	18	40	47	52	61	55	64	59	54	64	59	50	55	63	58	53	46	56	64	35	
1040	18	40	47	52	61	55	64	59	54	64	59	50	55	64	59	54	47	57	64	35	
1045	18	40	47	53	61	56	64	59	54	65	60	50	55	65	59	54	47	57	64	35	
1050	18	40	48	53	61	56	64	59	55	65	60	51	56	65	59	54	47	57	65	35	
1055	19	40	53	61	56	49	44	53	62	56	52	61	56	50	60	54	45	50	56	62	35
1060	19	40	53	61	56	49	44	54	62	57	52	62	56	51	60	54	45	50	57	62	35
1065	19	40	53	62	57	50	44	54	63	57	52	62	56	51	61	54	45	50	57	62	35
1070	19	40	54	62	57	50	45	54	63	57	52	62	57	51	61	55	45	50	57	63	35
1075	19	40	54	62	57	50	45	55	64	58	53	62	57	51	61	55	45	50	58	63	35
1080	19	40	54	63	57	50	45	55	64	58	53	62	57	52	62	55	46	51	58	63	35
1085	19	40	55	63	58	51	46	55	64	58	53	63	57	52	62	55	46	51	58	63	35
1090	19	40	55	64	59	51	46	55	65	59	53	63	57	52	62	55	46	51	58	64	35
1095	19	40	56	64	59	52	46	55	65	59	53	64	57	52	62	55	47	51	59	64	35
1100	19	40	56	64	59	52	47	56	65	59	53	64	58	52	63	55	47	52	59	64	35

Note: In case of tension towers, one additional Spacer Damper shall be placed within 10m of dead end clamp.