HARDWARE AND ACCESSORIES

August 2023

Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

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TECHNICAL SPECIFICATION OF HARDWARES FOR INSULATOR STRING, CONDUCTOR AND EARTHWIRE ACCESSORIES

1. GENERAL:

A. SCOPE:

This specification covers design, type testing, manufacture, testing at manufacturer's works before dispatch, supply and delivery of complete hardware fittings and accessories to be used in the construction Sub Station and Transmission lines.

The bidders shall also have to take the responsibility for matching their hardware fittings with the Conductor/Earth wire & Insulator Disc and conduct tests on the complete string arrangement.

B. STANDARDS:

The conductor and earth wire accessories and hardware fittings shall conform to the latest edition of the following Indian Standards as amended up to date unless otherwise specified hereinafter. Corresponding standards of IEC or other reputed international standards which ensure equivalent or better quality are acceptable. In such case English version of standards followed shall be furnished.

. The equipment shall also comply with the latest revision of Indian Electricity Act and Electricity Rules and any other electrical statutory provision, rules and regulations.

The Indian Standards, to be followed are indicated below:

Sl. No.	International standards	Indian Standard	T i t l e
1	BS:3436-1986	IS:209 – 1996	Specification for Zinc
2	BS:215-1970	IS:398 – 1982(Part IV)	Aluminium Alloy Conductors
3	IEC:1098-1991 BS:215-1970	IS:398 – 1982(Part V)	Aluminium Conductors Galvanised steel Reinforced for Extra high voltage (400KV)
4	IEC:383-1993	IS:731 – 1971	Porcelain Insulators for Overhead Power lines with a Nominal Voltage greater than 1000 Volts
5		IS:1570 – 1961	Steel Plates, round & flats
6		IS:1576 – 1973	Electroplated Coating of Zinc on Iron & Steel
7		IS:2004 – 1962	Forged Steel

8		IS:2070 – 1962	Method of Impulse Voltage Testing
9		IS:2071 -1962	Method of High Voltage Testing
10		IS:2121 – 1981	Conductor and Earthwire Accessories for Overhead Power line a) Armour Rods, Binding wire for conductor b) Mid-span joints and repair sleeves
11		Do-Part I – 1981	Insulator Fittings for Overhead Power lines with a nominal voltage greater than 1000 volts a) General requirements & Tests b) Dimensional requirements c) Locking Devices d) Test for locking device
12		Do-Part II – 1981	Recommended practice for Hot Dip Galvanising of Iron and Steel
13		IS:2486	Methods of Testing Uniformity on zinc Coated Articles
14		Do-Part I – 1971	Hexagonal Bolts and Nuts
15	ASTM A472-729 BS:443-1969	Do-Part II – 1974	Galvanised Coating on Round Steel wires
16	ISO/R-272	Do-Part III- 1974	Hexagonal Bolts for Steel Structure
17	BS:433 ISO:1460(E)	Do-Part IV	Method for Determination of weight of Zinc Coating on Iron & Steel Articles
18	IEC:437 / NEMA:107/CISPR	IS:2629 – 1966	Method s of RI Test of HV Insulators
19		IS:2633 – 1972	Methods of Switching Impulse Test on HV Insulators
20		IS:3138 – 1966	Stock bridge Vibration Dampers for Overhead Power Lines
21		IS:4826 – 1968	Spacers & Dampers for Quad /Twin Horizontal Bundle Conductors
22	ASTM-D1 171	IS:6639 – 1972	Ozone test on Elastomer
23		IS:6745 – 1972	Electric Power Connectors

C. DEVIATION:

Normally the offer should be as per Technical Specification without any deviation. But any deviation proposed must be mentioned in the Deviation Schedule. Deviation not mentioned in 'Deviation Schedule' will not be considered afterwards.

2. SYSTEM PARTICULARS:

A. Electrical System Data:

	33 KV	**132 KV**	**220 KV**	**400 KV**
Maximum Voltage (KV)	36	145	245	420
BIL (Impulse withstand for –ve polarity of complete string) (KVp)	170	650	1050	1425
Frequency	50 HZ			
System grounding	through grounding transformer	Effectively Earth		
Power frequency withstand voltage (wet) of complete string (KVrms)	70	275	460	630
Switching surge withstand voltage (wet) of complete string (KVpeak)	-	-	-	1050
Minimum Corona extinction voltage at 50Hz	-	-	-	Not less than 320 KVrms phase to ground
RIV at one MHZ for 305 KV phase to earth voltage	-	-	-	Not exceeding 1000 micro volts

B. Conductor Data:

	Name	ACSR "Panther"	ACSR "Zebra"	ACSR "Moose"
a)	Strands and wire diameter of i) Aluminium ii)Steel	 30/3.00 mm 7/3.00 mm	 54/3.18 mm 7/3.18 mm	 54/3.53 mm 7/3.53 mm
b)	Conductor per phase	1 no.	1 no.	2 / 4 nos.

c)	Spacing between the conductors of same phase	-	-	457 mm
d)	Overall diameter of conductor	21 mm	28.62 mm	31.77 mm
e)	Sectional area of Aluminium	-	418.6 mm2	515.7 mm^2
f)	Weight of conductor	976 Kg/Km	1621 Kg/Km	2004 Kg/Km
g)	Minimum Ultimate tensile strength of the conductor	9127 Kgf	13316 Kgf	16250 Kgf
h)	Total sectional area	207 mm^2 (Al)	418.6 mm^2 (Al)	597 mm^2
i)	Modulus of elasticity (Kg/sqcm)			$0.689x10^6$
j)	Coefficient of linear expansion			$19.3x10^{-6}/^oC$

C. Galvanised Steel Earthwire:

		220 KV/132 KV	**400 KV**
a)	Size (strands & wire diameter	7/3.15 mm	7/3.66 mm
b)	Overall diameter	9.45 mm	10.98 mm
c)	Standard weight	428 Kg/Km	583 Kg/Km
d)	Location of earthwire	One continuous earthwire to run horizontally on top of the tower	One continuous earthwires to run horizontally on top of the tower through one peak*
e)	Minimum breaking load	5710 Kgf	6969 Kgf
f)	Total sectional area	54.57 mm2	73.65 mm^2
g)	Modulus of elasticity	1.933x106 g/Sqcm.	$1.860x10^6$ Kg/Sqcm.
h)	Co-efficient of linear expansion	11.5x10-6/oC	$11.5x10^{-6}/^oC$

* OPGW wire will run through another peak.

3. WORKMANSHIP:

a) All the hardware fittings and Conductor/Earthwire Accessories shall be of the latest design and conform to the modern practices adopted in the extra high voltage field. The tenderer shall offer only such equipment which is guaranteed by him to be satisfactory and suitable for transmission lines and will give continuous good performance.

b) The design, manufacturing process and quality control of all the materials shall be such as to given (i) good finish of materials, elimination of sharp edges, corners etc. to limit corona and radio interference and (ii) Maximum factor of safety and highest mobility provides best resistance to consider.

c) All ferrous parts including bolts, nuts & washers shall be hot dip galvanised after all machining has been completed. Nuts may be tapped (threaded) after galvanising. The spring washers shall be electro galvanised. The bolt threads shall be undercut to take care of increase in diameter due to galvanising and shall be done in accordance with IS 2633-1986. Bolts, Nuts & Washers shall withstand 4(four) dips while spring washers 3 dips-other galvanised materials shall be guaranteed to withstand at least 6 successive dips each lasting 1(one) minute under standard 'Preece' test for galvanising.

d) The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from such imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be electrolytic High Grade (HG) quality of 99.95% purity. It shall conform to the requirements of IS:209 – 1992.

e) Forged/Cast fittings shall be free from all internal defects like shrinkage inclusion, blow holes, cracks etc. 100% checking of each item is to be made and a certificate to this effect is to be produced with each lot offered for inspection.

f) All current carrying part shall be designed and manufactured so that contact resistance is reduced to minimum.

g) No component shall have sharp ends or edges, abrasion or projection 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 machining surfaces shall be such as to prevent corrosion of the contact under service conditions.

h) All bolts and clamps shall have suitable and corona free locking arrangements and guard against vibration loosening.

i) Welding of aluminum shall be by inner gas shielded tungsten arc or inner gas shielded metal earth process. Welding should be clear, sound, smooth, and uniform without overlaps properly fused and completely shield. There should be no cracks, voids, incomplete penetration, incomplete fusion, undertaking or inclusions. Porosity shall be minimized so that mechanical strength of aluminum alloyed are affected.

4. TECHNICAL PARTICULARS OF LINE HARDWARES

4.1. DETAILS OF HARDWARE FITTINGS:

i. General design of the hardware fittings shall be such as to ensure uniformity, high strength, freedom from corona formation and high resistance against corrosion.

ii. All shackles, eyes, fasteners, suspension & Tension Clamp and other fittings for attaching insulator to the tower or line Conductor shall be so designed as to reduce any damage to the Conductor, Insulator, or the fittings arising from Conductor vibration.

iii. Smooth finished surface of all parts shall be ensured to reduce the level of RI of the line.

iv. Design of the fittings shall be such as to avoid local corona formation or discharges likely to cause interference to telecommunication signals of any kind.

v. Adequate bearing area between fittings shall be provided and point or line contacts shall be avoided. All current carrying parts shall be designed to have minimum contact resistance.

vi. The hardware fittings shall be as per specification and approved drawings.

vii. Each of the above hardware fittings shall be supplied complete in all respect.

viii. Standard anchor shackles for the suspension strings should be suitable for attaching to “U” hanger of 22 mm dia to be supplied with the tower. The attachment fittings to be supplied with the tower shall be so arranged that the place of the “U” hanger shall be transverse to the run of the conductor.

ix. ‘D’ Shackle to be supplied shall be suitable for attaching the tension strings to the strain plates of tower. The strain plates to be supplied with the towers will have a minimum thickness of 20 mm with vertical holes between 25 mm to 32 mm diameter.

x. Suitable yoke plates for single/double suspension and Single/Quad Tension strings for conductor arrangements shall be supplied as per requirement.

xi. Sag adjustment Plate/turnbuckle for Quad tension/single tension assembly respectively for 400KV line only shall be supplied.

xii. Suspension and tension clamps assembly to sit all types of Conductor size are to be supplied.

xiii. Other fittings such as corona control ring (for 400KV only) arcing horns eye link, ball clevis, socket clevis, clevis eye, clevis, chain link etc. shall have to be supplied to make the insulator string complete.

xix. For every set of Quad tension hardware fittings, one number 250mm rigid spacer suitable for Quad ACSR Moose conductor shall also be provided to ensure that there is no fouling of conductors or any components of the fittings while bringing down top two conductors of Quad bundle at the jumper connection.

4.2. INTERCHANGEABILITY:

All the hardware fittings (Suspension and Tension type) together with ball and socket fittings shall be of standard design so that these hardwares are interchangeable with each other.

4.3. CORONA AND RADIO INTERFERENCE PERFORMANCE:

Sharp edges on all hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. No part of any hardware shall be subjected to excessive localised pressure. The hardware shall not produce noise owing to corona under the operating conditions.

The Bidder shall guarantee the satisfactory corona and radio interference performance of the hardware fittings offered.

4.4. HARDWARE ACCESSORIES:

A. BALL AND SOCKET DESIGNATION:

i. Ball fittings shall be made of class IV steel as per IS 2004 are equivalent grade forged in one piece. They shall be normalised to achieve the minimum breaking strength specified in the respective drawings. Before galvanising of ball fittings, all dying crashing in shank and on the bearing surface of the ball shall be carefully removed without reducing the dimension below the requirement.

Socket ends, before galvanizing shall be of uniformed contour. The bearing surface of socket ends shall be uniformed about the entire circumference without depression of high spots. The international contour of socket ends shall be concentrate with the axis of fittings as per IS 2486/IEC 120. The axis of the bearing surfaces of socket ends shall be coaxial with the axis of fittings.

ii. The dimension of the ball and socket shall be of 20 mm designation in accordance with the standard dimension as per IS:2486 (Part II) - 1974 in case of 400KV line. And the nominal pin ball shank diameter of the insulator shall be 20 mm for tension string unit & 16 mm for

suspension string unit for 220 KV/132 KV line. All dimensions are to be checked by appropriate gauge after galvanizing only.

iii. Ball eye/Clevis & ball/Socket Clevis.

All the load bearing HRH bolts shall be of property class 5.6 to 8.8 as per IS:6639 – 1972 with matching property class of nuts. The bolt and nuts shall be galvanised as per IS:1367 (Part 13). Thickness of the spring and place washers, wherever used, shall be of minimum 2.5 mm.

Split pins of Phosphor bronze / stainless steel are to be used. Clevis and eyes shall be suitable for appropriate fittings for which they are connected. The minimum breaking strength of these fittings shall not be less than the respective minimum breaking strength of the insulator strings. Before assembly, all these parts are to be checked against void, internal crack etc.

B. ANCHOR SHACKLE & CHAIN LINK:

The above fittings components shall be made of forged steel of class designation-IV as per IS 2004-1978. All the load bearing HRH bolts shall be of property class 5.6 to 8.8 as per IS:6639-1972 with matching property class of nuts. The bolt and nuts shall be galvanised as per IS:1367 (Part 13). Thickness of the spring and plane washers, wherever used, shall be of minimum 2.5 mm. Split pins of Phosphor bronze / stainless steel are to be used. The diameter and centre clearances will be as per matching loads to be catered. Minimum breaking strength of the fittings will be the U.T.S. of the respective strings where the same is to be used. All these parts are to be checked individually and thoroughly before assembly so that absence of void, internal cracks etc. may be ensured.

C. SECURITY CLIPS AND SPLIT PINS:

Security clips for use with ball and socket coupling shall be 'R' shaped hump type and shall provide positive locking of the coupling as per IS 2486 (Part IV) – 1981. The legs of the Security Clips shall be spread after assembly in the works to prevent complete withdrawal from the Socket. The locking device shall be resilient, corrosion of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall the locking device allow separation of fittings.

Split pins shall be used with cotter bolts.

Security clip and Split Pin shall be made of good quality phosphor bronze / stainless steel as per Is-1385.

D. ARCING HORNS:

i. The Arcing horns shall be suitably designed and attached on the hardware fittings only. The attachments shall be provided with minimum two bolts for fitting the arcing horns. It shall be made of mild steel tube or rod and hot dip galvanised.

ii. The arcing horns to be supplied shall be either loop or ball ended rod type or tubular type. The minimum clearance between the arcing horn and corona control rings/grading ring at nearest point shall be 3050 mm minimum (in 400 KV).

iii. Arcing horns should be provided at both tower and line side.

iv. The air gap should be so adjusted to ensure effective operation under actual field condition.

E. YOKE PLATES:

The Yoke plates shall be of high quality mild steel and shall be of hot dip galvanised.

The strength of the Yoke Plate / arcing horn shall be adequate to withstand the designed load. The plates shall be triangular or rectangular in shape as may be necessary. It shall be ensured that grain of yoke plate shall be in the direction of tensile load. All the coroners and edges shall be rounded of with a radius of at least 3 mm. Yoke plate shall have holes for fixing Corona control rings and hole in the centre for supporting stringing blocks.

Holes shall be cylindrical, clean cut and perpendiculars to the plain of the material. The periphery of the holes shall be free from burrs. The holes provided for bolts in the yoke plate should satisfy shear edge conditions as per clause 8.10 IS: 800

F. CORONA CONTROL RING/GRADING RING (For 400 KV line):

i. The Corona Control rings shall be provided with all string hardware fittings and shall be of such shape &design that it should cover at least one disc insulator in disc insulator string so that they will reduce the voltage across the insulator units adjacent to the conductor for each insulator string to a value which will prevent visual Corona forming on the metal parts of the insulators and shall minimize the radio interference voltage on the complete insulator string assemblies.

ii. The Coronal Control ring/Grading ring shall be made of high strength heat treated aluminium alloy tube of suitable size with a minimum wall thickness of 2.5 mm. If mild 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 centre of the Corona Control ring/Grading ring shall be suitably grinded before buffing and shall not allow penetration of water inside the tube during service. Alternately, aluminium tubes/flats of suitable dimensions welded to the corona control ring /grading ring may be used for connection to yoke plate. The mechanical strength of the welded joint should be atleast 2000 kgf. The brackets for supporting the rings and mounting bolts shall be of high strength aluminium alloy or hot dip galvanised mild steel. The welding of corona control ring should be done with argon welding. The design shall be such as to limit the maximum voltage at the line side to 9%.

iii. The Corona Control rings should have a satin finish and not a bright glossy surface to pass electrical requirements for smoothness. No blemish should be seen or felt when rubbing a hand over the metal surface.

G. SAG ADJUSTMENT DEVICE:

i. The Sag adjustment plates shall be of high quality mild steel hot dip galvanised to be provided with Quad /Twin tension hardware fittings shall be of three plate type. The minimum ultimate tensile strength of the device shall be provided with safety locking arrangement. Its design shall be such that adjustment should be possible with ease, speed and safety.

ii. The maximum length of the total sag adjustment device from the connecting part of rest of the hardware fitting shall be about 520 mm. The details of maximum and minimum adjustment possible and steps of adjustment shall be clearly indicated in the tender drawings. An adjustment of at least 150 mm should be possible with the above device.

iii. The holes provided for bolts should satisfy shear edge conditions as per clause 8.10 of IS 800.

H. TURN BUCKLE:

The turn buckle to be provided with single tension fittings and double tension fittings shall be made from class-II steel and shall have the minimum ultimate tensile strength of 160 KN.

The maximum length of the turn buckle from the connecting part of the rest of the hardware fitting shall be 520 mm.

The details of the minimum and maximum adjustment possible shall be clearly indicated in the tender. With the turn buckle and adjustment of at least 150 mm should be possible.

I. SUSPENSION CLAMP ASSEMBLY:

i. The suspension assembly shall be suitable for A.C.S.R. Moose conductor for 400 KV lines, A.C.S.R. Zebra conductor for 220 KV and ACSR Panther conductor for 132KV lines.

ii. The suspension assembly along with standard and preformed armour rod set shall be designed to minimise the stress and strain developed in conductor at suspension points resulting from static and dynamic load (maximum wind pressure Aeolian vibration, broken wire condition etc.). The suspension assembly set shall have slip strength between 20KN to 29 KN for ACSR Moose and 8% to 15% of UTS for ACSR Zebra & ACSR Panther conductor.

iii. 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 assembly shall be smooth, without any cuts, abrasions, projections, ridges etc. which might damage the conductor.

iv. The magnetic power loss should not be more than 1 watt at 600 amp for ACSR Moose conductor, 1 watt at 500 amp. for ACSR Zebra conductor and 1 watt at 400 amp for ACSR Panther while that of pilot suspension clamp (envelop type) should not be more than 2 watts at above current ratings.

J. ARMOUR GRIP SUSPENSION CLAMP:

Armour Grip Suspension Clamp shall consist of elastomer insert, one set of Armour Rods made of Aluminium alloy, two aluminium housing having inner profile matching with the profile of the armour rods cage and jointed by supporting strap made of Aluminium alloy.

The elastomer insert shall be resistant to the effects of temperature upto 85^{o}C. Ozone, ultraviolet radiation and other atmospheric contaminants likely to be encountered into service. The physical properties of elastomer shall be of approved standards. It shall be electrically shielded by a cage of A.G.S preformed rod sets. The elastomer insert shall be so designed thus the curvature of the A.G.S rod shall follow the contour of the neoprene insert.

The A.G. Type Suspension clamp shall be so designed, manufactured and finished to have a suitable shape without sharp angles at the end and to hold the respective conductor properly. It should have sufficient contact surface to minimise damage due to fault current.

The A.G. Type Suspension Clamp shall permit the conductor to slip before failure of the conductor occurs and shall have sufficient slip strength to resist the conductor tension under broken wire condition.

K. FREE CENTRE TYPE CLAMP:

The clamp body and keeper plate shall be of high strength corrosion resistant and heat Treated Cast/forged aluminum alloy. The components such as cotter bolts, hangers, shackles, brackets shall be of mild steel, 'U' bolt shall be of stainless steel or high strength Alloy 6061. The steel materials shall be hot dip galvanized.

L. ENVELOPE TYPE CLAMP:

The same are to be used only in Pilot insulator strings. The seat of the envelope type clamp shall be smoothly rounded and suitably curved at the ends. The lip edges shall have round bead. There shall be at least two 'U' bolts for tightening of clamp body and keeper pieces together. Sizes of inside groove of the clamp will be such to just hold conductor only. Hexagonal bolts and nuts with spring and plain washers of standard quality shall be used for attachment of the clamp.

M. TENSION CLAMP ASSEMBLY:

i. The tension clamp shall be suitable for specific Conductor.

ii. The tension clamp shall be of compression type with provision for compressing Jumper terminal at one end. The angle of Jumper terminal to be mounted should be 30°C with respect to the vertical line. The area of bearing surface on all the connectors shall be sufficient to ensure positive electrical and mechanical contact. The conductivity of the clamp shall not be less than that of conductor.

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

iv. The clamp shall not permit slipping at a load less than 95% of the ultimate tensile strength of the conductor. Its outer sleeve shall be made out of EC grade Aluminium of purity not less than 99.5% for ACSR conductor and high strength Aluminium Alloy of type 6201 or equivalent for AAAC. The steel sleeve shall be made of mild steel and hot dip galvanised.

N. FASTENERS:

i. All fasteners shall be as per IS:6639-1972. All bolt heads and nuts shall be hexagonal and when required the nuts shall be locked in an approved manner. All fasteners shall be hot dip galvanised including the threaded portion of the bolts.

ii. Fully threaded bolts shall not be used. Length of threaded shall be such that no thread shall be extended into the plane of contact of the component parts but shall be sufficient to take full depth of the nuts and threaded enough to permit firm gripping of the component parts only. It shall be also ensured that the threaded portion of the bolt protrudes not less than 5 mm and not more than 10 mm when fully tightened. Flat washer and spring washer shall be provided as required. Thickness of washer shall conform to IS:2016-1967.

iii. Fasteners of grade higher than 8.8 are to be avoided.

O. PREFORMED ARMOUR RODS:

i. This shall be provided at all suspension points of each sub-conductor/conductor to minimise the stress and strain developed in the conductor at suspension supports resulting from static and dynamic loads (viz. Maximum wind pressure, Aeolian vibrations, broken wire conditions etc.). They shall also withstand power arcs, abrasions from clamps and localised heating effect due to magnetic power losses of the clamps.

ii. The preformed armour rods shall be made of high strength special aluminium alloy. The alloy shall be properly heat treated during manufacturing process. Conductivity of each strand of Armour rod shall not be less than 40% of the conductivity of International Annealed Copper Standard (IACS). Number of Armour rods in each set shall not be less than twelve for AGS suspension clamp. The ends of Armour rods shall be parrot billed type. The armour rods shall be capable of being fixed by hand on the conductor without the aid of any tool. The direction of the helix (right hand lay) shall be same as that of the conductor and internal dia of the helix shall be less than the conductor dia. so as to grip the same tightly. Each set shall be suitably marked with black paint at its centre for easy application on the line. The armour rod shall not lose their resilience even after five applications. The surface of armour rods when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

iii. The armour rods shall have perfect uniformity of pitch and diameter within the limit of tolerance not exceeding +/- 1%. Each strand of the preformed armour rods shall be interchangeable with any other strands.

iv. The armour rods should not lose resilience even after 5 applications.

v. The length of the A.G.S preformed rod shall be such that it shall ensure sufficient sliping strength and shall not introduce unfavourable stress on the under all operating conditions. However, the length of the A.G.S preformed rods shall not be less than as mentioned in S.T.P. The tolerance in length of completed set should be within thirteen mm between longest and shortest rod.

P. BALANCING WEIGHTS:

For limiting the swings of 400KV single suspension pilot insulator string used for jumper connection at the transposition towers or in similar uses from excessive deflection, suitable balancing weights about 200kg are to be suspended through the line side yoke plate. Each unit shall be of multiple of 50kgs weight and shall be connected to the yoke plate by means of eye bolts and shackle arrangement.

The balancing weight shall be of malleable cast iron / machined miled steel with sharp edges and shall be hot dip galvanised.

The bottom weight shall be provided with recess to shield the ends of eye bolts. The same shall be suitable for use on specific transmission lines.

5. TECHNICAL PARTICULARS OF SUB STATION HARDWARES

(i) General design of hardware fittings shall be such as to ensure uniformity, high strength, and freedom from corona formation and high resistance against corrosion.

(ii) The materials of the fittings shall be so selected that yield strength of the material shall not be less than maximum working load.

(iii) All shackles, fasteners, eyes, suspension and tension clamp and other fittings for attaching insulators to the Gantry tower, A-frame & other sub-station structure with conductor shall be so designed as to reduce any damage to conductor, insulator & hardware fittings. Anchor shackles, Ball hook, Ball eye, Ball clevis, Ball link, Socket clevis, Yoke plates, Arcing horn, turnbuckle, jumper cone. Comp. Dead end assembly Bolted type suspension clamp etc. shall be supplied as per requirement.

The materials for various hardware accessories shall conform to IS:2486.

(iv) All ferrous metal parts, which will be exposed to the atmosphere in service, shall be protected by hot dip galvanizing.

(v) All forgings and castings shall be of good finish and free from flaws and other defects. The edges on the outside of fittings such as the eye, clevis and holes shall be rounded.

(vi) All parts of different fittings which provide the inter connection shall be made such that sufficient clearance is provided at the connection point to ensure free movement and suspension of the insulator string assembly. Suspension clamps shall be so designed that the effects of vibration both on conductors and fitting itself are minimised. The clamp shall permit the conductor to slip before the failure of the conductor occurs. The fitting shall have sufficient contact surface to minimise damage due to fault current.

(vii) The Hardware fittings for Suspension and Tension string shall be supplied complete in all respect.

(viii) The suspension hardware is to be used with normal (B-type) disc insulator having Electro-mechanical Strength of 70 KN for all voltage classes except 400KV and tension hardware are to be used with normal. (B-type) disc insulator having Electro-mechanical Strength of 120 KN for 220 KV, 132 KV & 33 KV voltage class & 160KN for 400KV voltage class. For 400KV suspension string Disc insulator with normal (B) type disc insulator having electro mechanical strength of 120KN shall be used.

(ix) Suspension and tension hardware shall be suitable for insulator with nominal pin shank diameter of either 16 mm. or 20 mm. as per approved 12KV Class Disc insulator to be utilised at sub-station. Unless specifically mentioned the tension clamps shall be of compression dead end type and shall have a steel sleeve to be compressed on the steel core end of the conductor.

(x) Sag compensating spring shall be within the scope of supply by the Contractor for 400 KV Main I, Main II and Transfer Bus. Design calculation of the springs are to be submitted during detailed Engineering

(xi) Suspension clamp shall be of Armour Grip type.

(xii) Design of fittings shall be such as to avoid local corona formation or discharges and shall have smooth finished surface of all parts.

6. INSULATOR HARDWARE COMPONENT DETAILS

Sl.No.	Description	220KV/132 KV	400 KV
1	**Single Suspension String:** i. Electro mechanical strength of insulator disc: ii. Material: - Anchor shackle - Horn holder type ball eye - Full arcing horn set - Corona control ring - Socket clevis - Yoke Plate line side - Suspension clamp assembly - U-clevis (for AGS type)	70 KN	120 KN
2	**Double Suspension String:** i. Electro mechanical strength of insulator disc: ii. Material: - Anchor shackle - Yoke plate (tower side) - Clevis – Clevis - Ball and rod type arcing horn - Corona control ring - Socket Clevis - Yoke plate (line side) - Suspension clamp assembly	2x70 KN	2X120 KN
3	**Single Tension String:** i. Electro mechanical strength of insulator disc: ii. Material: - Anchor shackle - Turn buckle - Clevis – Clevis - Horn holder type ball eye - Tubular arcing horn - Socket Clevis - Yoke plate (line side) - Corona control ring - Anchor shackle - Dead end assembly	120 KN	120 KN
4	**Quad / Double Tension String:** i) Electro mechanical strength of insulator disc: ii Material: - Anchor shackle - Chain link - Ball & rod type half arcing horn - Yoke plate tower side - Ball clevis - Corona control ring	- / 2X120 KN	4X160KN / 2X160 KN

Sl.No.	Description	220KV/132 KV	400 KV
	- Socket clevis - Yoke plate line side - Clevis eye - Sag adjusting plate - Chain shackle - Dead end assembly		
5	**Tension clamp (Tubular compression type) and Dead End Assembly Component Details**: i) Electro mechanical strength of insulator disc: ii Material: - Anchor shackle - Aluminium dead end - Filler plug - Jumper plate - Hexagonal bolts & nuts - Jumper - Plain washer - Spring washer	120 KN	160 KN
6	**Suspension Clamp Component Details**: i) Electro mechanical strength of insulator disc: ii Material: - Clamp body - Keeper - U bolt with nuts - Plain washers - Hex. bolts - Jumper - Saddle - Line strap - Twisted shackle	70 KN	120 KN
7	Armour Gri: i) Electro mechanical strength of insulator disc: ii Material: - Armour rod type retaining rods - Neoprene cushion - Clamp body - Round strap - Hex. bolts with nut - Spring washer - Plain washer - Split pin	70 KN	120 KN

DETAILS OF MATERIALS FOR HARDWARE FITTINGS AND ACCESSORIES

Sl. No.	NAME OF ITEM	MATERIAL	PROCESS OF TREATMENT	REFERENCE STANDARD	REMARKS
1.	Security Clips	Stainless Steel / Phosphor Bronze	-	AISI 302 or 304-L / IS:1385-1968	
2.	Arcing Horn	Mild Steel Rod / Tube type	Hot Dip Galvanised	As per IS:226-1975 or IS:206201992	
3.	Ball fittings, Socket All Shackles, link clevis	Class IV forged steel	Forged and normalised Hot Dip Galvanised	As per IS:2004-1978	
4.	Yoke Plate	Mild Steel	Hot Dip Galvanised	As per IS:226-1975 or IS:2062-1992	
5.	Sag Adjustment Plate	Mild Steel	Hot Dip Galvanised	As per IS:226-1975 or IS:2062-1992	
6.	(a) Corona Control Rings (b) Supporting Brackets and Mounting Bolts	High strength Alumi9nium Alloy tube (6061/6063/1100 type or 65032/63400 type or Mild Steel	Heat treated Heat treated Hot Dip Galvanised	ASTM-B429 Or as per IS:226 or IS:2062	Mechanical strength of welded joints shall be not less than 20 KN
7.	**Turn Buckle**	Class-II Steel	Forged and Hot Dip Galvanised	As per IS:2004-1978	
8.	**Free Centre Type / Envelop Type** (a) Cleap Body / Keeper Piece (b) Cotter bolts, Hangers, Shackles, Brackets (c) U bolts	 High Strength Al. Alloy 4600/LM-6 or 6061/65032 Mild Steel Stainless Steel or High Strength Al. Alloy 6061/6063 or 65032/63400	 Casted or Forged & Heat treated Hot Dip Galvanised Forged and Hot treated	 IS:617 or ASTM-B429 IS:226/IS:2062 AISI-302 or 304-L ASTM-B429	
9.	**P. A. ROD**	High Strength Al. Alloy type 6061/65032	Heat Treatment during manufacturing	ASTM-B429	Min. Tensile strength of 35 Kg/Sq.mm.

10.	**A.G.S. Clamp** (a) Supporting House (b) Al. Insert & Retaining Strap (c) Elastometer Cushion	High Strength Corrosion resistant Al. Alloy LM6, 4600 or 6061/65032 High Strength Al. Alloy of type 6061/65032 Moulded on Aluminium reinforcement	Casted/Forged Heat Treated Forged and Heat treated	IS:617 or ASTM-B429 ASTM-B429 or as per IS	
11.	**DEAD END ASSEMBLY** (a) Outer sleeve of dead end for ACSR Conductors (b) Outer sleeve of dead end for AAAC Conductors (c) Steel Sleeve (d) Jumper Cone	EC grade Al. of purity not less than 99.5% High Strength Al. Alloy of type 6201or equivalent Mild Steel EC grade Al. of purity not less than 99.5%	Heat treated during manufacturing Hot Dip Galvanised	As per IS:226 / IS :2062	
12.	Balancing Weight	Cast Iron/MCI/Machined Mild Steel	Hot Dip Galvanised		
13.	**MID SPAN COMPRESSION JOINT (For ACSR conductor):** (a) Al. Sleeve (b) Steel Sleeve	EC grade Al. of purity not less than 99.5% Mild Steel	Hot Dip Galvanised	IS:226/IS:2062	
	For AAAC conductor	High Strength Al. Alloy of type 6201or equivalent	Heat treated during manufacturing		
14.	**MS Joint for Earth Wire**				
	(a) Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/IS:2062	
	(b) Al. encasing	EC grade Al. of purity not less than 99.5%			

15.	T-Connector / Repair Sleeve	EC grade Al. of purity not less than 99.5%			
16.	VIBRATION DAMPER				
	(a) Clamp	High strength Al. Alloy of type LM-6			
	(b) Damper Mass	Mild Steel/Cast Iron/Zinc Ally	Forged/Casting Hot Dip Galvanised	IS:226/IS:2062	
	(c) Messenger Cable	High Tensile Steel/Stainless Steel	Hot Dip Galvanised	IS:4826	Minimum strength of cable 135kg/Sq.mm
17.	BUNDLE SPACER				
	(a) Retaining Rod	High Strength Al. Alloy of type 6061/65032	Heat treated during manufacture		
	(b) Spacer tube	High strength Al. Alloy of type 6061/65032	Heat treated during manufacture		

7. ACCESSORIES FOR ACSR CONDUCTOR AND GALVANISED STEEL EARTHWIRE:

7.1. CONDUCTOR ACCESSORIES:

A. Repair Sleeves:

The compression type repair sleeves for conductor are required for repairing the minor damages on the aluminium strands of the conductor. The repair sleeves will be used where the damage is limited to two strands of outer layer of conductor strands. The sleeves hall comprise of two pieces, one sliding in the other. The edges of the two pieces of repair sleeve shall be properly rounded so that the conductor strands are not damaged during installation. The repair sleeve shall be made by extrusion process and shall be manufactured of EC grade aluminium of 99.5% purity. After compression, the sleeve shall have smooth surface. The portion where repair sleeves provided shall have resistance less than 75% of the equivalent length of conductor.

B. Mid-span compression joints:

i. Compression type mid span joints are required for jointing of Moose Conductor. The joint shall have a resistance less than 75% of the equivalent length of the 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 UTS of the conductor. The joint shall comprise of steel and aluminium

sleeves for steel core and aluminium core respectively. The steel sleeve shall be hot dip galvanised as per relevant IS specifications. The Brinneal hardness no. of the steel plate shall not exceed 200.

ii. For ACSR Conductor the Aluminium sleeve shall be made of 99.5% purity EC Grade aluminium and should be made by extrusion process. Compression and non-compression zones to be marked clearly on the aluminium sleeve either by providing holes (to be plugged by Aluminium filler plugs subsequently) or by knurling marks.

iii. For AAAC Conductor the Aluminium sleeve to be provided shall be made of aluminium alloy of type 6201 or equivalent.

C. VIBRATION DAMPERS (for Zebra and Panther Conductor):

i. Suitable 4R Stock Bridge type vibration dampers shall be used at all tension and suspension points on each sub-conductor/conductor in each span. The damper shall eliminate fatigue on the conductor and damp out the vibrations effectively, so that the dynamic strain at the suspension point/tension point shall not exceeds 150 micro strains. The Bidder shall furnish, with supporting calculations, the required damper placement ranging from 100 metre to 800 metres. The minimum no. of vibration damper per conductor for suspension and tension tower shall be 2 for Ruling Design Span.

ii. The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6, so designed that it is capable of supporting the damper during installation and to prevent any damage to conductor including chafing during erection or continued operation.

iii. The messenger cable shall be made of high tensile steel strands or spring and performed in order to prevent subsequent fall of weights in service. The number of strands in the messenger cable shall be 19 each having a minimum strength of 135 Kgf/mm^2.

iv. Clamping bolts shall be provided with self-locking nuts designed to prevent corrosion of the threads or loosening during service, ensuring that no slippage occurs on clamp along with conductor. All ferrous parts including the messenger cable shall be effectively sealed to prevent corrosion. The damper mass shall be made of hot dip galvanised mild seel/cast iron or zinc alloy. All castings shall be free from defects and the surface to be smooth.

V. The clamp shall be capable of being removed and reinstalled on the conductor at the designed torque without shearing or damaging bolts, nuts or cap screws.

vi. The vibration damper shall not have magnetic power loss more than 1 watt at 500 amps. 50 Hz for ACSR Zebra and at 400amps.50 Hz for ACSR Panther conductor.

vii. The vibration analysis of the system, with and without damper, dynamic characteristic of the dampers, slip strength & fatigue test on damper shall have to be submitted by the Bidder along with the bid.

D. Spacer Damper (for Quad bundle conductor):

i. Suitable spacer dampers for four bundle ACSR MOOSE conductor for 400 kV (Quad/Twin) line shall be offered. The spacer damper covered by this specification shall be designed to maintain the bundle spacing of 457 mm under all normal operating conditions and to effectively control Aeolian vibrations as well as sub span oscillation and to restore conductor spacing after release of any external extraordinary load. The nominal sub conductor spacing shall be maintained within ±5 mm.

ii. 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.

iii. The design offered shall be presented as a system consisting of spacer dampers and their staggering scheme for spans ranging from 100 m to 1100 m. A vibration performance test shall be carried out on an experimental test line. The systems tested should be those specified by the Supplier for the 800 kV line conditions. Only systems satisfying the performance criteria under Annexure-A shall be submitted by Bidder along with bid.

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

iv. Under the operating conditions, 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.

v. 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.

vi. The spacer damper shall consist of a rigid central body called the frame linked to the conductor by four articulated arms terminated by suitable clamping system. The articulation shall be designed to provide elastic and damping forces under angular movement of the arms. The dynamic characteristics of the articulations shall be maintained for the whole life of the transmission line.

vii. 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.

viii. Bolted type clamps shall allow installation without removal of the bolts or the clamps from clamp body. Locking mechanism shall be suitable to prevent bolt loosening. Clamp locking devices with small loose components shall not be accepted. Nut cracker, hinged open or boltless type clamps are acceptable provided adequate grip can be maintained on the conductor.

ix. Bolts and nuts shall be of mild steel, stainless steel, or high strength steel in accordance with the design of the spacer damper.

x. Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 25 kg/mm2. The insert shall be moulded on the insert surface. The insert shall be duly heat treated and aged to retain its consistent characteristics during service. The grain flow of the forged insert shall be in the direction of the maximum tension and compression loads experienced.

xi. If clamps involving preformed rods are used, these rods shall be designed for specific conductor size. They shall be made of high strength aluminium alloy of type 6061 or equivalent aluminium alloy having a minimum tensile strength of 35 kg/mm3. The rods shall be ball ended. The rods shall be heat treated and aged to achieve specified mechanical properties and to retain the same during service. The length of the rods shall be such that the ends fall inside the imaginary square whose sides are vertical and horizontal outer tangents to the conductor sections.

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

xiii. The rubber components involved in the design such as damping elements shall be made with rubber compound selected specifically for that particular application. The Bidder shall submit a complete list of physical and mechanical properties of the elastomer used. This list shall make reference to all applicable ASTM standards.

xiv. The rubber components used shall have good resistance to the effects of temperature up to 95°C and to ultraviolet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi-conductive.

xv. The spacer damper involving ferrous material shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars at 500 A, 50 Hz alternating current per sub-conductor.

xvi. 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.

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

xviii. The spacer damper assembly shall be capable of being installed and removed from the energized line by means of hot line techniques. The Bidder shall supply with the bid the complete description of the installation, removal and reinstallation procedure.

xix. The Bidder shall recommend the staggering scheme for installation of spacer dampers on the line which shall ensure most satisfactory fatigue performance of the line as specified. The scheme shall indicate the number of spacer dampers per phase per span and the sub span lengths to be maintained between spacer dampers while installing on the four bundle conductors.

xx. The staggering scheme shall be provided for spans ranging from 100 m to 1100 m. The number of spacer dampers for a nominal ruling span of 400 m shall not be less than six.

xxi. No sub span shall be greater than 70 m and no end sub span shall be longer than 40 m.

xxii. The staggering scheme shall be such that the spacer dampers be unequally distributed along the span to achieve sufficient detuning of adjacent subs pans for oscillations of sub span mode and to ensure bundle stability for wind speeds up to 60 km/hr.

xxiii. The Bidder shall furnish all the relevant technical documents in supports of the staggering scheme recommended for the spacer damper.

E. Rigid Spacer for Jumper of Quad Conductor:

Jumpers at tension points shall be fitted with spacers so as to limit the length of free conductor to 3.65 m and to maintain the sub conductor spacing of 457 mm 400 kV (Quad) line. Bidder shall quote for rigid spacer for jumper. It shall meet all the requirements of spacer used in line except for its vibration performance. Spacers requiring retaining rods shall not be quoted for jumpers.

The spacer offered by the Bidder shall satisfy the following requirements.

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

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 6061/65032 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.

Four number of rods shall be applied on each clamps to hold the clamp in position. The minimum diameter of the rods shall be 7.87 $\pm$ 0.1 mm and the length of the rods shall not be less than 1100 mm.

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 6061/65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.

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.

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

The clam 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.

For the 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.

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

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.

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

Rigid spacers shall be acceptable only for jumpers.

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

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

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

The spacer tube shall be made of aluminium alloy of type 6061/65032. 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 one watt at 600 Amps 50 Hz alternating current per sub conductor.

Elastomer, if used, shall be resistant to the effects of temperature up to 95 deg.C, 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.

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.

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

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

F. T – CONNECTOR:

The connector shall be of compression type and shall be used for jumper connection at transposition towers. It shall be made of E.C. grade aluminium of 99.5% purity and shall be strong enough to withstand normal working load. The connector shall have a resistance across jumper less than 75% resistance of equivalent length of conductor. The welded portions shall be designed for 30KN tensile load.

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

7.2. EARTHWIRE ACCESSORIES:

A. Suspension clamp assembly:

Free centre type suspension clamps made of heat treated malleable iron or forged steel of suitable size are required for holding the galvanised steel stranded earthwire of 7/3.66 mm size at suspension points, the suspension assembly shall conform to IS:2486/1971.

There shall be no sharp point in the clamp coming in contact with earthwire nor any part of the earthwire should be displaced, damaged or unduly stressed in final assembly during

working condition. The keeper piece and the clamp body shall be clamped by at least two inverted type U-bolt & nut and one nut shall be long enough to accommodate the lug of the flexible copper bond for connecting with tower body.

Eye hook for clamp shall be supplied for attaching to the hanger plate having a minimum thickness 12 mm with a hole of 21.5 mm diameter.

The major component of suspension assembly includes shackles, bolts, nuts, washers, pin etc.

The complete suspension clamp assembly shall be guaranteed for a slip strength of not less than 12KN but at the same time shall not be more than 17KN for 7/3.66 mm galvanized steel earthwire and in between 18% to 25% of UTS of 7/3.15 mm earth wire.

B. Tension clamp Assembly:

i Compression type tension clamp complete with anchor shackles, bolts, nuts, split pin, washers jumper arrangement etc. suitable for respective size of galvanised steel earth wire shall be offered to hold the earthwire at all tension towers. The tension clamp shall be made of mild steel with Al. encasing. The anchor shackle and bolts & nuts shall be of galvanised steel. One of the bolts holding the jumper clamp shall be sufficiently long and shall be provided with locking nuts etc. for connecting flexible earthing bond between the tension clamp and the tower structure.

ii. The Anchor Shackle shall be suitable for attaching the; tension clamp with the strain plates of tower the minimum thickness of strain plates will be 20 mm for 7/3.15 mm earth wire and 10 to 16 mm for 7/3.15 mm earth wire with provision of one 25 to 32 mm diameter hole. The angle of jumper terminal to be mounted should be 30^{o} with respect to vertical plain.

iii The slip strength of the assembly should not be less than 95% of the breaking load of the earthwire. The clamps shall have adequate area of bearing surface to ensure positive electrical and mechanical contacts and shall not permit any slippage under vibration condition at maximum working tension.

iv. The slip strength of tension clamp assembly shall not be less than 95% of the ultimate tensile strength of earth wire.

C. Flexible copper bonds:

Flexible copper bonds shall be offered for all towers for connecting the ground wire to the nearest tower members. These should be made of electrolytic copper wire of size 37/7/0/47 mm duly tinned and having copper area equivalent to 34.59 Sq.mm. The length of each; bond shall not be less than 500 mm (approx.). Two forged steel hot dip galvanised lugs shall be press jointed to either end of the copper cable.

D. Mid-span Compression Joints:

Compression type mid span joints, required for jointing two lengths of respective galvanised steel earth wire should be easily compressible by means of 100 Ton hydraulic compressor. The joint shall be made of mild steel with Aluminium encasing. Filler Aluminium Sleeve shall also be provided at the both ends. It shall not fail or crack during compressing process or in service. The slip strength of the joint shall not be less than 95% of the ultimate tensile strength of the earth wire. The joints shall have conductivity similar to earthwire.

E. Vibration damper:

4R-Stock Bridge type vibration damper for ground wire shall be used to damp out the vibrations of the earthwire so that dynamic strain developed at the suspension/tension points shall be less than 150 micro strains at the suspension or tension points of the wires. Minimum one damper each on one side of sub-conductor/conductor shall normally be used both for suspension or tension points. No damper shall be allowed to be used on jumper. Bidders shall indicate most suitable placing of the damper in the earthwire. However, the required damper placement shall have to be furnished by the Bidder.

The design particulars of clamp, messenger cable, and damper mass & clamping arrangements are similar to that of dampers for conductors excepting that the damper clamp materials shall be of steel (hot dip galvanised) and no armour rods will be used at ground wire suspension locations.

The vibration analysis of the system, with and without damper, dynamic characteristic of the dampers, slip strength & fatigue test on damper shall have to be submitted by the Bidder alongwith the bid.

8. INSPECTION, TESTING AND MARKING:

The entire cost of testing for the type, acceptance test and routine test shall be treated as included in the quoted unit price of hardware and conductor / earthwire accessories.

INSPECTION

i. The representative of WBSETCL shall have full facility for unrestricted inspection of manufacturer's works, the raw materials and manufacture of hardwares conductor/Earthwire Accessories etc. and for carrying out necessary tests as detailed herein before. The supplier shall keep purchaser informed well in advance of the time of starting and progress of manufacture of various items in its various stages so that arrangement can be made for inspection.

ii. No hardwares, Conductor/Earthwire Accessories etc. shall be dispatched before it has been satisfactorily inspected, tested and clearance issued by WBSETCL for dispatch unless the inspection is waived by WBSETCL in writing.

iii. Acceptance of any quantity of material shall in no way relieve the contractor of any of its responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective

MARKING:

1) Name or Trade mark of manufacturer
2) Country of manufacturer

TESTS & REPORTS:

Type, acceptance & routine test shall be carried out on clamps (suspension & tension) for hardware fittings, conductor and earthwire accessories as per approved manufacturing quality plan, WBSETCL specification and relevant IS / IEC & other standards.

Type tests are to be conducted in accordance with the procedures laid down in relevant IS / IEC and standards referred to therein. Annexure 'A' wherever mentioned is to be followed.

The contractor shall submit all type test results of offered materials (six copies) to WBSETCL for approval. Validity of the type test shall be as per latest CEA guidelines.

Routine test shall be carried out on all the clamps and Test Report shall be maintained by the manufacturer at his works for periodic inspection of the same by the WBSETCL representative.

Routine Tests are to be carried out on individual hardware fittings and Conductor / Earthwire Accessories as well as on complete string of conductor

Acceptance tests are to be carried out at the works of manufacturer as per latest IS/IEC in presence of representative of WBSETCL and shall be conducted on every Lot offered for inspection.

The number of samples to be selected at random from the lot shall be in accordance with relevant standards.

i. MIDSPAN JOINTS FOR CONDUCTOR & EARTHWIRE AND REPAIR SLEEVE FOR CONDUCTOR:

Following acceptance test shall be conducted on every Lot offered for inspection.

1) Visual Examination
2) Dimensional Verification
3) Failing load test
4) Galvanising test
5) Resistance test
6) Temperature rise test

ii. ARMOUR ROD:

Following acceptance test shall be conducted on every Lot offered for inspection.

1) Visual Examination
2) Verification of Dimension
3) Tensile Strength Test
4) Electrical Resistance Test
5) Resilience Test
6) Slip Strength Test
7) Bend test

iii. Spacer Damper:

Following acceptance test shall be conducted on every Lot offered for inspection.

1) Visual Examination
2) Dimensional Verification
3) Galvanising test
4) Movement test
5) Clamp Slip test
6) Compression tension test
7) Assembly torque load
8) Hardness test for Elastomer

iv. VIBRATION DAMPER (For Conductor/Earthwire):

Following acceptance test shall be conducted on every Lot offered for inspection.

1) Visual Examination
2) Verification of Dimension
3) Clamp slip Strength Test
4) Clamp Bolt Hot Test
5) Mass Pull off Test
6) Verification of Resonance Frequency
7) Galvanising / Electro Plating Test

v. HARDWARES:

For all hardware fittings each component shall be subjected to a load equal to the specified minimum.

UTS which shall be increased at a steady rate of 67% of minimum UTS specified. The load shall be held for five minutes and then removed. The component then shall again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS is achieved and held for 1 minute. No fracture should occur. The applied load shall then be increased until failing load is reached and the value recorded.

9. TENDER / CONTRACT DRAWINGS & DOCUMENTS:

a. The bidder shall furnish detailed dimensional drawings of the Hardware / conductor and earth wire accessories and all component parts.

b. Separate drawings are to be submitted for each type of equipment identified by a separate drawing number neatly arranged. All dimensions and dimensional tolerance shall be indicated clearly.

c. The major information to be furnished in the drawings are as follows:

(i) Dimensions and dimensional tolerances, if any, of all the Hardware fittings including clamps, vibration dampers, corona control ring, repair sleeves, mid span compression joint etc.
(ii) Dimensional General Arrangement Drawings of Insulator string along with all fittings and accessories, technical parameter of the string etc.
(iii) Material fabrication details, welding details and any specified finished and coatings of individual parts.
(iv) Catalogue No.
(v) Marking.
(vi) Weight of assembly and individual parts.
(vii) Withstand torque that may be applied to bolts or cap screw without failure of component parts.
(viii) The Compression die details for tension clamp with recommended compression pressure.
(ix) All other relevant technical details.

d. Six sets of approved drawings, test certificates and particulars, along with of operation/maintenance instruction shall be submitted for record and distribution to site.

STANDARD TECHNICAL PARTICULARS

Suspension hardware fittings for Quad/Twin ACSR MOOSE conductor

Sl.	Description	Unit	Particulars/ Value		
			Double "I" Suspension Fittings with (ACSR MOOSE Conductor)		Single suspension Pilot Fitting with
			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		8
2.	Slipping strength of suspension assembly	KN	20-29		20-29
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly				
	a) No. of rods per set	No.	12		NA
	b) Direction of lay		Right hand		NA
	c) Overall length after fitting on conductor	mm	2235	2540	NA
	d) Diameter of each rod	mm	9.27		NA
	e) Tolerance in		NA		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
	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	^oC	65 to 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 85^o 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.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m2	600		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209)		
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		

Tension hardware fittings for Quad/Twin ACSR Moose conductor

Sl.	**Description**	**Unit**	**Particulars/ Value**		
			Single Tension	**QuadTension /Double Tension**	
1.	Mechanical strength of Tension fitting(excluding dead end clamp)	KN	120	4x160/ 2x160	
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.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m2	600
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209)
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

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	

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

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

Quad/Twin Spacer Damper for ACSR MOOSE conductor (For Quad/Twin bundle conductor only)

Sl.	Description	Unit	Particulars/ Value
1.	Type of Clamp		Rigid type without retaining rods
2.	**Type of Damping element**		Spring/Elastomer/EPDM
3	Material of		
	(a) Clamp		All Aluminum alloy (4600) or equivalent
	(b) Main body		Galvanised Steel /Al.Alloy 4600 0r equivalent
4.	**Elastomer (if used)**		
	(a) Shore hardness		Die-casting
	(b) Temp.range for which designed	^{0}C	Upto 85^{0}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		Clamp Type / Longitudinal load(KN) / Maxm. Slip permitted(mm) Metal-Metal Bolted: 6.5 / 1 Rubber loaded: 2.5 / 2.5 Preformed rods: 2.5 / 12
	b)After Vibration test	KN	80% of the above values
6.	Maximum Magnetic power loss per spacer for 600 Amps, 50 Hz Alternating Current	Watts	Below 1 watt
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

Rigid Spacer for Jumper for ACSR MOOSE conductor (For Quad/Twin bundle conductor only)

Sl.	Description	Unit	Particulars/ Value
1.	Type of Spacer		Rigid type without retaining rods
2.	**Material of component parts**		
	(a) Clamp		Aluminum alloy (4600)
	(b) Main body		Aluminum alloy 6063/63400 ; **6061/65032**
3.	**Manufacturing process of component parts**		
	(a) Clamp		Die-casting
	(b) Main body		Aluminum extrusion
4.	**Minimum ultimate tensile strength of spacer**		
	(a) Compressive load	kN	14
	(b) Tensile load	kN	7.0
5.	Slipping strength of spacer clamp	kN	2.5
6.	Maximum Magnetic power loss per spacer for 600 Amps, 50 Hz Alternating Current	Watts	1
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

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	600		
4.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	11.50 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	32.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	400 ± 5	230 ± 5	60 ± 5
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve		Steel Sleeve
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5		20.20 ± 0.5
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5		17.50 ± 0.5
iii)	Length	mm	430 (approx)		265 (approx)
6.	Slip strength	KN	65		
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75		

Flexible Copper Bond for 7/3.66 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Stranding		37/7/0.417
2.	Cross sectional area	Sq.mm	35.4
3.	Minimum copper equivalent area	Sq.mm	34
4.	Length of copper cable	mm	500 + 5
5.	Material of lugs		Tinned copper
6.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

Vibration Damper for 7/3.66 mm GS 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)

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	600
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 7/3.66 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	600
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

ANNEXURE - A

1.0 **Tests on Complete Strings with Hardware Fittings**

1.1 **Voltage Distribution Test (For Insulator String with Disc Insulators)**

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 following percentage value for different voltage level lines:-

SL. NO.	VOLTAGE LEVEL OF LINE	SUSPENSION STRING	TENSION STRING
1	400 kV	9.0 %	10.0 %

1.2 **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 no. of sub conductors and tension in each sub conductor secured them with clamps shall be as mentioned in the table below.

NO.	VOLTAGE LEVEL OF LINE	NAME OF CONDUCTOR	NO. OF SUB-CONDUCTOR	TENSION OF EACH SUB-CONDUCTOR
1.	400 kV	ACSR MOOSE	4/2	43KN

The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point nearest to the string shall be measured and the same shall not be less than $1000/f^{18}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the 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. The disc insulators shall be subjected to the following, tests as per relevant standards :

Sl. No.	Test	Percentage of insulator units to be tested	
		Disc Insulators	Long Rod Insulators
a)	Temperature cycle test followed by mechanical performance test	60	100
b)	Puncture test/steep wave front test (Only for glass insulators)	40	-

1.3 **Assembly Test**

This test shall be carried out to ensure that the cotter pins, bolts, clamps etc., fit freely and properly.

2.0 **Tests on Hardware Fittings**

2.1 **Magnetic Power Loss Test for Suspension Assembly**

2.1.1 For 400 kV line with Quad /Twin ACSR MOOSE conductor, four hollow aluminium tubes of 32 mm diameter shall be placed 457 mm apart. An alternating current over the range of 400 to 800 Amps for shall be passed through each tube. The reading of the wattmeter with and without two suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly. shall be plotted for each value of current. The value of the loss corresponding to 600 amperes shall be read off from the graph.

2.2 **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.

2.3 **Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly**

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

2.4 **Proof Load Test**

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS

specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

2.5 **Ozone Test for Elastomer**

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

3.0 Tests on Conductor and Earth wire Accessories

3.1 **Flexible Copper Bond for earthwire**

Slip Strength Test

On applying a load of 3 KN between the two ends, stranded flexible copper 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.

3.2 **Vibration Damper for conductor and earth wire**

(a) **Dynamic Characteristics, 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 as per table 3.4 for vibration damper for different type of conductor/earthwire. The damper assembly shall be vibrated vertically with a $\pm$ 1 mm amplitude from 5 to 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 damper 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 limits as per table 3.4.

(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.

Table 3.4

Conductor name	**Range of vibration frequency for dynamic characteristic test**	**Range of mean reactance**	**Tension of each sub-span for vibration analysis test**
ACSR MOOSE	5 Hz to 40 Hz	0.191 f to 0.762 f	43 KN
7/3.66 mm GS EARTHWIRE	5 Hz to 40 Hz	0.060 f to 0.357 f	14 KN

3.3 Spacer Damper

a) Performance Test

One very important quality of a spacer damper is its ability to control Aeolian vibrations and sub-span oscillations within acceptable limits. Performance testing shall be carried out on an experimental test line, as described in Clause 2.5.3, 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) Sub-span Oscillations

The spacer damper system shall control sub-span oscillations in order to prevent conductor damage due to clashing or to severe bending stresses at the spacer damper clamp, and avoid wear of spacer dampers elements.

In order to achieve that performance level, sub-span oscillation shall be controlled within the following limits, for any wind speed below 60 km/hr.

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

  f.Yrms< 80 mm/sec.

  Where

  Y (rms) = anti node amplitude (mm)

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

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

  L = sub-span length (m)

  T = Conductor tension (N)

  m = conductor mass (kg/m)

  For any set of 10 or more measurement samples associated with a given wind sector and a given sub-span, the Y rms value shall be such that:

  f. Yrms<70 mm/sec.

  The wind sector is defined as a combination of 5 km/hr wind speed range and 10º wind direction range.

  Each measurement sample shall be at least one (1) minute long.

b) Clamp Slip Test (for spacer for jumper also)

The spacer damper assembly shall be installed on a four conductors bundle string at a tension of 39 kN. 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, shall not slip on the conductor, i.e. the permanent displacement between the conductor and the clamp of the sample measured after removal of the load shall not exceed specified values. The minimum slip under longitudinal pull varies with clamp type according to the following table.

CLAMP TYPE	**LONGITUDINAL LOAD (kN)**	**MAXIMUM SLIP(mm)**
Metal-Metal bolted	6.5	1
Rubber loaded	2.5	2.5

Clamp using		
Preformed rods	2.5	12

In order to determine the effect of conductor creep with the spacer dampers only, the conductor shall be re-tensioned to 68 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 above table.

Similar testing shall be performed of the other clamps of the same sample. For spacer dampers only, such clamp slip tests shall also be conducted after each of the vibration tests mentioned in Clause 3.5 (a) but under longitudinal loading corresponding to 80% of the values given in the above table.

c) Dynamic Characteristic Test for Spacer Damper

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 will consist in the application of sinusoidal movement to the spacer damper articulation and measurement of the force (F), displacement (X) and phase angle (Ø) between these two. From these values, the stiffness (K) and damping faction (n) shall be calculated as:

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.

In case of spacer dampers with a single articulation for each arm, the central body shall be applied between two arms corresponding to a horizontal pair of conductors. In this case, one spacer clamp may be fixed and the other displaced in its direction, the central body being free to move.

d) Fatigue Test for Spacer Damper

The purpose of this test is to evaluate the capacity of the spacer damper to sustain without damage the cyclic movements which can be induced by vibrations.

The spacer damper articulation shall be subjected to cyclic motions for a total of 10 million cycles. The test frequency shall be between 2 and 3 Hz. The amplitude of motion shall be established on the following basis:

- the load applied on the spacer damper clamp shall not be less than 300N;
- The clamp displacement under the applied load shall not be less than 60% of the maximum displacement permitted by the design;

- If the 300 N load generates movement exceeding the maximum permitted displacement, the load can be reduced to limit the movement to 95% of the maximum displacement.

After the test, the sample shall be subjected to a second dynamic characteristic test. The test shall be performed at two amplitudes, 10% and 60% of the maximum displacement.

The spacer damper shall show no signs of cracks or detoriation, loosening of bolts or abnormal wear.

The dynamic characteristics (k and n) shall not be less than 75% of the values measured before the fatigue test. The test shall be performed on three samples which have been previously subjected to dynamic characteristics test. Motion shall be as described in Dynamic Characteristic Test.

e) Ozone Test

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

f) Compression and Tensile Tests

Three samples of spacer dampers shall be subjected to a tension compression test. The load shall be applied between each pair of diagonally opposed conductors. Under the compressive load, the arms shall be allowed to rotate until they reach their mechanical stops. A compressive load of 15 kN shall first be applied and held for five minutes. Then a tensile load of 5 kN shall be applied on the same pair of arms. The test shall be repeated on the other pair of arms. After the test, the spacer damper must be dismantled and the components examined. There should not be any failure of components or damage impairing the reusability of the spacer damper such as permanent deformation. The spacer geometry shall be maintained within 5% of the original dimensions.

3.4 Magnetic Power Loss Test for Spacer Damper/Spacer for jumper

The sample involving ferrous parts shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. The test should be carried out at various currents ranging from 400 amperes to 800 amperes for 400 kV line and the magnetic power loss at various currents should be specified in tabulated graphical form. The difference between the power losses without and with sample at room temperature shall be limited to 1 watt for 600 amperes current (rms) for ACSR MOOSE Conductor. The losses shall be determined by averaging the observations obtained from at least four samples.

3.5 Mechanical Strength Test for Earthwire Suspension/Tension Clamp

(a) The suspension assembly/tension assembly (excluding tension clamp) shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to loosen the nuts initially. The

assembly shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

(b) Clamp Slip Strength Vs Torque Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Earthwire shall be fixed in the clamps. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the earthwire. The clamp slip strength Vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be more than 12 kN but less than 17 kN for 7/3.66 mm earthwireand more than 9 kN but less than 14 kN for 7/3.15 mm earthwire.

(c) Slip Strength Test of Tension Clamp

Tension clamps shall be compressed on a 5 m length of earthwire on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load of 50% of the specified breaking load of the earthwire shall be applied & the sample shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the specified breaking load and maintained for one minute. There shall be no movement of the earthwire relative to the fitting during this one minute period and no failure of the fitting also.

(d) Electrical Resistance Test of Tension Clamp

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

3.6 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage 320 kV (rms) line to ground for 400 kV lines under dry condition for 400 kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731.

3.7 Radio Interference Voltage Test (Dry)

Under the conditions as specified under (3.8) above, the sample shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV rms line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS 8263.

3.8 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

4.0 Tests on All components (As applicable)

4.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS-209-1979. The purity of zinc shall not be less than 99.95%.

4.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The, sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Purchaser in Quality Assurance Programme.

4.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognised 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.

GUARANTEED TECHNICAL PARTICULARS

(To be filled in and signed by the Bidder)

A. MIDSPAN COMPRESSION JOINT FOR CONDUCTOR:

1. Maker's name & country :

2. Type :

3. Suitable for (conductor size) :

4. Outside diameter of sleeves (mm) :

   Before compression:
   i) Aluminium :
   ii)Steel :
   :

   After compression:
   i) Aluminium :
   ii)Steel :
   :

5. Length of sleeves:

   Before compression:
   i) Aluminium :
   ii)Steel :
   iii)Aluminium Alloy :

   After compression:
   i) Aluminium :
   ii) Steel :
   iii) Aluminium Alloy :

6. Weight of sleeves

   i) Aluminium (Kg) :
   ii)Steel (Kg) :
   iii)Total (Kg) :

7. Slipping strength of Midspan joint Expressed as percentage of ultimate Tensile strength of conductor (%) :

8. Breaking strength of Midspan joint Expressed as percentage of ultimate Tensile strength of conductor(%) :

9. Conductivity of the compression Joint expressed as percentage of the Conductivity of the conductor (%) :

10. Resistance of percentage of measured Resistance of equivalent length of Conductor (%) :

11. Corona Extinction voltage on the joint:

    i) Dry condition :
    ii)Wet condition :

12. Full details of the Hydraulic Compressor and die sets :

13. Packing details (number of joint Assemblies per packages and Gross Weight) in Kg :

14. Standard to which conforming :

15. Galvanising on Ferrous

    i) Minimum weight of zinc coating (gm/^{m2}) :
    ii) Number of dip per minute :

16. RIV performance of joint at 1(one)

MHz :

B. REPAIR SLEEVES FOR CONDUCTOR:

1. Maker's name & Country :

2. Type :

3. Suitable for (conductor size) :

4. Outside diameter of sleeves (mm) :

   i) Before compression :
   ii) After compression :

5. Length of sleeves:

   i) Before compression :
   ii) After compression :

6. Weight of sleeves :

7. Breaking strength of Midspan joint Expressed as percentage of ultimate Tensile strength of conductor(%) :

8. Conductivity of the compression Joint expressed as percentage of the Conductivity of the conductor (%) :

9. Resistance of percentage of measured Resistance of equivalent length of Conductor (%) :

10. Corona Performance :

11. Full details of the Hydraulic Compressor and die sets :

12. Packing details (number of joint Assemblies per packages and Gross Weight) in Kg :

13. Standard to which conforming :

C. Quad Spacer Damper for ACSR MOOSE conductor (For quad bundle conductor only)

Sl.	Description	Unit	Particulars/ Value
1.	Type of Clamp		
2.	Type of Damping element		
3	Material of		
	(a) Clamp		
	(b) Main body		
4.	Elastomer (if used)		
	(a) Shore hardness		
	(b) Temp.range for which designed	^{0}C	
5.	Minimum ultimate tensile strength of spacer		
	(a) Compressive load	kN	
	(b) Tensile load	kN	
6.	Slipping strength of spacer clamp		
	a)Before vibration test		
	b)After Vibration test	KN	
7.	Maximum Magnetic power loss per spacer for 600 Amps, 50 Hz Alternating Current	Watts	
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	

9.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro volts

D. Rigid Spacer for Jumper for ACSR MOOSE conductor (For quad bundle conductor only)

Sl.	Description	Unit	Particulars/ Value
1.	Type of Spacer		
2.	Material of component parts		
	(a) Clamp		
	(b) Main body		
3.	Manufacturing process of component parts		
	(a) Clamp		
	(b) Main body		
4.	Minimum ultimate tensile strength of spacer		
	(a) Compressive load	kN	
	(b) Tensile load	kN	
5.	Slipping strength of spacer clamp	kN	
6.	Maximum Magnetic power loss per spacer for 600 Amps, 50 Hz Alternating Current	Watts	
7.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	
8.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro volts	

E. PREFORMED ARMOUR RODS FOR CONDUCTOR :

1. Maker's name & Country :
2. Type :
3. Suitable for (conductor size) :
4. Total weight of a set of Armour Rods (Kg) :
5. Number of wire per set (No.) :
6. Nominal diameter of :
7. Length of wire (mm) :
8. Percentage of tolerance of length And diameter of wires (%) :
9. Overall diameter of the conductor After use of the armour rods(mm) :
10. Conductivity of PA Rods :
11. Breaking strength (Kgf) :
12. Centre Marking provided :
13. Pitch of Helix :
14. Direction of lay :
15. Corona formation voltage :

16. Efficiency of damping (%) :

17. Packing details :

18. Standard to which conforming :

19. Material :

F. VIBRATION DAMPERS FOR CONDUCTOR :

1. Maker's name & Country :

2. Type :

3. Suitable for (Conductor size) :

4. Total weight of each damper(Kg) :

5. Diameter of balancing weight(mm) :

6. Length of balancing weight (mm) :

7. Weight of each balancing weight(Kg) :

8. Tolerance in balancing weight % :

9. Material, Quality, Length and size of Messenger cable :

10. Slipping strength of messenger cable (Kgf)
    i) Before fatigue test :
    ii) After fatigue test :

11. Diagram showing power dissipated By the damper for various vibration Frequency & amplitude :

12. Damping efficiency of damper :

13. Natural frequency of the damper

    a) Upper c.p.s. :
    b) Lower c.p.s. :

14. The number of dampers required per Span for various span length and their Spacings (No.) :

15. Position of fixing damper on the Conductor from the clamp mouth(mm)

a) At Tension Points:
i) First Damper :
ii)Second Damper :

b) At Suspension Points:
(After fixing Armour Rods)
i) First Damper :
ii) Second Damper :

16. Corona Performance of the Damper :

17. Clamping bolt tightening torque :

18. Minimum fatigue strength of the damper in cycles :

19. Amplitue of fatigue at the highest Resonant frequency :

20. Slip strength of clamp :

21. Magnetic power loss of damper at 500 for Zebra Amps., 50 cycles AC :

22. Reports of damping characteristics And energy discipation :

23. Maxm. Dynamic strain on the Conductor with the damper at clamping Points :

24. Packing Details :

25. Standard to which conforming :

26. Interchangeability of Damper :

27. Maximum bending Amplitude :

28. Galvanising on Ferrous Parts:

i) Min^{m} zinc coating :
ii)No. of dip per minute :

G. HARDWARE:

1. Maker's Name & Country :

2. Size and Designation of ball and socket with Standard specification to which conforming :

3. Material:

a)	Anchor Shackle	:
b)	Arcing Horn	:
c)	Ball Eye	:
d)	Ball Clevis	:
e)	Ball Link	:
f)	Chain Link	:
g)	Clevis Eye	:
h)	Clevis-Clevis	:
i)	Socket Eye	:
j)	Socket Clevis	:
k)	Yoke Plate (LS/TS)	:
l)	Suspension Clamp	:
m)	Dead End Clamp	:
n)	Corona Control Ring	:
o)	Security Clips & Split Pin	:
p)	Sag Adjustment Device	:
q)	Turn Buckle	:

4. Minimum Failing Load (Kg) :
i) Single/Double Suspension :
ii) Single/Quad Tension :

5. Standard specification to which conforming :

6. Standard specification of Galvaniziation :

7. Number of Dip of the Galvanised iron material :
   i) 3 Minutes :
   ii) 1 Minute :

8. Corona Performance :

9. Reference to drawing attached :

10. Reference to type and other test reports Attached :

H. CLAMPS (SUSPENSION & TENSION)

1. Maker's name & Country :

2. Type :

3. Material :

4. Breaking Strength (Kgf) :

5. Slipping strength (Kgf) :

6. Angle of inclination of jumper terminal :

7. Electrical Conductivity:
   a) Results of heating cycle test carried out :
   b) Value of Electrical resistance :

8. a) Whether a graph showing the power Losses in Watts against current in Ampere is enclosed :
   b) Magnetic Power Losses in Watts :

9. Reference to type tests and other test Reports attached :

10. Weight :

11. Interchangeability :

12. Packing Details :

13. Corona Performance :

14. Galvanising of Ferrous Parts :
    a) Minimum weight of zinc (gm/gm^2) :
    b) No. of Dip per Minute :

I. INSULATOR STRINGS :

		SUSPENSION	TENSION
1.	Maker's Name & Country :		
2.	a)Type of insulator units : b) Size and designation of Ball & Socket with standard to Which it will conform :		
3.	Electro-mechanical strength Of complete string(Kg) :		
4.	Whether hardware Manufacturer guarantee to conduct string test on complete assembly with Insulator Manufacturer in some independent Laboratory:		
5.	Galvanizing of ferrous parts: a) Minimum weight of Zinc (gm/m^2) : ii) Number of dip per minute :		

J. MIDSPAN COMPRESSION JOINT FOR GSS EARTH WIRE

1. Maker's name & Country :
2. Material :
3. Size :
4. Suitable for Groundwire :
5. Weight (Kg) :
6. Minimum Failing Load (Kgf) :
7. Galvanisation :
   a) Ferrous Parts :
   b) Spring washer :
   c) Quality of Zinc used :
   d) Number of dip which the clamp Can withstand
      3 Minutes
      1 Minute :
   e) Minimum weight of Zinc (gm/gm^2) :
8. Standard to which conforming :
9. Packing Details :

K. FLEXIBLE COPPER BOND FOR GSS EARTH WIRE:

1. Maker's name & Country :
2. Material :
3. Length (mm) :
4. Bolt Nut Size :
5. Copper Area (sq mm) :

6. Thickness of Lug (mm) :

7. Materials for Connecting Socket :

8. Standard to which conforming :

9. Packing details :

L. SUSPENSION CLAMP FOR GSS EARTH WIRE:

1. Maker's Name & Country :

2. Type :

3. Material :

4. Length of Clamp (mm) :

5. Suitable for Groundwire :

6. Weight (Kg) :

7. Slip Strength (Kgf) :

8. Minimum Failing Load(Kgf) :

9. Galvanisation:

   a) Ferrous Parts :
   b) Spring washer :
   c) Quality of Zinc used :
   d) Number of dip which the clamp can withstand :
      3 Minutes
      1 Minute
   e) Minimum weight of zinc (gm/gm^2) :

10. Standard to which conforming :

11. Packing Details :

M. COMPRESSION TYPE DEAD END ASSEMBLY FOR GSS EARTH WIRE

1. Maker's Name & Country :
2. Material :
3. Overall Length (mm) :
4. Jumper Length (Straight Portion) (mm) :
5. Suitable for Groundwire :
6. Weight (Kg) :
7. Minimum Failing Load(Kgf) :
8. Outer Diameter (mm) :
   - i) Before Compression :
   - ii) After Compression :
9. Galvanisation :
   - a) Ferrous Parts :
   - b) Spring washer :
   - c) Quality of Zinc used :
   - d) Number of dip which the Clamp can withstand :
     - 3 Minutes
     - 1Minute
   - e) Minimum weight of zinc (gm/m^2) :
10. Standard to which conforming :
1. Packing Details :

N. VIBRATION DAMPER FOR GSS EARTH WIRE

1. Maker's Name & Country :

2. Type :

3. Suitable for (conductor size) :

4. Total weight of each damper(Kg) :

5. Diameter of balancing weight(mm) :

6. Length of balancing weight (mm) :

7. Weight of each balancing weight(Kg) :

8. Tolerance in balancing weight % :

9. Material, Quality, Length and size Of messenger cable :

10. Slipping strength of messenger Cable (Kgf) :

11. Damping efficiency of damper :

12. Natural frequency of the damper

    a) Upper c.p.s. :
    b) Lower c.p.s. :

13. The number of dampers required per Span for various span length and their Spacings :

14. Position of fixing damper on the Conductor from the clamp mouth(mm)

    a) At Tension Points:
       i) First Damper :
       ii) Second Damper :

    b) At Suspension Points:
       i) First Damper :

ii) Second Damper :

15. Clamping bolt tightening torque :

16. Minimum fatigue strength of the Damper in cycles :

17. Amplitude of fatigue at the highest Resonant frequency :

18. Slip strength of clamp (Kgf) :

19. Reports of damping characteristics And energy dissipation :

20. Maxm. Dynamic strain on the Earthwire with the damper at clamping Points :

21. Packing Details :

22. Standard to which conforming :

23. Interchangeability of Damper :

24. Material used for
    a) Clamp :
    b) Messenger Cable :
    c) Damper :

25. Galvanising on Ferrous Part:
    i)Minimum weight of zinc(gm/gm^2) :
    ii) No. of dip per minute :