BIDDING DOCUMENT

FOR

"Upgradation of the existing 132KV Bus with HTLS Conductor at Agia GSS"

(E-Tender)

VOLUME -2

https://assamtenders.gov.in

BID IDENTIFICATION NO:

AEGCL/MD/TECH-1191/SOPD 2025-26/BID

ASSAM ELECTRICITY GRID CORPORATION LIMITED

CONTENTS

SECTION-1
SCOPE AND GENERAL TECHNICAL CONDITIONS

1.1.0 INTENT OF THE SPECIFICATION

1.1.1 This volume of the specification deals with the general technical information & criteria for design, manufacture, supply & delivery of equipment/material, erection, testing & commissioning and setting to work of construction on "Design, Supply and Install" basis as defined in Volume-1.

1.1.2 The provisions of this section shall supplement all the detailed Technical Specifications and requirements brought out herein. The CONTRACTOR's proposal shall be based on the use of materials complying fully with the requirements specified herein.

1.2.0 SCOPE

1.2.1 The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage and erection & commissioning at site of various equipment and materials including associated works and civil foundations for equipment as specified in subsequent Clauses and Sections.

1.2.2 It is not the intent to specify completely herein all details of design and construction of the equipment and accessories. However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the bidder's guarantees in a manner acceptable to the Purchaser. The Purchaser will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgement is not in full accordance therewith.

1.2.3 The major items of works included in the scope of this specification are listed below: -

i) Design & supply of all equipment as per BoQ.
ii) Installation and commissioning services as specified in BoQ.
iii) Other associated works as specified in BoQ.

1.2.4 The various items of supply are described very briefly in the schedule of Bid Form, Prices & Other Schedules and annexure. The various items as defined in these schedules shall be read in conjunction with the corresponding section in the technical specifications including amendments and, additions if any.

1.2.5 The bidder is required to fill up the BOQ/price schedule as given in the e-tendering portal.

1.3.0 DESIGN IMPROVEMENTS

1.3.1 The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

1.4.0 DESIGN CO-ORDINATION

1.4.1 Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.5.0 DESIGN REVIEW MEETING

1.5.1 The contractor will be called upon to attend design review meetings with the Employer, and the consultants of the Employer during the period of Contract. The contractor shall attend such meetings at his own cost at Assam or at mutually agreed venue as and when required. Such review meeting will be held generally minimum once a

month or the frequency of these meeting shall be mutually agreed between the Employer and the Contractor. Frequency of Design Review Meetings shall depend upon the project requirement to ensure project implementation as per the Master Programme.

1.6.0 PACKING

1.6.1 All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. The CONTRACTOR shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

1.6.2 The CONTRACTOR shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.

1.6.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

1.6.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e., fragile, handle with care, use no hook etc. wherever applicable.

1.6.5 Each package shall be legibly marked by the-CONTRACTOR at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the CONTRACTOR etc.

SECTION-2
TECHNICAL SPECIFICATION FOR CONSTRUCTION WORKS IN SUBSTATIONS

2.1.0 GENERAL

2.1.1 The intent of this Section of the Specification is to cover requirements which are to be followed in construction of switchyards including civil works in the switchyard.

2.1.2 The work shall be generally carried out as per approved drawings.

2.1.3 The Contractor shall be required to prepare his own drawings based on project with modifications as and if required and shall submit those for Employer's scrutiny.

2.2.0 SURFACE PREPARATION AND STONE SPREADING

2.2.1 Before taking up PCC base (pro-1:4:8) and stone filling at the location in the construction site, the area shall be thoroughly de-weeded including removal of roots as directed by the Engineer-in-Charge.

2.2.2 After all the structures, equipment & earthing system are erected and after construction of cable trenches, the surface of the switchyard area shall be maintained, rolled/ compacted to the lines and grades as decided by Engineer-in-Charge. De-weeding including removal of roots shall be done before rolling is commenced. Engineer-in-Charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the drawing using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface.

2.2.3 A base layer of PCC of 80 mm thickness with proportion of 1:4:8 shall be provided before spreading of crushed rocks. PCC base shall be done in panels of 4 m x 4 m with expansion gap of 25 mm between panels. The gap shall be filled with bitumen. Each panel shall be provided with four (4) numbers of PVC pipes (per panel) of 100 mm dia of length 450 mm for soaking of water. The pipes will be provided with gratings at the top and the same will be flushed with the PCC top.

2.2.4 Over the PCC layer, a surface course of minimum 100mm thickness of 20mm nominal size river pebbles or (single size ungraded) broken stone shall be spread.

2.3.0 CABLE TRENCHES AND CABLE TRAYS

2.3.1 Construction of cable trenches with pre-cast removal R.C.C cover (with lifting arrangement) as per drawings supplied with the Bid Documents shall be carried out by the Contractor.

2.3.2 The Contractor shall provide embedded steel plates of adequate size on the walls of concrete cable trench for supports for cable trays. Insert plates will be provided at an interval of 2000mm.

2.3.3 If asked for, the cable trench walls shall be designed for following loads: -
(a) Dead load of 155 kg/M length of cable support (tray) + 75 kg on one tier at the end.
(b) Triangular earth pressure + uniform surcharge pressure of 2T/m2.

2.3.4 RCC cable trench cover shall be designed for self-weight of slab + UDL of 2000 kg/m2 + a concentrated load of 200 kg at center of span on each slab panel.

2.3.5 Cable trench inside the Control Room shall be covered with 6 mm thick chequered plates with lifting arrangement.

2.3.6 Cable trench crossing the road/rails shall be designed for class AA. Loading of IRC/relevant IS Code and

should be checked for transformer loading.

2.3.7 Trenches shall be drained. Necessary sumps be constructed and sump pumps if necessary, shall be supplied. Cable trenches shall not be used as storm water drains.

2.3.8 All metal parts inside the trench shall be connected to the earthing system.

2.3.9 Cables from trench to equipment shall run in hard conduit pipes.

2.3.10 Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

2.3.11 The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

2.3.12 All the construction joints of cable trenches i.e., between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.

2.3.13 Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12 mm thick 1:6 cement sand mortar.

2.3.14 Cable Trays

(i). The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2 mm.

(ii). The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)

The test shall be done as per approved standards.

b) Deflection Test: (Type Test)

A 2.5 metre straight section of 300mm, wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

2.4.0 FOUNDATION AND RCC CONSTRUCTION

2.4.1 General

2.4.1.1 Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, control cubicles, bus supports, transformer, marshalling kiosks, auxiliary equipment and systems, buildings, tanks, boundary wall or for any other equipment or service and any other foundation required to complete the work.

2.4.1.2 Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification.

A minimum grade of M20 concrete shall be used for all structural/load bearing members as per latest IS 456.

2.4.1.3 If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of the structures to compensate for such slopes.

2.4.1.4 The switchyard foundation's plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

2.4.1.5 Minimum 75 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches, etc., to provide a base for construction.

2.4.1.6 Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

2.4.1.7 The design and detailing of foundations shall be done based on the approved soil data and subsoil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

2.4.1.8 If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

2.4.2 Design

2.4.2.1 All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20.

Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Employer.

2.4.2.2 Limit state method of design shall be adopted unless specified otherwise in the specification.

2.4.2.3 For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe- 415 N/mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

2.4.2.4 RCC water retaining structures like storage tanks, etc., shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress

method.

2.4.2.5 The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and or superstructure and other conditions, which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

2.4.2.6 Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

2.4.2.7 Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/ harmful to the concrete foundations.

2.4.2.8 RCC columns shall be provided with rigid connection at the base.

2.4.2.9 All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

2.4.2.10 Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable).

However, for the design of sub-structures of any underground enclosures, earth pressure at rest shall be considered.

2.4.2.11 In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, sub-structure of any underground hollow enclosure, etc., for the vehicular traffic in the vicinity of the structure.

2.4.2.12 Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

a) Full water pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).

b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

2.4.2.13 The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

2.4.2.14 The foundations of transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

2.4.2.15 The tower and equipment foundations shall be checked for a factor of safety of 2.0 for normal condition and 1.50 for short circuit condition against sliding, overturning and pull out. The same factors shall be used as partial safety factor overloads in limit state design also.

2.4.3 Admixtures & Additives

2.4.3.1 Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

2.4.3.2 Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Employer shall approve concrete Admixtures/Additives.

2.4.3.3 The Contractor may propose and the Employer may approve the use of a water-reducing set retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

2.4.3.4 The water reducing set-retarding admixture shall be an approved brand of Ligno- sulphonate type admixture.

2.4.3.5 The water proofing cement additives shall be used as required/advised by the Employer.

2.5.0 SUBMISSION

2.5.1 The following information shall be submitted for review and approval to the Employer as far as Civil Works are concerned:

(a) Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.

(b) Structural design calculations and drawing (including constructions / fabrication) for all reinforced concrete and structural steel structures.

(c) Any other data, drawings and information required to be submitted as per various clauses of the specification.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable

2.6.0 BUS BARS AND BUS BAR SUPPORTS

2.6.1.1 The bus bars shall be outdoor strung bus bars with ACSR conductor supported on lattic.

2.6.1.2 If asked for, the substation steel structures shall be designed as per bid specification.

2.7.0 ACSR CONDUCTORS

2.7.1 The Conductor shall conform to IS: 398 (latest edition) except where otherwise specified herein.

2.7.2 The details of the ACSR Moose, ACSR Zebra and ACSR Panther conductors are tabulated below:

Sl. No.	DESCRIPTION	ACSR 'MOOSE'	ACSR 'ZEBRA'	ACSR 'PANTHER'
1	Code name	MOOSE	ZEBRA	PANTHER
2	Number of strands & size	Al: 54/ 3.53 mm St: 7/ 3.53 mm	Al: 54/ 3.18 mm St: 7/ 3.18 mm	Al: 30/ 3.00 mm St: 7/ 3.00 mm
3	Overall diameter	35.05 mm	28.62 mm	21.00 mm
4	Breaking load	136.38 kN	130.32 kN	130.32 kN
5	Weight of conductor	2004 Kg/km	1621 kg/km	974 kg/km
6	Co-efficient of linear expansion	$23x10^{-6}$ / ºC	$19.35x10^{-6}$ / ºC	$19.35x10^{-6}$ / ºC
7	Number of strand			
	Steel centre	1	1	1
	1st Steel Layer	6	6	6
	1st Aluminium Layer	12	12	12
	2nd Aluminium Layer	18	18	18
	3rd Aluminium Layer	24	24	-
8	Sectional area of Aluminium	528.50 mm²	428.90 mm²	212.10 mm²
9	Total sectional area	597.00 mm²	484.50 mm²	261.50 mm²
10	Calculated D.C. resistance at 20º C	0.05552 ohm/km	0.06869 ohm/km	0.1400 ohm/km
11	Ultimate tensile strength	161.2 kN	130.32 kN	89.67

2.8.0 ELECTRICAL CLEARANCES

2.8.1 Following minimum electrical clearances (outdoor) shall be maintained in the switchyard:

Sl. No.	Clearance	220 KV	132 KV	33 KV
1	Phase to Phase	2400 mm	1300 mm	320 mm
2	Phase to Earth	2400 mm	1300 mm	320 mm
3	Sectional Clearance	5000 mm	4000 mm	2800 mm
4	Live part to ground	5500 mm	4600 mm	3700 mm
5	Base of insulator (supporting live part) to ground	2500 mm	2500 mm	2500 mm

2.9.0 EARTHING SYSTEM

2.9.1 General

(a) Earthing system shall be installed as per drawings provided with this bidding document.

(b) The main earthing system for the switch yard shall consist of a mesh made out of Galvanised MS flats of size not less than 65 mm in width and12 mm thick covering the entire switchyard area and earth electrodes distributed all over the mesh. The earth electrodes shall also be placed all around the periphery of the mesh at regular intervals.

(c) The earth mat shall be created by laying the earthing conductor (Galvanised MS flats) in both directions perpendicularly. The mesh points so created and all other joints shall be welded and painted and painted with rust proof paint after welding.

(d) Minimum depth of burial of main earthing conductors shall be 600 mm from FGL.

(e) Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.

(f) The earthing system must conform to requirements of the Indian Electricity Rules and the provisions of IS: 3043.

(g) All earth electrodes and risers for equipment and other earthing must be connected at mesh points of the earth mat. All such connections shall be welded.

(h) All metallic supporting structures and non-current carrying metallic parts of all equipment shall be provided with double earthing.

(i) All LAs, VTs, CVTs and all transformer neutrals must be earthed through separate earth electrodes and in turn these electrodes shall be connected to the main earth grid.

(j) One number 40mm dia, 3000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive &inductive voltage transformers, lightning masts and towers with peak.

(k) 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.

(l) The earthing system in the Control Room must also be connected to the main station grid. For this purpose, earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building which in turn shall be connected to the main earth grid by two runs of 65mm x 12mm GI flats.

(m) Each earthing lead from the neutral of the power transformers shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer

like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points. These electrodes must also be connected to the Main Earth Mat of the substation.

2.9.2 Summary of Earthing System

Sl. No.	Item	Size	Materials
1	Main Earthing Conductor to be buried in ground	65mm x 12 mm	GI Flat
2	Conductor above ground & earthing leads (for equipment)	65mm x 12 mm	GI Flat
3	Conductor above ground & earthing leads (for columns & aux. structures)	65mm x 12 mm	GI Flat
4	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc.	50mm x 6 mm	GI Flat
5	Rod Earth Electrode	40mm dia, 3000 mm long	Mild Steel
6	Pipe Earth Electrode (in treated earth pit) as per IS 3043	40mm dia, 3000 mm long	Galvanised Steel

2.10.0 PROTECTION AGAINST DIRECT LIGHTNING

2.10.1 Protection against direct lightning shall be provided by stringing GI shield wires and/or by lightning masts (SPIKES) as per layout drawings attached.

2.10.2 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

2.10.3 Down conductors shall be cleated on the structures at 2000 mm interval. For grounding of lightning spikes and shield wires, 7/3.66 mm GI steel wires shall be used.

2.10.4 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earth-mat.

2.10.5 Two runs of down conductors shall be used for grounding of each Lightning Spikes. For that, lugs with bolts shall be provided at base of spikes.

G.I. wires for shielding shall conforming to IS 2141.Parameters of galvanised steel wires shall be as follows:

a) No of Strand: 7
b) Diameter of single strand: 3.66 mm
c) Minimum Breaking Load: 6970 KG
d) Overall Diameter: 10.98 mm
e) Area: 72.25 mm2

2.11.0 BAY MARSHALLING KIOSK

2.11.1 **1 (One)** number of bay marshalling **kiosk** shall be **provided for each 132 kV bay** under present scope. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose: -

(i) Incoming:

To receive **2(two)** incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and

(ii) Outgoing:

(a) To distribute **4(four)** outgoing 415V, 16 Amps 3 phase AC supplies to be controlled by MCB.
(b) To distribute **3(three)** outgoing 240V, 16 Amps single phase supplies to be controlled by MCB.
(c) To distribute **3(three)** outgoing 240V, 10 Amps single phase supplies to be controlled by MCB

2.11.2 The steel sheet thickness of BMK shall be minimum 3.15 mm and painting shall be as per Clause 7.15.0.

2.11.3 The BM shall be protective Class of IP 55.

2.11.4 The BMK shall have a minimum of 700 mm clearance to switchyard floor.

2.12.0 INSULATOR AND HARDWARE FITTINGS

2.12.1 General

a) The Contractor shall supply insulators of suspension, tension and post type as required complete with all necessary hardware and accessories, including fittings for fixing insulators to steel structures as required.

b) The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

c) Unless otherwise specified, the glaze shall be brown colour. The glaze shall cover all the porcelain parts of the insulators except those areas which serve as support during firing or are left unglazed for purpose of assembly.

d) The design of the insulator shall be such that stress due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

e) Cement use in the construction of insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fitting and its thickness shall be as uniform as possible.

f) Pins and caps shall be made of drop forged steel, duly hot dip galvanized as per IS 2629.These shall not be made by jointing, welding, shrink fitting or any other process.

g) Security clips/split pins shall be made of good quality of stainless steel.

h) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings.

i) Post type insulators shall be of long rod type or solid core type and preferably of single piece type for all voltage classes. These shall be complete with necessary fittings to hold Aluminium tubes or ACSR conductor as required.

j) The items of hardware and fittings shall make complete assemblies which are necessary for their satisfactory performance. Such parts shall be deemed to be within the scope of this specification.

2.12.2 Disc Insulator Strings

Each insulator string shall consist of following numbers of Disc & parameters.

Sl. No.	Description	No of Disc Insulator Unit for		
		220 kV	**132 kV**	**33 kV**
1	No. of Disc, Suspension String	14	9	3
2	No. of Disc, Tension String	15	10	4
3	Creepage Distance of complete String (min)	6125 mm	3625 mm	900 mm

2.12.3 Parameters

2.12.3.1 Disc Insulators

a) Type : Ball and Socket
b) Colour : Brown
c) Surface : Glazed
d) Locking Device : W or R type security clip
e) Size of Disc : 255 mm x 145 mm
f) Size of Pin Ball : 16 mm
g) Creepage Distance

(Min subjected requirement of clause 7.19.2):25 mm/kV

h) Electro mechanical Strength : 70 KN
i) Power frequency withstand test voltage : 75 KV Dry
j) Minimum dry Impulse withstand : 125 KV peak Test voltage (+/- wave)
k) Puncture Voltage : 1.3 X actual dry flash over voltage.

2.12.3.2 Post Insulators

Sl. No.	**Parameters**	**220 kV**	**132 kV**	**33 kV**
1	Highest system voltage	245 kV	145 kV	36 kV
2	Dry one minute power frequency test voltage	510 kV	275 kV	75 kV
3	Wet one minute power frequency test voltage	460 kV	275 kV	75 kV
4	Impulse voltage withstand test	510 kV	650 kV	170 kV
5	Minimum Creepage Distance	31mm/kV	31mm/kV	31mm/kV
6	Minimum Bending Strength (upright)	6 kN	4 kN	3 kN

2.13.0 CLAMPS, CONNECTORS AND SPACERS

2.13.1 Clamps and connectors shall conform to IS 2121 unless otherwise mentioned hereunder.

2.13.2 Clamps and connectors shall be made of materials listed below: -

(i) For connecting ACSR: Aluminium alloy casting conforming to designation A6 of IS 617.
(ii) For connecting equipment: Bimetallic connectors made from aluminium alloy terminals made of copper casting conforming to designation A 6 of IS 617.
(iii) For connecting GI Shield wire: Malleable iron casting.
(iv) Expansion Connectors: Copper lamination to grade FRTP-2 of IS 191.
(v) Bolts, nuts, plain washers: Hot dip galvanised mild steel and spring washers for items (i), (ii) and (iii).

2.13.3 Spacers

Spacers shall conform to IS 10162. Spacers for bundle conductors (where specified) shall be provided at but not limited to the following locations:

(i) At intervals not exceeding 2.5 meters in case of strung bus bars or other bundled strung conductors.
(ii) At one meter interval in case of jumper connections.

No magnetic material shall be used in fabrication of spacers except for the GI bolts and nuts.

2.13.4 <u>T Clamp and Equipment Clamps</u>

a) <u>T Clamps:</u>

i. Standard Specification and tests shall be as per IS:5561.
ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.
iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.
v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.
vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.
vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.
viii. All sharp edges and corners shall be blurred and rounded off.
ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.
x. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

b) <u>Equipment Clamps (CVT, CB, ISOLATOR, CT, etc.):</u>

i. Standard Specification and tests shall be as per IS:5561.
ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.
iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.
v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.
vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.
vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.
viii. All sharp edges and corners shall be blurred and rounded off.
ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

2.14.0 ILLUMINATION SYSTEM

2.14.1 The Contractor shall design, supply and install illumination system for the entire substation.

The average illumination level and limiting glare index for different parts of the substation shall be as follows:

Sl. No.	Location/Area	Average Illumination Level, 'Lux'	Limiting Glare Index
1	Control Room	300	19
2	Battery Room	100	19
3	Carrier Room	300	
4	Office/Conference Room	300	
5	Stairs and Corridors	100	
6	Air Conditioning Plant	150	
7	Outdoor Switchyard	20	

8	Approach Road	20	
9	Store Room	100	

2.14.2 The lighting system of a particular area whether indoor or outdoor shall be designed such a way that uniform illumination level is achieved. In outdoor switchyard illumination shall be aimed as far as possible towards transformers, circuit breakers, isolators etc.

2.14.3 Following types of lamps shall be used for various location of the substation:

Sl. No.	**Location/Area**	**Type of Lamp**	**Type of Fitting**
1	Control Room, Office, Carrier Room	LED	Decorative
2	Battery Room	Fluorescent	Acid Proof, Industrial
3	Outdoor Switchyard	LED	Water Tight Flood Light
4	External Lighting on Buildings	LED	Water Tight Flood Light
5	Gate Lighting	LED	Post type, water tight Flood Light

2.14.4 Provisions shall be made in the switchyard steel structures for mounting of lamps for switchyard.

2.15.0 PAINITNG

2.15.1 All surfaces of ferrous materials used for construction of outdoor equipment and enclosures such as instrument transformer main tanks and equipment, marshalling boxes, kiosk, operating boxes, metallic enclosures etc. shall be cleaned and painted as given below if not specified otherwise in respective Sections. The quality of paint such that its colour should not fade even if it is exposed to temperature up to 1200-degree C.

Description	**Surface preparation**	**Primer coat**	**Intermediate undercoat**	**Finish coat**	**DFT**	**Colour Shade**
CT & PT Main tanks of CT, PT and other oil filled equipment, etc. (**External surface)**	Shot Blast cleaning Sa 2½ (ISO 8501-1)	Epoxy base zinc primer (30-40 mm)	Epoxy high build micaceous iron oxide (75 mm)	Aliphatic Polyurethane 2 coats (25 mm/coat)	Minimum 155 mm	Shade No. 631 of IS:5
do (**Internal surfaces)**	Shot Blast cleaning Sa 2½ (ISO 8501-1)	Hot oil resistant, non-corrosive varnish or paint or epoxy			Minimum 30 mm	Glossy white or paint
Marshalling boxes, operating	Chemical/Shot Blast cleaning Sa	Epoxy base zinc primer (30-40 mm)				

2.15.2 All paints shall be carefully selected to withstand heat, rain and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

2.15.3 In case finish paint chips off or crinkle during transit or installation, the contractor shall arrange for repainting transformer at site at his cost. The paint for repainting/touchup shall be supplied by the contractor.

2.15.4 The paint work done shall be guaranteed for a minimum period of 5 years from the date of receipt of the equipment.

2.15.5 1(One) coat of additional paint to the exposed exterior surfaces shall be given at site prior to commissioning in presence of the Employer's representative.

2.16.0 SUPPLY OF CONSTRCUTION MATERIALS BY THE CONTRACTOR

2.16.1 The contractor has to make his own arrangements for procurement, supply and use of construction materials like cement, M.S. rounds, H.B.G. metal and sand.

2.16.2 Cement

The contractor has to make his own arrangements for the procurement of cement to required specifications required for the work subjected to the follows:

a) The contractor shall procure cement (approved BSI marked of PPC of Grade 53), required for the works only from reputed cement factories (Main producer) acceptable to the Engineer-in-Charge. The contractor shall be required to be furnished to the Engineer in-Charge bills of payment and test certificates issued by the manufacturers to authenticate procurement of quality cement from the approved cement factory.

The contractor shall make his own arrangement for adequate storage of cement.

b) The contractor shall procure cement in standard packing of all 50 kg per bag from the authorized manufacturers. The contractor shall make necessary arrangement at his own cost to the satisfaction of Engineer-in-Charge for actual weighment of random sample from the available stock and shall conform with the specification laid down by the Indian Standard Institution or other standard foreign institutions laid down by the Indian Standard Institution or other standard foreign institutions as the case may be. Cement shall be got tested for all the tests as directed by Engineer-in-Charge at least one month in

advance before the use of cement bags brought and kept on site Stores. Cement bags required for testing shall be supplied by the contractor free of cost. If the tests prove unsatisfactory, then the charges for cement will be borne by the Contractor.

c) The Contractor should store the cement of 60 days requirement at least one month in advance to ensure the quality of cement so brought to site and shall not remove the same without the written permission of the Engineer-in-Charge. The Contractor shall forthwith remove from the works area any cement that the Engineer-in-Charge may disallow for use, an account of failure to meet with required quality and standard.

d) The contractor shall further, at all times satisfy the Engineer-in-Charge on demand, by production of records and books or by submission of returns and other proofs as directed, that the cement is being used as tested and approved by Engineer-in-Charge for the purpose and the Contractor shall at all times, keep his records up to date to enable the Engineer-in-Charge to apply such checks as he may desire.

e) Cement which has been unduly long in storage with the contractor or alternatively has deteriorated due to inadequate storage and thus become unfit for use in the works will be rejected by the department and no claim will be entertained. The Contractor shall forthwith remove from the work area, any cement the Engineer-in-Charge may disallow for use on work and replace it by cement complying with the relevant Indian Standards.

2.16.3 Steel

The Contractor shall procure mild steel reinforcement bars, high yield strength deformed (HYSD) bars, rods and

structural steel, etc., required for the works, only from the main or secondary producers manufacturing steel to the prescribed specifications of Bureau of Indian Standards or equivalent and licensed to affix ISI or other equivalent certification marks and acceptable to the Engineer-in-Charge. Necessary ISI list certificates are to be produced to Engineer-in-Charge before use on works. The unit weight and dimensions shall be as prescribed in the relevant Indian Standard specification for steel.

2.17.0 SUPPLY OF CONSTRCUTION MATERIALS BY THE EMPLOYER

2.17.1 As it is a single responsibility contract supply, and/or arrange all materials and services including construction and testing equipment to complete the works in all respects described in the specification, shall be under the scope of the Contractor unless otherwise specifically mentioned elsewhere in the bidding document.

2.18.0 MISCELLANEOUS GENERAL REQUIREMENTS

2.18.1 Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

2.18.2 All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting.

The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

2.18.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

2.18.4 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10conforming to IS:456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

2.18.5 Bricks having minimum 75 kg/cm2 compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75kg/cm2 compressive strength before submitting his offer.

2.18.6 Angles 50 x 50 x 6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/ openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole pre-cast cover and any other place where breakage of corners of concrete is expected.

2.18.7 Anti- termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.

2.18.8 Items/components of equipment/materials/components etc. not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

SECTION- 3
TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS

3.1.0 SCOPE

3.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor, and accessories for Power Conductors.

3.2.0 POWER CONDUCTOR

3.2.1 TYPE OF CONDUCTOR

The ACSR Conductor shall generally conform to IEC: 61089/ IS: 398 (relevant part)/ ASTM:B-232 except where otherwise specified herein.

Conductor conforming to a standard other than the Indian Standard specification then an English version of the Standard in addition to the original standard if written in a language other than English should be submitted indicating clearly the advantage, if any, that would be obtained by the Employer for adopting this standard instead of the said India Standard.

3.2.2 STANDARD TECHNICAL PARTICULARS

All ACSR Conductor shall satisfy all the parameters as furnished in Technical Data Sheet.

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

The steel strands shall be hot dip galvanised and shall have a minimum zinc coating.

3.2.3 MATERIAL

i. The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IEC: 60889.

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

iii. The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC : 60888.

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

3.2.4 JOINTS IN WIRE

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

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

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

3.2.5 STRANDING

The wires used in construction of a ACSR conductor shall, before and after stranding, satisfy all requirements as per IS 398.

The lay ratio of the different layers shall be within the limits as per the said Standard. In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right-handed. The wires in each layer shall be evenly and closely stranded. In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

3.2.6 TYPE/ROUTINE/ACCEPTANCE TESTS

Type Test:

The following tests shall be conducted on a sample/samples of the conductor(s) required under the package from each stranding machine from which the conductor is to be manufactured & supplied:

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

Acceptance Test:

a) Visual and dimensional check on drum
b) Visual check for joints, scratches etc. and length measurement of conductor by rewinding
c) Measurement of diameters of individual Steel and Aluminium strands

1. Galvanizing test on steel strands
2. Check for lay Ratios of various layers
3. Torsion and Elongation tests on steel strands
4. Breaking load test on steel and Aluminium strands
5. Wrap test on Steel & Aluminium strands
6. DC resistance test on Aluminium strands
7. Procedure qualification test on welded joint of Aluminium strands
8. Drum strength test (steel drum)
9. Barrel Batten strength test (wooden drum)

The above acceptance tests shall be repeated on one conductor sample taken from site in presence of AEGCL's representative for each 500km progressive supply. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by AEGCL's site representative and the tests shall be witnessed by AEGCL's representative.

Routine Tests:

a) Check to ensure that the joints are as per Specification
b) Check that there are no cuts, fins etc. on the strands
c) Check that drums are as per Specification
d) All acceptance test as mentioned above to be carried out on aluminium and steel strands of 20% of drums

Tests During manufacture:

a) Chemical Analysis of Zinc used for galvanising
b) Chemical Analysis of Aluminium used for making Aluminium Strands
c) Chemical Analysis of Steel used for making Steel Strands.

3.2.7 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

3.2.8 PACKING

All conductor reels shall conform to latest edition of IS : 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable, that is next to the lagging.

The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

The wooden drums shall preferably be given protective coating of a reliable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.

3.2.9 TECHINCAL DATA SHEET FOR CONDUCTOR

ACSR MOOSE

Sl. No	DESCRIPTION	PARTICULARS
I	II	III
1	Type of Conductor	Aluminium Conductor Steel Reinforced (ACSR)
2	No of Strand x size	54 x 3.53 mm
3	Conductor over all diameter	31.77 mm
4	Total sectional area	597 mm^2
5	Approx. weight	2004 kg/km
6	Minimum UTS	161.2 kN
7	Modulus of Elasticity (Final)	0.7034 kg/cm^2
8	Coefficient of linear expansion	19.3 x 10^{-6} /^{0}C
9	Calculated maximum resistance/Km of Conductor at 20°C	0.05552 ohms/km
10	Layer and No of Wire	
	Steel core	1
	1st steel layer	6
	1st Aluminium layer	12
	2nd Aluminium layer	18
	3rd Aluminium layer	24
11	**Aluminum strands after stranding**	
(a)	Diameter	
	Nominal	3.53
	Maximum	3.55
	Minimum	3.51
(b)	Minimum breaking load of strand	
	Before stranding	1.57
	After stranding	1.49
12	**Steel strand after stranding**	
(a)	Diameter	
	Nominal	3.53
	Maximum	3.59
	Minimum	3.47
(b)	Minimum breaking load of strand	
	Before stranding	12.86
	After stranding	12.22
13	DC resistance of the conductor at 20°C	0.05552
14	Direction of lay of outer layer	Right Hand
15	Linear mass of the conductor	
	Standard	2004
	Minimum	1969
	Maximum	2040

ACSR Zebra

1.	Code Name	ZEBRA

2.	Equivalent area of Aluminium (sq.mm.)	418.6
3.	Wire Strand (Al./Steel)	54/7
4.	Nominal diameter of strand (Al./Steel)(mm.)	3.18/3.18
5.	Weight (Kg/Km)	1621
6.	Co-eff. of linear expansion per oC	19.30x10 $^{-6}$
7.	Ultimate Tensile Strength (kgf.)	13316
8.	Maxm. DC resistance at 20°C (Ω/Km) (Calculated from maxm. Value of resistivity and min. Cross-sectional area)	0.0680
9.	Zinc coating of steel :	
	i) No. of one minute dip	3
	ii) Min. wt. of zinc.(gm.m^2)	260
	iii) Purity of zinc (%)	99.95
10.	Diameter of conductor (mm)	28.62
11.	Standard Length (meter)	1100

ACSR Panther

Sl. No.	DESCRIPTION	ACSR 'PANTHER'
1	Code name	PANTHER
2	Number of strands & size	Al: 30/ 3.00 mm St: 7/ 3.00 mm
3	Overall diameter	21.00 mm
4	Breaking load	130.32 kN
5	Weight of conductor	974 kg / km
6	Co-efficient of linear expansion	19.35x10^{-6} /^{0}C
7	Number of strand	
	Steel centre	1
	1st Steel Layer	6
	1st Aluminium Layer	12
	2nd Aluminium Layer	18
	3rd Aluminium Layer	-
8	Sectional area of Aluminium	212.10 mm^2
9	Total sectional area	261.50 mm^2
10	Calculated d.c. resistance at 20^0 C	0.1400 ohm/km
11	Ultimate tensile strength	89.67

3.3.0 GROUND WIRES

Optical ground wire (OPGW) shall be used as per bid specification.

3.4 FITTINGS AND ACCESSORIES FOR CONDUCTORS

The accessories for conductors shall conform to IS: 2121 and 2486 (Latest version) in all respects

- **Mid Span Compression Joint**

• Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

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

- **T-Connector**

T-Connector of compression type shall be used for jumper connection at transposition tower. It shall be manufactured out of 99.5% pure aluminium and shall be strong enough to withstand normal working loads. The T-connector shall have a resistivity across jumper less than 75% resistivity of equivalent length of conductor. The T-connector shall not permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of T-connector should be kept at an angle of 15 deg. from vertical and horizontal plane of the conductor in order to minimise jumper pull at the welded portion. The dimensions and dimensional tolerances of T-connector shall be as per Standard Technical Particulars.

- **Repair Sleeve**

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions and dimensional tolerances of repair sleeve shall be as per Standard Technical Particulars.

- **Vibration Damper (Applicable for 400kV D/C (Twin Moose), 220kV & 132kV Lines)**

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

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

• One damper minimum on each side per Conductor/Sub-conductor for suspension points and two dampers minimum on each side per conductor/sub-conductor for tension points shall be used for ruling design span.

• The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

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

• The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it.

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

- Preformed type armoured rods shall be provided for the conductors at all suspension points. Vibration dampers of stock bridge type shall be used for power conductors.

➢ **Bundle Spacer (for Twin Bundle Conductor) & Rigid Spacer (for Hexa/Quad / Triple/ Twin Bundle Conductor)**

- Armour grip bundle spacers shall be used to maintain the spacing of 450 mm (for 400 kV voltage level line twin bundle conductor) between the two sub-conductors of each bundle under all normal working conditions.
- Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the Specification.
- The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 30 km/hr and to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operating conditions.
- 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 clamp to hold the clamp in position. The minimum diameter of the rods shall be 7.87 + 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.
- 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.
- 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 tube shall be made of aluminium alloy of type 6061/65032 or 6063/63400. If fasteners of ferrous material are used, they shall conform to and be galvanised conforming to relevant Indian Standards. The spacer involving ferrous fasteners shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars.
- 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.

3.5 FITTINGS AND ACCESSORIES FOR GROUND WIRES

Fittings and accessories for OPGW shall be used as per bid specification.

SECTION-4
TECHNICAL SPECIFICATION FOR INSULATOR STRING HARDWARE

4.1.0 HARDWARE

Each insulator string assembly shall generally include the following hardware:

Anchor shackle for attachment of suspension string assembly to the tower hanger and tension string assembly to the tower strain plate. Suitable top and bottom yoke assemblies with the arrangement of fixing a set of arcing horns.

- Set of arcing horns
- Suspension or tension clamp
- Bolts, nuts, washers, split pins etc.
- Other fitting s necessary to make the strings complete such as ball clevis, socket clevis, chain links etc.

The tenderer shall be responsible and satisfy himself that all the hardware included in strings are entirely suitable for the conductor offered.

4.2.0 SUSPENSION CLAMP

The suspension clamps shall be made of malleable iron or aluminium alloy, hot dip galvanised and shall be suitable to accommodate the conductor together with one set of preformed armour rods. Suitable sheet aluminium liners shall be provided. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor. The lips shall be rounded off and the seating and the bell mouths shall be smooth to avoid corona and radio interference noises. The suspension clamps shall be suitable to carry the bottom part of the arcing horn and to receive the fittings of the insulator string.

The suspension clamps shall be such that the conductor should not slip at a load of 25% of the breaking load of the conductor. The ultimate strength of the clamp for vertical load shall not be less than the failing load of the Disc Insulators.

4.2.1 STRAIN CLAMP

The bolted strain clamps shall also be made of malleable iron or aluminium alloy; hot dip galvanised, lined with sheet aluminium liners and shall be suitable to accommodate the conductor with necessary binding tapes etc. The lips shall be rounded off carefully and conductor seating and the ball mouth shall be smooth to avoid corona and radio interference noises. Suitable attachment for receiving one side of arcing horns and for connecting to the insulator strings shall be provided.

The strain clamps shall be such that the conductor should not slip at a load of 90% of the breaking load of the conductor. The ultimate strength of the clamp for horizontal load shall not be less than the ultimate strength of the conductor

4.2.2 ARCING HORNS:

Arcing horns of approved size and dimensions shall be provided for every string of insulators. The performance data for arcing horns to be supplied shall be made available to the Employer.

4.2.3 OTHER INSULATOR STRING HARDWARE:

The strength of other string hardware namely anchor shackle, yoke plates, socket-clevis etc. shall be co-ordinated with insulator disc strength.

4.3.0 Interchangeability

The hardware together with ball and socket fittings shall be of standard design, so that this hardware is interchangeable with each other and suitable for use with disc insulators of any make con1orming to relevant Indian/International Standard.

4.4.0 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Contractor/Manufacturer must give suitable assurance about the satisfactory corona and radio interference performance of the materials offered by him.

4.5.0 Maintenance

The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method. The Bidder should clearly establish in the bid, the suitability of his fittings for hot line maintenance.

The line side yoke plate shall have a notch & a working hole of suitable size. The design of corona control rings/grading ring shall be such that it can be easily replaced by employing hot line maintenance technique.

4.6.0 Designation

Ball and Socket Designation

The dimensions of the ball and socket shall be 16 mm (Alt-B) designation for 70 KN &90KN Insulators, 20 mm designation for hardware with 120kN & 160 kN Insulators, in accordance with the standard dimensions stated in IS: 2486-(Part-II) /IEC:120. The dimensions shall be checked by the appropriate gauge after galvanising only.

4.7.0 Security Clips and Split Pins

4.7.1 Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking 9f the coupling as per IS: 2486-(Part-III)/IEC: 372. The legs of the security clips shall be spread after assembly in the works to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall the locking devices allow separation of fittings.

4.7.2 The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall neither be less than 50 N (5 kg) nor more than 500 N (50 kg).

Split pins shall be used with bolts & nuts.

4.8.0 Arcing Horn for EHV Strings

4.8.1 The arcing horn shall be provided on tower side of the hardware fittings. The same shall be either ball ended rod type or tubular type.

4.8.2 The spark gap shall be so adjusted to ensure effective operation under actual field conditions.

4.9.0 Yoke Plates

- The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.
- The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/grading ring/arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the Contractor/Manufacturer. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS:800-2007.

4.10.0 Corona Control Rings/Grading Ring (For 220 kV & above voltage level line)

- The Corona control rings/grading ring shall be provided with hardware fittings and shall be of such design that it should cover at least one disc insulator in disc insulator strings/ metal polymer junction point in composite insulator strings so that they will reduce the voltage across the insulator units. It shall also improve corona and radio interference performance of the complete insulator string along with hardware fittings.
- The corona control rings/grading ring shall be made of high strength heat treated aluminium alloy tube of minimum 2.5 mm wall thickness. If mild steel brackets are used then the brackets shall not be welded to the pipe but shall be fixed by means of bolts and nuts on a small aluminium plate attachment welded to the pipe. The welded center of the corona control ring/grading ring shall be grinded before buffing. Alternately, Aluminium tube/flats of suitable dimensions welded to the corona control rings/grading rings may be used for connection to yoke plate.
- The Corona control rings/grading ring should have a brushed satin finish and not a bright glossy surface. No

blemish should be seen or felt when rubbing a hand over the metal.

• Bidder may quote for grading ring with armour grip suspension assembly. The grading ring shall be of open type design with a gap of 125 mm. The open ends shall be suitably terminated. The outside diameter of the tube shall be 75 mm. The ends of grading ring tube shall be sealed with welded aluminum cap duly buffed.

4.11.0 Sag Adjustment Plate (For 400 kV voltage level line)

• The sag-adjustment plate to be provided with the double tension hardware fitting (for 400kV (Twin) line) shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.

• The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.

• Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by Contractor/Manufacturer. The hole provided for bolts should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS:800-2007.

4.12.0 Turnbuckle

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

4.12.2 The maximum length of the turn buckle from the connecting part of the rest of the hardware fittings shall be 380 mm for 132KV and 220KV Line and 520mm for 400KV Line. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing submitted with the bid. An adjustment of 135 mm minimum for 132KV and 220KV Line and 150mm minimum for 400KV Line shall be possible with turnbuckle.

4.13.0 Suspension Assembly

4.13.1 The suspension assembly shall include free center type suspension clamp along with standard preformed armour rods or armour grip suspension clamp; except for Pilot insulator string for which only suitable Envelope type suspension clamp shall be used.

4.13.2 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

4.13.3 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth and without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

4.13.4 The suspension assembly/clamp shall be so designed so that it minimises the static and dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs and have required level of Corona/AIV performance.

4.14.0 Free Center Type Suspension Clamp

For the Free Center Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

4.15.0 Standard Preformed Armour Rod Set

4.15.1 The Preformed Armour Rod Set suitable for Conductor shall be used to minimise the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localised heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

4.15.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor in order to gently but permanently grip the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions, etc.

4.15.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

4.15.4 The conductivity of each rod of the set shall not be less than 12% of the conductivity of the International Annealed Copper Standard (IACS).

4.16.0 Armour Grip Suspension Clamp

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

• Elastomer insert shall be resistant to the effects of temperature up to 95oC, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

• The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as specified in the Standard Technical Particulars and shall not introduce unfavourable stress on the conductor under all operating conditions.

4.17.0 Envelope Type Suspension Clamp

• The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.

4.18.0 Dead End Assembly

4.18.1 The dead-end assembly shall be suitable for Conductor as detailed in the document.

4.18.2 The dead-end assembly shall be compression type with provision for comprising the jumper terminal at one end. The angle of the jumper terminal to be mounted should be 30º with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

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

4.19.0 Fasteners: Bolts, Nuts and 'Washers

4.19.1 All bolts and nuts shall conform to IS: 6637. All bolts and nuts shall be galvanised as per IS-1367 -(Part 13)/IS-2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

4.19.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties arid effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS-12427. Bolts should be provided with washer face in accordance with IS: 1363 Part-1 to ensure proper bearing.

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

4.19.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

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

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

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

4.19.8 The Bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

4.19.9 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

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

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

4.20.0 Materials

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

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS-1385	
2	Arcing Horn	Mild Steel Rod/ Tube Type	Hot dip galvanised	As per IS-226 or IS-2062	
3	Ball Fittings, Socket, all shackles links cleves	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
4	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
5	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
6(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20 KN
6(b).	Supporting Brackets & Mounting Bolts	High Strength Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	
7(a).	Envelope type Clamp: Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032 or 6063/63400	Casted or forged & Heat treated	IS:617 or ASTM-B429	
7(b).	Envelope type Clamp: Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
7(c)	Envelope type Clamp: U Bolts	Stainless Steel or High Strength Al alloy 6061/ 6063 or 65032/63400	Forged & Heat treated	AISI 302 or 304-L ASTM-B429	

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
8(a).	Dead End Assembly: Outer Sleeve	EC grade Al of purity not less than 99.50%			
8(b).	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-2062	
9.	AGS clamp (a) Supporting house	High strength corrosion resistant Al. alloy LM6, 4600 or equivalent 6061	Cast/forged heat treated.	IS:617 or equivalent	
	(b) Al insert and retaining strap	High strength Al alloy type 6061 or equivalent	Forged and Heat treated	ASTM:B429	
	(c) Elastomer cushion	Moulded on Al reinforcement			
10.	P. A. rod	High strength Al alloy type 6061 or equivalent	Heat treatment during manufacturing	ASTM:B429	Min. tensile strength of 35 kg/mm2
11.	Turn Buckle	Class-II Steel	Forged hot dip galvanized	IS:2004	

4.21.0 Workmanship

4.21.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for rated voltage of transmission lines and will give continued good performance.

4.21.2 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and comers to limit corona and radio-interference, best resistance to corrosion and a good finish.

4.21.3 All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall he done in accordance with IS: 2629 / IS-1367 (Part 13) or equivalent International Standards and shall satisfy the tests mentioned in IS: 2633-1986or equivalent International Standards. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalent to 610 gm / sq.m shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard price test for galvanizing.

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

4.21.5 The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright. Continuous and free from imperfections such as flux, ash, rust, stains, bulky white deposits and blisters. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209or equivalent International Standards.

4.21.6 Pin balls shall be checked with the applicable “GO” gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90o to this line. "NO GO" gauges shall not pass in any direction.

4.21.7 Socket ends, before galvanizing, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions, of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS: 2486or equivalent International Standards.

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

4.21.8 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm

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

4.21.10 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the inductor in any way during erection or during continuous operation which would product high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

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

4.21.12 All fasteners shall have suitable corona free locking arrangement to guard against Vibration loosening.

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

4.22.0 Bid Drawings

4.22.1 The Bidder shall furnish full description and illustrations of materials offered.

4.22.2 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished in five (5) copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

(i) Attachment of the hanger or strain plate.
(ii) Yoke Plate
(iii) Suspension or dead-end assembly.
(iv) Arcing horn attachment to the string
(v) Hardware fittings of ball and socket type for inter connecting units.
(iv) Corona control rings/grading ring attachment to conductor and other small accessories.

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

The drawings shall include:

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

4.22.4 After placement of award, the Contractor shall submit fully dimensioned drawings including all the components in four (4) copies to the Employer for approval. After getting approval from the Employer and successful completion of all the type tests, the Contractor shall submit thirty (10) more copies of the same drawings to the Employer for further distribution and field use at Employer's end.

4.23.0 Completeness of works

Bidder shall assess the complete requirement of line hardware, hardware accessories and assemblies in complete for the erection of the lines as per the recommended erection practices.

The hardware assemblies shall be supplied complete with components, sub-components, nuts, bolts, washer etc. fittings and accessories for conductor & earth wire like Mid Span Joints, Repair Sleeves, and Stockbridge Vibration Dampers.

The Contractor shall also supply all line and tower accessories.

4.24.0 Standards

4.24.1 The Hardware Fittings, conductor and earth wire accessories shall conform to the following Indian Standards or equivalent International Standards, which shall mean latest revisions, amendments/changes adopted and published unless specifically stated otherwise in the specification.

1.	IS: 209	Specification for Zinc.
2.	IS: 398	Specification for Aluminum Conductors. for Overhead Transmission Purposes,
3.	IS: 1327	Method of Determination of Weight of Zinc Coating on Tin Plate.
4.	IS: 1573	Electroplated Coating of Zinc on Iron and Steel
5.	IS: 2121	Specification for Conductors and Earthwire Accessories for Overhead Power Lines
	(Part-1)	Armour Rods, Binding Wires and Tapes for Conductors
	(Part-2)	Mid-span joints and Repair Sleeves for Conductors
6.	IS : 2486	Specification for Insulator Fittings for Overhead Power Lines With a Nominal Voltage Greater than 1 000 V
	(Part 1)	General Requirements and Tests
7.	IS:2629	Recommended Practice for Hot Dip Galvanizing of Iron and Steel
8.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
9.	IS:4826	Galvanized Coating on Round Steel Wires
10.	IS : 6639	Hexagonal Bolts for Steel Structures
11.	IS: 6745	Methods for Determination of Weight of Zinc Coating on Zinc Coated Iron and Steel Articles
12.	IS : 8263	Method for Radio Interference Tests on High Voltage Insulators
13.	IS : 9708	Specification for Stock Bridge vibration Dampers for Overhead Power Lines

4.25.0 TESTS

The insulator discs and hardware fittings shall be subjected to the tests before despatch, in accordance with the relevant standards. The successful contractor shall submit the test results in quadruplicate to the Employer.

4.26.0 MARKING

Each insulator disc shall be legibly and indelibly marked with the following:

- Name or trade mark of the manufacturer.
- Month and year of manufacture.
- Minimum failing load in Newton.
- Country of manufacture
- Standard certification mark, if any.

The marking of the porcelain shall be printed and shall be applied before firing.

4.27.0 STANDARDIZED TECHNICAL PARAMETERS

A. 220 kV Transmission Line with ACSR ZEBRA conductor

1. Suspension hardware fittings for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value				
			Single "I" Suspension Fittings with		Double "I" Suspension Fittings with		Single suspension Pilot Fitting with
			AGS clamp	Free Centre clamp	AGS clamp	Free Centre clamp	Envelope clamp
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 500 amperes	Watt	2	2	2	2	4
2.	Slipping strength of suspension assembly	KN	16-24	16-24	16-24	16-24	16-24
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly						
	a) No. of rods per set	No.	12	12	12	12	NA
	b) Direction of lay		Right hand	Right hand	Right hand	Right hand	NA
	c) Overall length after fitting on conductor	mm	2080	2540	2080	2540	NA
	d) Diameter of each rod	mm	7.87	7.87	7.87	7.87	NA
	e) Tolerance in						
	i) Diameter of each rod	±mm	0.10	0.10	0.10	0.10	NA
	ii) Length of each rod	±mm	25	25	25	25	NA
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	13	13	13	NA
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	6061/ 65032	6061/ 65032	6061/ 65032	NA
	g) Minimum UTS of each rod	Kg/mm^2	35	35	35	35	NA
4.	**Particulars of Elastomer (For AGS Clamp only)**						
	a) Type of elastomer		Chloroprene/ Neoprene Rubber	NA	Chloroprene /Neoprene Rubber	NA	NA
	b) Shore hardness of elastomer		65 to 80	NA	65 to 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95^o C	NA	Upto 95^o C	NA	NA
	d) Moulded on insert		Yes	NA	Yes	NA	NA
5.	Mechanical strength of suspension fitting(excluding suspension clamp)	KN	70		2 x 70		70
6.	Mechanical strength of suspension clamp	KN	70		70		70
7.	Galvanising						
a)	Weight of Zinc coating for steel parts	gm/m^2	600				
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209: 1992) or 98.5 (IS 13229:1991)				
c)	Min. No. of dips in standard preece test the ferrous parts can withstand	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute &				

	(wherever applicable)		c) all others: 6 dips of 1 minute

2. Tension hardware fittings for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value	
			Single Tension	**Double Tension**
1.	Mechanical strength of Tension fitting(excluding dead end clamp)	KN	120	2x120
2.	Type of dead end assembly		Compression	
3.	Compression pressure	MT	100	
4.	Maximum electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	75	
5.	Slip strength of dead end assembly	KN	123.80	
6.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	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	

B. Accessories for ACSR ZEBRA conductor for 220 kV transmission line

1. Mid span compression Joint for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200	
3.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	31.00 ± 0.5	10.00 ± 0.2
ii)	Outside diameter	mm	48.00 ± 1.0	20.00 ± 0.5
iii)	Length	mm	710 ± 5	241 ± 5
4.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension(Corner to corner)	mm	47.00 ± 0.5	19.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5	16.00 ± 0.5
5.	Slip strength	KN	123.8	
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
7.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154	
8.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000	
9.	Galvanising			
a)	Minimum weight of Zinc coating for	gm/m^2	600	

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

2. Repair sleeve for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter	mm	31.00 ± 0.5
ii)	Outside diameter	mm	48.00 ± 1.0
iii)	Length	mm	275.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
i)	Outside dimension(Corner to corner)	mm	47.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000

3. Vibration Damper for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc alloy
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	135
5.	Slip strength of stranded messenger cable (mass pull off)	KN	5
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	KN	2.5
	(b) After fatigue test	KN	2
7.	Resonance frequencies range	Hz	5 to 45
8.	Maximum magnetic power loss per vibration damper watts for 500 amps, 50 Hz Alternating Current	Watts	1
9.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154
10.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000
11.	Percentage variation in reactance after fatigue test in comparison with	%	+/-40 (Maximum)

	that . before fatigue test		
12.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
13.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	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

C. Accessories for 7/3.15 mm GS Earthwire for 220 kV and 132 kV transmission line

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

Sl.	**Description**	**Unit**	**Particulars/ Value**		
			Aluminium / Filler Sleeve	Steel Sleeve	
1.	**Material of Joint**		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)	
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200		
3.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	315 ± 5	230 ± 5	25 ± 2
4.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
5.	Slip strength	KN	53.20		
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75		
7.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	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		

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

Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Stranding		19 (12+6+1) / dia 2.54

2.	Cross sectional area	Sq.mm	95
3.	Minimum copper equivalent area	Sq.mm	750 + 5
4.	Length of copper cable	mm	Aluminium alloy
5.	Material of lugs		19 (12+6+1) / dia 2.54
6.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

3. Vibration Damper for 7/3.15 mm GS Earthwire

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

4. Suspension Clamp for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	**Material of components**		
	(a) Shackle		Forged Steel
	(b) Clamp Body & Keeper		Malleable cast iron / SGI
	(c) U- Bolt		Mild Steel (Fe 410, IS 2062)
2.	Total Drop (Maximum)	mm	150
3.	Breaking Strength (Minimum)	kN	25
4.	Slipping Strength	kN	9 to 14
5.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	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	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute &

	applicable)		c) all others: 6 dips of 1 minute

5. Tension Clamp for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value		
1.	**Material of components**				
	(i) Anchor Shackle		Forged Steel		
	(ii) Compression Clamp				
	a) Steel Sleeve		Mild Steel (Fe 410, IS 2062)		
	b) Aluminium sleeve		Aluminium of purity 99.5%		
	c) Aluminium Filler sleeve		Aluminium of purity 99.5%		
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	100-200		
3.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	220 ± 5	180 ± 5	25 .0±2
4.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
5.	Slip strength	KN	53.20		
6.	Minimum Breaking strength of assembly (excluding clamp)	KN	70		
7.	Compression Pressure	Ton	100		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m^2	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		

SECTION-5
TECHNICAL SPECIFICATION OF DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS

5.1.0 SCOPE.

5.1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery at site, testing and commissioning for manufacturers of disc Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulator strings for the suspension and anchoring of the conductors on EHV transmission line towers.

5.1.2 Following are the list of documents constituting this package.

(i) Technical specification.

(ii) Technical data sheet.

(iii) Drawings of insulators

5.1.3 All the above volumes along with amendments there of shall be read and interpreted together. However, in case of a contradiction between the "Technical Specification" and any other volume, the provisions of this volume will prevail.

5.1.4 The insulators shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which in his judgment, is not in full accordance therewith.

5.2.0 STANDARDS:

5.2.1 Except as modified in this specification, the disc/porcelain long rod insulators shall conform to the following Indian Standards, which also includes latest revisions and amendments if any. Equivalent International and Internally recognized standards to which some of these standards generally correspond are also listed below.

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 60274 IEC 60383
4.	IS: 2071 Part-(I)	Method of High Voltage Testing.	
	Part-(II) Part-(III)		
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 60120
	Part – III	Locking devices.	IEC: 60372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272

10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 60305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 60437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse Test on HV insulators.	IEC: 60506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 60575
16	IEC	Ceramic Long Rod Insulators	IEC: 60433

5.2.2 The standards mentioned above are available from

Reference.	Name & Address:
BS	British Standards, British Standards Institution, 101, Pentonvile Road, N- 19 ND,U.K
IEC / CISPR	International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS	Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001,
ISO	International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej- 12 DK-2900 Helleprup DENMARK.

5.3.0 PRINCIPAL PARAMETERS.

5.3.1 DETAILS OF DISC INSULATORS:

5.3.1.1 The Insulator strings shall consist of standard discs for use in three phases. 50 Hz effectively earthed 33/132/220 KV transmission system of AEGCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type. Radio interference data and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

5.3.1.2 The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware shall be as follows:

PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-

Sl. No.	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc (mm),	No. of standard discs 132 KV /220 KV/400kV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255 x 145	320	1x9/1x14 /-	70 KN/90 KN Normal Disc Insulator

2.	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Normal Disc Insulator
3	Single suspension	255 x 145	430	1x9/1x14 /-	70 KN/90 KN Antifog Insulator
4	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Antifog Disc Insulator
5.	Single Suspension	280 x 145	430	1x10/1x15 /-	120 KN Anti fog Disc insulator
6.	Double suspension	280 x 145	430	2x10/2x15 /-	120 KN Anti fog Disc insulator
7.	Single Tension	305 X 170	475	1x10/1x15/1x25	160 KN Anti fog Disc insulator
8.	Double Tension	305 X 170	475	2x10/2x15/2x25	160 KN Anti fog Disc insulator
9.	Single Suspension	280 x 145	430	1x10/1x15/1x25	120 KN Anti fog Disc insulator
10.	Double suspension	280 x 145	430	2x10/2x15/2x25	120 KN Anti fog Disc insulator

5.3.2 SPECIFICATION DRAWINGS:

5.3.2.1: The Specification in respect of the disc insulators are described, the specification is for information and guidance of the bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

5.4.1 Porcelain glaze:

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lusture, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal service conditions. The glaze shall have the same coefficient of expansion as of the porcelain body throughout the working temperature range.

5.4.2 METAL PARTS:

5.4.2.1 Cap and Ball Pins:

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless-steel cotter pins and shall provide positive locking of the coupling.

5.4.2.2 Security Clips:

The security clips shall be made of phosphor bronze or of stainless steel.

5.4.3 FILLER MATERIAL:

Cement to be used, as a filler material be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and its thickness shall be as small and as uniform as possible.

5.4.4 MATERIALS DESIGN AND WORKMANSHIP:

5.4.4.1 GENERAL:

(I) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

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

5.4.4.2 INSULATOR SHELL:

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

5.4.4.3 METAL PARTS:

i) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

5.4.4.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

5.4.4.5 CEMENTING:

The insulator design shall. Be such that the insulating medium shall not directly engaged with hard metal. The surface of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

5.4.4.6 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as locking device for ball and socket coupling shall be „R" shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation, which placed in position, and under no circumstances shall it allow separation of insulator units and fittings. „W" type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked positions shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

5.4.4.7 MARKING:

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture. Marking on porcelain shall be printed, not impressed, and shall be applied before firing

5.4.5 BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets for 70 and 90 KN insulator strings shall be of 16 mm and for 120 KN and 160 KN insulator strings shall be of 20 mm designation in accordance with the standard dimensions stated in IS: 2486

(Part-II).

5.4.6-DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

Sl. No.	Diameter of Disc (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN & 120 KN	**255/255 & 280**	As per IS	As per IS
2.	160 KN	305	As per IS	As per IS
(b)				
Sl. No.	Ball to Ball spacing Between Discs (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN/120 KN	**145**	As per IS	As per IS
2.	160 KN	170	As per IS	As per IS

NOTE: Tolerance as per relevant IS (Latest edition).

(**5.4.7**) GUARANTEED TECHNICAL PARTICULARS FOR ANTIFOG DISC INSULATORS

Sl. No.	DESCRIPTION	70 KN	90 KN	120KN	160 KN
1.	Manufacture‟s name &address				
2	Type of Insulator	Ball & Socket	Ball & socket	Ball & socket	Ball & socket
3	Size of ball & socket	16B	16B	20	20
4	Dimensions				
(a)	Disc diameter	255	255	280	305
(b)	Unit spacing	145	145	145	170
(c)	Creepage distance of the single insulator-mm	430	430	430	475
5	Electro-mechanical strength of single insulator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
7	**Electrical value**				
7.1	Power frequency Withstand Voltage Disc				
	(a) Dry-kV (rms)	80	80	85	90
	(b) Wet-kV (rms)	45	45	50	50
7.2	Power frequency Flashover Voltage Disc				
	(a) Dry-kV (rms)	85	85	90	95
	(b) Wet-kV (rms)	50	50	55	55
7.3	Impulse Withstand Voltage Disc				

	1.2/50 micro second				
	(a) Positive – kV(Peak)	125	125	130	135
	(b) Negative – kV(Peak)	125	125	130	135
7.4	Impulse Flashover Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)	135	135	140	145
	(b) Negative – kV(Peak)	130	130	135	140

5.4.8 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

5.4.9 CORONA AND RIV PERFORMANCE:

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subject to excessive localized pressure. The metal parts and porcelain shall not produce any noise-generating corona under all operating conditions

5.5.0 SUITABILITY FOR LIVE LINE MAINTENANCE:

The insulator shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operation can be carried out with easy speed and safety.

5.5.1 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

1) Ball pin shake.

2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.

3) Sand fall defects on the surface of the insulator.

5.5.2 INSULATOR STRINGS:

5.5.2.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/220 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent towers are to be fitted with discs 70/90 KN EMS rating while tension insulator strings for use with Anchor/ Tension towers are to be fitted with discs of 120 KN / 160 KN EMS level rating.

5.5.2.2 STRING SIZE:

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 5.3.1.2.

5.5.3 STRING CHARACTERISTICS

5.5.3.1 The characteristics of the complete string shall be as follows:

Sl. No.	**Description.**	**Suspension.**		**Tension.**	
		132KV	**220kV**	**132KV**	**220KV**
I	Switching surge withstand voltage (dry& wet) KV Peak	-	-	-	-
II	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
III	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
IV.	Corona extinction voltage level KV rms	-	176	-	176

V	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). … hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
VI.	Mechanical failing load for each string (kgf)	6500	11500	11500	15500
VII.	No deformation load for each string (kgf)	-	7705	-	10385
VIII	Max. voltage across any disc.	13%	13%	13%	13%

5.5.3.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.
5.5.3.3 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.

SECTION-6
TECHNICAL SPECIFICATION AAAC CONDUCTORS AND ACCESSORIES FOR CONDUCTOR

6.1.0 SCOPE

6.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor and accessories for Power Conductors.

6.2.0 POWER CONDUCTOR

6.2.1 TYPE OF CONDUCTOR

The Power Conductor shall be stranded, 37/4.00 mm size (AAAC Zebra) and 37/3.15mm size (AAAC Panther) all aluminium alloy conductor (AAAC) conforming to IS: 398, Part-IV.

Conductor conforming to a standard other than the Indian Standard specification then an English version of the Standard in addition to the original standard if written in a language other than English should be submitted indicating clearly the advantage, if any, that would be obtained by the Employer for adopting this standard instead of the said India Standard.

6.2.2 TECHNICAL PARTICULARS

All Aluminium Alloy Conductor shall satisfy all the parameters as furnished in Technical Data Sheet.

6.2.3 MATERIAL

All Aluminium Alloy Conductor shall be stranded consisting of heat treated aluminium magnesium silicon alloy wires (Strands) containing approximately 0.5% magnesium and approximately 0.5% silicon.

6.2.4 JOINTS IN WIRE

In conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the brass rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor, such joint shall be made by resistance or cold pressure butt welding. They are not required to fulfil the mechanical requirement of un-jointed wires. Joints made by resistance butt welding shall, subsequent to welding, be annealed over a distance of at least 200 mm on each side of the joint.

6.2.5 STRANDING

The wires used in construction of a stranded All Aluminium Alloy Conductor (AAAC) shall, before and after stranding, satisfy all requirements as per IS 398 (Part-IV).

The lay ratio of the different layers shall be with in the limits as per the said Standard.

In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right-handed. The wires in each layer shall be evenly and closely stranded.

In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

6.2.6 ROUTINE/ACCEPTANCE TESTS

The samples of individual wires for the test shall normally be taken before stranding. The manufacture shall carry out test on samples taken out at least from 10 % of the aluminium wire spools. However, when desired by the Employer, the test sample may be taken from the stranded wires. The wires used for alloy conductors shall comply with the following tests as per IS: 398 –Part - IV) (amended up to d):

i) Breaking load test

ii) Elongation test

iii) Resistance test.

6.2.7 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

6.2.8 PACKING

6.2.8.1 All conductor reels shall conform to latest edition of IS : 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

6.2.8.2 All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

6.2.8.3 All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable, that is next to the lagging.

6.2.8.4 The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

6.2.8.5 The wooden drums shall preferably be given protective coating of a reliable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.

6.2.9 TECHINCAL DATA SHEET FOR CONDUCTOR

AAAC Zebra

Sl. No	DESCRIPTION	PARTICULARS
I	II	III
1	Type of Conductor	All Aliminium Alloy Conductor (AAAC), Stranded
2	No of Strand x size	37 x 4.00 mm
3	Conductor over all diameter	38.00 mm
4	Total sectional area	465 mm^2
5	Approx. weight	1280.5 kg/km
6	Minimum UTS	136.38 Kn
7	Modulus of Elasticity (Final)	0.5814 kg/cm^2
8	Coefficient of linear expansion	23.0 x 10^{-6} /^{0}C
9	Calculated maximum resistance/Km of Conductor at 20°C	0.0734 ohms/km
10	Particulars of Aluminium Alloy Wires (strands)	
	(a) Wire Diameter (i) Standard: (ii) Maximum: (iii) Minimum:	 4.00 mm 4.04 mm 3.96 mm
	(b) Resistivity of wire	0.0328 ohms.mm^2/m
	(c) Density	2.70 kg/dm^2
	(d) Co-efficient of Linear expansion	23.0 x 10^{-6} /^{0}C
	(e) Cross Sectional area of Aluminium wire	12.57 mm^2
	(f) Approximate Total weight of each strand	33.93 kg/km
	(g) Calculated resistance at 20°C (D.C.)	2.663 ohm/km
	(h) Minimum Breaking Load of each strand	4.40 Kn – before stranding 4.18 Kn – after stranding

AAAC PANTHER

Sl. No	**DESCRIPTION**	**PARTICULARS**
		IV
1	Type of Conductor	All Aliminium Alloy Conductor (AAAC), Stranded
2	No of Strand x size	37 x 3.15 mm
3	Conductor over all diameter	22.05 mm
4	Total sectional area	288 mm^2
5	Approx. weight	794.05 kg/km
6	Minimum UTS	84.71 kN
7	Modulus of Elasticity (Final)	0.5814 kg/cm^2
8	Coefficient of linear expansion	23.0 x 10^{-6} /^{0}C
9	Calculated maximum resistance/Km of Conductor at 20°C	0.1182 ohms/km
10	Particulars of Aluminium Alloy Wires (strands)	

Sl. No	DESCRIPTION	PARTICULARS
		IV
	(i) Wire Diameter (iv) Standard: (v) Maximum: (vi) Minimum:	 3.15mm 3.18 mm 3.12 mm
	(j) Resistivity of wire	0.0328 ohms.mm^2/m
	(k) Density	2.70 kg/dm^2
	(l) Co-efficient of Linear expansion	23.0 x 10^{-6} /^{0}C
	(m) Cross Sectional area of Aluminium wire	7.793 mm^2
	(n) Approximate Total weight of each strand	21.04 kg/km
	(o) Calculated resistance at 20°C (D.C.)	4.290 ohm/km
	(p) Minimum Breaking Load of each strand	2.41 kN – before stranding 2.29 kN – after stranding

6.3.0 GROUND WIRES

Optical ground wire (OPGW) shall be used as mentioned in Bid.

6.4.0 FITTINGS AND ACCESSORIES FOR CONDUCTORS

6.4.1 The accessories for conductors shall conform to IS: 2121 and 2486 (Latest version) in all respects.

6.4.2 The tension joints and repaired sleeves in the conductors shall be of compression type. The joints shall be such that in electrical resistance of the joints measured between two points just beyond the fittings shall not exceed 75% of that of an equivalent length of the conductor without joint and shall be capable to withstand a load of 95% of the breaking load of the conductor itself.

6.4.3 The non tension joints such as the parallel groove clamps shall conform to IS 2121 and should be able to withstand a load of 10% of the breaking load of conductor without any slip.

6.4.4 Preformed type armoured rods shall be provided for the conductors at all suspension points. Vibration dampers of stock bridge type shall be used for power conductors.

6.5.0 FITTINGS AND ACCESSORIES FOR GROUND WIRES

Fittings and accessories for OPGW shall be used as per Bid.

SECTION-7
TECHNICAL SPECIFICATION OF HTLS CONDUCTOR

7.1 GENERAL REQUIREMENTS

7.1.1 The offered HTLS Conductor shall be Zebra equivalent HTLS conductor and shall be capable of providing minimum 1500A capacity and shall conform to latest CEA "Guidelines for Rationalised use of high performance conductors" at a continuous operating conductor temperature higher than that of not exceeding the maximum permissible operating temperature for continuous operation of the offered HTLS Conductor and without exceeding the level of maximum permissible sag as prescribe in clause no 7.1.6. and 7.2.

The physical and operating performance requirements of the transmission line with HTLS conductor are mentioned below. The bidder shall offer HTLS conductor complying with the specified requirements. The Biddershall indicate particulars of the proposed conductor in the relevant GTP schedule of BDS along with calculations to establish compliance with the specified requirements.

7.1.2 The calculations for Ampacity shall be based on IEEE Standard 738 and CEA Guidelines for Rationalized use of High-Performance Conductors, Feb, 2019. The bidder in his bid shall furnish calculations for the ampacity based on the above Standard for the proposed HTLS conductor.

7.1.3 The design of conductor shall be suitable for operation at a steady state conductor temperature experienced for AC current flow of rated ampacity under the above ambient conditions based on ampacity calculations mentioned above. The bidder shall also indicate the maximum permissible conductor temperature for continuous operation without any deterioration of its electrical, mechanical & metallurgical properties. The bidder shall also furnish the maximum permissible conductor temperature for short- term operations including permissible duration of such short-term operation.

7.1.4 Each conductor / sub conductor in the bundle of HTLS conductor shall be suitable to carry minimum specified 50 Hz alternating current of 1500A under the ambient conditions & maximum conductor sag specified below while satisfying other specified technical requirements/ parameters as mentioned in the Service condition above.

7.1.5 Maximum permissible conductor sag for 320 (132kV ACSR Panther) and 350 m (220kV ASCR Zebra) span conductor at 85°C operating temperature and nil wind corresponding to 50 Hz and at maximum alternating current 437 (132kV) amp and 900 (220kV) amp per conductor under ambient conditions specified above = 7.224m (132kV) and 8.435m (220kV). In case of HTLS conductor, the maximum sag for permissible conductor temperature and nil wind for continuous operation shall not be considered more than 7.224m (132kV) and 8.435m (220kV). The bidder shall also furnish the maximum permissible conductor temperature for short term operations including permissible duration of such short-term operation. (Not required for bus)

Technical Particulars of HTLS Conductor

The HTLS conductor shall meet the following minimum requirements:

Overall diameter of complete conductor	Not exceeding 28.62mm
Approx. mass of complete conductor (kg/km)	Less than or equal to 1621 kg/km
Direction of lay of outer layer	Right Hand

7.1.6 The bidder shall indicate the technical particulars and details of the construction of the conductor in the relevant schedule of GTP. The bidder shall also guarantee the DC resistance of conductor at 20 deg C and AC resistance at the calculated temperature corresponding to 50Hz alternating current flow of minimum 1500 amperes at specified ambient conditions (maximum continuous operating temperature).

The bidder shall submit the supporting calculations for the AC resistance at 1500A indicating details & justifications of values of temperature coefficient of resistance & DC to AC resistance conversion factor(s) with due reference to construction / geometry of the conductor.

Note: In case of any discrepancy, CEA guidelines for Rationalised use of High-Performance conductors shall govern.

7.2 Sag-Tension Requirements (Not required for bus)

7.2.2 The HTLS conductor shall meet the following sag tension requirements for ruling span of 325m (132kV) and 350 meters (220kV)

Particulars	Limiting value
Tension at every day condition (32°C, no wind)	Not exceeding 25% of UTS of proposed conductor
Sag at maximum continuous operating temp	≤ 7.24 m (132kV) & 8.435 meters (220kV)
i) Tension at 32 deg C, full wind (52 kg/m2)	not exceeding 70% of UTS of proposed conductor

7.2.3 Survey & profiling of existing line route using Total stations, verification of availability of statutory electrical clearances using PLS-CADD software.

Sag-Tension calculations at various conditions mentioned above using parabolic equations shall be submitted along with the bid. These calculations shall also include calculations for determination of transition/knee point temperature. The bidder must use PLS-CADD software for sag tension calculations.

7.2.4 The bidder shall also furnish sag & tensions under no wind for various temperatures starting from 0 deg C to maximum continuous operating temperature in steps of 5 deg C.

7.2.5 After award of the contract, the Supplier shall submit Sag-Tension calculations corresponding to various conditions given above for all the existing spans and spans ranging from 50 m to 350 m in intervals of 50 m.

Besides above, the Supplier shall also furnish details of creep characteristics in respect of HTLS conductor based on

laboratory investigations/ experimentation (creep test as per IEE1138) conducted on similar type of conductor andshall indicate creep strain values corresponding to 1 month, 6 month, 1 year & 10 year creep at everyday tension & at maximum continuous operating temperature.

7.3 Ohmic Loss and Liquidated damage for excessive losses: -

Average ohmic losses (kW)= Loss load factor X Line length X no. of sub conductors X (continuous operating current)^2 X AC resistance per km guaranteed by the bidder at temperature corresponding to continuous operating currentunder normal condition.

On testing, if it is found that actual losses are more than the values, quoted in the bid, undisputed liquidated damages shall be recovered from the supplier at the following rates.

For each KW of excess loss Rs.3, 30,220.00/ KW.

For fractional Kilowatt, penalties shall be applied on pro-rata basis. No bonus shall be payable for loss, which areless than those, stated in the GTP.

7.4 Workmanship:

All the conductor strands shall be smooth, uniform and free from all imperfections, such as spills and splits, cracks, die marks, scratches, abrasions, rust etc.

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

7.5 Joints in Wires

7.5.2 Aluminum OR Aluminum Alloy Wires

During stranding no Aluminum/ aluminum Alloy welds shall be made for the purpose of achieving the required conductor length.

7.5.3 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints are permitted in the inner layer(s) of the conductor unavoidably broken during stranding providedsuch breaks are not associated with either inherently defective wire or with the use of short lengths of AluminiumAlloy wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other Aluminium Alloy wire of the completed conductor. A record of such joints for each individual length of the conductor shall be maintained by The Contractor for Owners review.

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

7.5.5 Core

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

7.5.6 Tolerances

Manufacturing tolerances on the dimensions to the extent of one percent (±1%) shall be permitted for individual strands and the complete conductor. CEA Guidelines shall be referred.

7.6 Materials

The materials used for construction of the conductor shall be such that the conductor meets the specified technical and performance requirements.

7.6.2 Outer layer

The material of outer layer HTLS conductor shall be of fully annealed aluminium (0 tempered) having purity not less than 99.5% and a copper content not exceeding 0.04%. The strands shall be manufactured through appropriate manufacturing process to ensure consistent electrical, mechanical and metallurgical properties under continuous high temperature operation. Bidder shall guarantee the chemical composition in the schedule GTP of BDS and also furnish description of the manufacturing process in the Bid.

In case of fully annealed type (0 tempered) aluminium strands trapezoidal/Z-shaped wire shall only be accepted.

7.6.3 Non-Metallic Solid Core

Core of offered HTLS conductor shall be as per CEA guidelines for rationalized use of High performance conductors.

Bidder shall furnish properties and composition of the core in the GTP schedule. The core shall be of such proven quality that its properties are not deteriorated by the normal operating conditions of 145 KV transmission line in tropical environment conditions as experienced by the existing lines. The Bidder shall provide adequate details including specifications, Design Validation test reports as per ASTM B987 and performance certificates etc. in support of the suitability of the offered materials. Care to be taken for internal friction due to different material having different thermal co efficient of expansion.

7.7 Standard conductor Length

After survey of the involved section of the line by tower contractor, the supplier shall determine the most appropriate individual conductor lengths to be manufactured and supplied keeping in view tower schedules, section lengths, special crossings etc. and the drum schedules shall be submitted to the owner for review and approval.

The standard length of the conductor shall be indicated by the bidder in the guaranteed technical particulars of offer. A tolerance of +/-5% on the standard length offered by the Bidder shall be permitted. However, during execution cut lengths shall be acceptable matching with Tower Schedule and allowable wastage of 1% added. Standard Length shall not more than 2500 meters. All lengths outside this limit of tolerance shall be treated as random lengths.

Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered. When one number random length has been manufactured at any time, five (5) more individual lengths each equivalent to the above random length with a tolerance of +/- 5% shall also be manufactured and all the above six random lengths shall be dispatched in the same shipment. At no point, the cumulative quantity supplied of such random lengths shall not be more than12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.

Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer

reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

7.8 Supervision in Stringing

7.8.2 The installation & hotline restringing of the offered HTLS conductor for the above transmission lineshall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier or Qualified Bidder itself. Bidder's responsibility is to provide Sag- Tension chart based on existing site conditions. It may be noted that AEGCL will not consider any modifications (tower extensions etc) on existing tower/span.

7.8.3 The circuit on which the existing ASCR conductor is strung shall be kept under charged condition during the execution. The installation & stringing of the offered HTLS conductor for the above transmission lineshall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier or Qualified Bidder is self shall string the circuit with the HTLS conductor section by section and restore the line in original conditions as per program finalized in co-ordination with site. The bidder's engineers are to supervise whether appropriate safety measures along with necessary safety tools and equipment's to carry out stringing operations under the above conditions including mechanical/ structural safety of the towers, are maintained or not.

7.8.4 Necessary calculations shall be carried out by the bidder to ensure that by replacing the existing ASCR conductor with the HTLS conductor, the loadings on the towers due to conductor tens-ions as well as loads on account of the re-conductoring activities shall be within specified limits. These calculations shall be submittedby the bidder along with bid.

7.8.5 The Contractor should deploy hotline stringing/ installation experts during erection of the offered HTLS conductor.

7.9 Tests and Standards

7.9.1 Type Tests

Type Tests on Stranded Conductor/ Stranded wire

The following tests shall be conducted once on sample/samples of conductor from each manufacturing facility:

(i)	**On complete Conductor**	
a)	DC resistance test on stranded conductor	: As per Annexure-A
b)	UTS test on stranded conductor	: As per Annexure-A
c)	Stress- Strain test on stranded conductor and core at room temperature	: IEC 1089
d)	Stress-strain test on stranded conductor and core at elevated temperature	: As per Annexure-A
e)	High temperature endurance & creep test on stranded conductor	: As per Annexure-A & : IEC 1089
f)	Sheaves Test	As per Annexure-A
g)	Axial Impact Test	: As per Annexure-A
h)	Radial Crush Test	: As per Annexure-A
i)	Torsional Ductility Test	: As per Annexure-A

j)	Aeolian Vibration Test`	: As per Annexure-A
k)	Temperature Cycle Test	: As per Annexure-A
l)	Corona Extinction Voltage Test	: As per Annexure-A
m)	Radio Interference Voltage Test	: As per Annexure-A
(ii)	**On Conductor Strand/core**	
a)	Heat resistance test on Aluminium Alloy strands or core	: As per Annexure-A CEA Guidelines shall be referred.
b)	Bending test on composite core	As per ASTM B987
c)	Compression test on core	: As per Annexure-A
d)	Coefficient of linear expansion on core/core strands	: As per Annexure-A
e)	Strand Brittle fracture test for Carbon fibre composite core only.	: As per Annexure-A

Type tests specified under clause no. 7.9.1 shall not be required to be carried out if a valid test certificate is available for the offered design, i.e., tests conducted earlier (not more than 7 years old at the time of bid opening) should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of CTU or State Transmission Utility.

Type test of zebra equivalent HTLS conductors of minimum 1500A shall only be accepted for this project.

In the case of composite core conductors, the tests specified under clause 7.9.1 shall be carried out before stranding on as manufactured sample.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design/ material/manufacturing process change including substitution of components or due to non- compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Employer/ Employer/ Employer.

7.9.2 Acceptance Tests (Whichever applicable to Annealed Al. HTLS Conductor)

a)	Visual and dimensional check on drum	: As per Annexure-A
b)	Visual check for joints scratches etc. and length measurement of conductor by rewinding	: As per Annexure-A
c)	Dimensional check on core strands and Aluminium Alloy strands	: As per Annexure-A
d)	Check for lay-ratios of various layers	: As per Annexure-A
e)	Thickness of aluminum on aluminium clad wires	: As per Annexure-A
f)	Torsion and Elongation tests on composite core	: As per Annexure-A
g)	Breaking load test on core strands and Aluminium/Aluminium Alloy strands	: As per Annexure-A
h)	Minimum conductivity test on Aluminium/ thermal resistant Aluminium Alloy strands	: As per IEC : 889

i)	Procedure qualification test on welded joint of Aluminium/Aluminium Alloy strands	: As per Annexure-A
j)	Heat resistance test on Aluminium Alloy strands	: As per Annexure-A
k)	Ageing test on filler (if applicable)	: As per Annexure-A
l)	Minimum conductivity test on aluminium clad core wires (if applicable)	: As per Annexure-A
m)	Glass transition temperature test (For Carbon fibre Composite core only) before stranding.	: As per Annexure-A
n)	Flexural Strength test (For Polymer Composites only) before stranding.	: As per Annexure-A
o)	Galvanic Layer thickness test (For Polymer Composites only) before stranding.	: As per ASTM B987
Note:	All the above tests shall be carried out on Aluminium / Aluminium Alloy and core as Specified in CEA Guidelines for Rationalized use of High-Performance Conductors, Feb, 2019.	

7.9.3 Routine Test

a)	Check to ensure that the joints are as per Specification
b)	Check that there are no cuts, fins etc., on the strands.
c)	Check that drums are as per Specification
d)	All acceptance tests as mentioned above to be carried out on 10 % of drums

7.9.4 Tests during Manufacture

a)	Chemical analysis of zinc used for galvanizing	: As per Annexure-A
b)	Chemical analysis of Aluminium alloy used for making Aluminium Alloy strands	: As per Annexure-A
c)	Chemical analysis of core strands/composite core	: As per Annexure-A CEA Guidelines shall be referred.

As indicated in Clause no 7.9.1, no type test charges shall be payable to the supplier.
The entire cost of testing for the acceptance and routine tests and Tests during manufacture as well as type tests, if required, specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Owner's representative.

The Supplier shall intimate the Employer about carrying out of the type tests along with detailed testing program at least 2 weeks in advance of the schedule date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

7.10 Additional Tests

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

14.10.2. The Owner also reserves the right to conduct all the tests mentioned in this specification at

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

7.11 Test Reports

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

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

7.12 Inspection

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

The Supplier shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

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

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

7.13 Test Facilities

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

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

b) Standard resistance for calibration of resistance bridges.

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

7.14 Packing

The conductor shall be supplied in non-returnable, strong, wooden/painted steel/hybrid (painted steel cum wood) drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Supplier shall select suitable drums for supply of conductor and shall be responsible for any loss or damage to conductor and/or drum during transportation handling and storage due to improper selection of drum or packing.

The Bidder should submit their proposed drum drawings along with the Bid.

a. One conductor length only shall be wound on each drum.

b. The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

7.15 Marking

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

a. Contract/Award letter number.
b. Name and address of consignee.
c. Manufacturer's name and address.
d. Drum number
e. Size of conductor
f. Length of conductor in meters
g. Arrow marking for unwinding
h. Position of the conductor ends
i. Distance between outer-most Layer of conductor and the inner surface of lagging.
j. Barrel diameter at three locations & an arrow marking at the location of the measurement.
k. Number of turns in the outer most layer.
l. Gross weight of drum after putting lagging.
m. Tear weight of the drum without lagging.
n. Net weight of the conductor in the

drum. The above should be indicated in the packing list also.

7.16 **Service centre in India:** If any manufacturer is from outside INDIA, they must have their service centre and calibration facilities in India.

7.17 Verification of Conductor Length

The Employer reserves the right to verify the length of conductor after unreeling at least ten (10) percent of the drums in a lot offered for inspection.

7.18 Standards (Whichever applicable to Annealed Al. non-metallic solid core HTLS Conductor)

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

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

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS: 398-1982	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398-1990 Part-II	Aluminum Conductor Galvanised Steel Reinforced	BS;215-1970 IEC:1089-1991

4.	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced for Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
5.	IS : 1778-1980	Reels and Drums for Bare Conductors	BS:1559-1949
6.	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
7.	IS : 2629-1990	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
8.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9.	IS : 4826-1992	Galvanised Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969
10.	IS : 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973
11.	IS : 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
12.	IS : 9997-1988	Aluminium Alloy Redraw Rods	IEC 104 - 1987
13.		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
14.		Hard drawn Aluminium wire for overhead line conductors	IEC : 889-1987
15.	IS:398 (Part-IV)	Aluminium Alloy stranded conductor	IEC : 208-1966 BS-3242-1970
16.		Aluminium clad steel wires	IEC:1232
17.		Method of measurement of resistivity of metallic materials	IEC:468
18		Ampacity	IEEE738
19.		Standard Specification for Carbon Fiber Thermoset Polymer Matrix Composite Core (CFC) for use in Overhead Electrical Conductors	ASTM B987

SCHEDULE—1 (A)

Tower Schedule enclosed.ANNEXURE –A

Tests on Conductors

1) Tests on Conductor (Whichever applicable to Annealed Al. non-metallic solid core HTLS Conductor)

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached

and the value recorded.

1.2 Corona Extinction Voltage Test

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154
kV rms line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731- 1971

1.3 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the sample shall have a radio interference voltage level below 1000 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV rms line to ground under dry condition. The test procedure shall be in accordance with IS:8263.

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or using micro ohm meter of suitable accuracy by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20deg C as per IS:398-(Part- IV)/(Part-V). The resistance corrected at 20deg C shall conform to the requirements of this Specification.

1.5 Stress-strain test at elevated temperature

Stress-strain test as per IEC-1089 shall be conducted keeping conductor temperature at designed maximum temperature. CEA Guidelines shall be referred.

1.6 High Temperature endurance & creep test

Two conductor samples of length equal to at least 100 X d + 2 X a (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor samples shall be subjected to tests as indicated below:

On one of the conductor samples, the conductor temperature shall be maintained at 20 deg C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10-hour, 100 hour and subsequently every 100-hour upto 1000 hours' time period. (On other conductor sample, the conductor temperature shall be increased to design maximum temperature in steps of 20 deg. C and thermal elongation of the conductor sample shall be measured & recorded at each step. The temperature shall be held at each step for sufficient duration for stabilization of temperature. Further, the temperature of the conductor shall be maintained at maximum continuous operating temperature (+10 Deg. C) for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10-hour, 100 hour and subsequently every 100-hour upto 1000 hours' time period. After completion of the above, the core of the conductor sample shall be subjected to UTS test as mentioned above at clause 1.1 of Annexure-A. The conductor core shall withstand a load equivalent to 95 % of UTS. In case of polymer composite core conductor, the flexural strength & glass transition temperature of the core shall also be evaluated and the same shall not be degraded by more than 10 % over the initial value. The supplier shall plot the thermal elongation with temperature.

The supplier shall furnish details of creep characteristic in respect of the conducted based on laboratory test and other laboratory investigations/ experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension & continuous designed temperature as well as room temperature. CEA Guidelines shall be referred.

1.7 Sheaves Test

The conductor sample of minimum length of 35 meter shall be tensioned at 22 % of the UTS and shall be passed through pulleys having diameter of 32 times that of the conductor with angle of 20 deg. between the pulleys. The conductor shall be passed over the pulleys 36 times a speed of 2 m/sec. After this test UTS test on the conductor shall be carried out. The core shall be inspected for any sign of damage or cracking through dye penetration test as per ASTM D5117. CEA Guidelines shall be referred.

1.8 Axial Impact Test

The conductor sample shall be suspended vertically and load applied by dropping a 650 Kg from an elevation of 4 meters above the sample. The impact velocity shall be not be less than 8 m/sec. with an initial pre-tension of 200 kg. The curve for load vs time shall be recorded and recorded load of failure for core shall not be less than UTS of core.

1.9 Radial Crush Test

A section of conductor is to be crushed between two six-inch steel platens. Load shall be held at 350 Kg for 1 minute and then released. Core/ core strands shall be subsequently disassembled and tensile tested. Core/ core strands shall exhibit full strength retention.

1.10 Torsional Ductility Test

The conductor sample of 10-15 m shall be loaded to 25% of UTS and then rotated in increasing steps of +/-180 deg. In case of composite core conductors, after 4 rotations or after separation of aluminium strands, the aluminium wires shall be cut and removed from the conductor and the exposed core shall be twisted and shall withstand upto 16 rotations. CEA Guidelines shall be referred.

1.11 Aeolian Vibration Test

The conductor and supporting hardware shall be loaded to 25% of RTS. A dynamometer, load cell, calibrated beam or other device shall be used to measure the conductor tension. Some means should be provided to maintain constant tension to allow for temperature fluctuations during the testing. The overall span between system terminations shall be a minimum of 30 m. The span shall be supported at a height such that the static sag angle of the cable to horizontal is (1.5 + 0.5) deg in the active span. Means shall be provided for measuring and monitoring the mid-loop (antinode) vibration amplitude at a free loop, not a support loop. An electronically controlled shaker shall be used to excite the conductor in the vertical plane. The shaker armature shall be securely fastened to the conductor so it is perpendicular to the conductor in the vertical plane. The shaker should be located in the span to allow for a minimum of six vibration loops between the suspension assembly and theshaker.

The test shall be carried out at one or more resonance frequencies (more than 10 Hz). The amplitude at the antinode point shall be one third of conductor diameter. The assembly shall be vibrated for not less than 10 million cycles without any failure. After the test, the conductor should not exhibit any damage (broken strands). The conductor shall be tested to demonstrate that it retains at least 95% RTS.

1.12 Temperature Cycle Test

The purpose of this test is verification of degradation characteristics of metallic and non-metallic material when subjected to thermal cycling temperature cycling can create large internal stresses due to thermal expansion mismatch between constituents.Test Methods: -

7.18.1.1 Mechanical tension, 20 % RBS, marks on the conductor at the edge of the conductor.

7.18.1.2 100 cycles from room temperature up to maximum temperature. Hold at design maximum temperature ± 2.5 deg. C for 5 minutes.

7.18.1.3 After the above mentioned 100 cycles, the mechanical tension shall be increased up to 70 % RBS at roomtemperature and kept at this tension for 24 H. Thereafter release to 20 % RBS.

7.18.1.4 This cycling test shall be repeated 5 times.

7.18.1.5 During the test, temperature of connectors, conductor and resistance are recorded according to ANSI C 119.

7.18.1.6 A breaking load test is applied at the end of the test. Conductor strength has to be higher than 95% RBS.

In case of polymer composites, the flexural strength should not degrade by more than 10 % and the Glass Transition temperature shall not degrade by more than 10 % after thermal cycling. Flexural strength shall be obtained on the basis of test procedure indicated at 1.32 below. CEA Guidelines shall be referred.

1.13 Heat Resistance test on Aluminium Alloy wire

Breaking load test as per clause 1.12 above shall be carried out before and after heating the sample in uniform heat furnace at following temperature for one hour. The breaking strength of the wire after heating shall not be less than the 90% of the breaking strength before heating: -

Maximum continuous operating temperature of the conductor	Test Temperature
Upto 150 deg. C	230 degC (+5/-3 degC)
More than 150 deg. C & upto 210 deg. C	280 degC (+5/-3 degC)
More than 210 deg. C & upto 230 deg. C	400 degC (+5/-3 degC)

CEA Guidelines shall be referred.

1.14 Bending test on aluminium clad core wire (if applicable)

A sample of aluminium clad invar strand measuring 30 cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and 90-degree right. After this operation the strand should cut at the bending point. There should be no separation of core and aluminium at the bending point after this operation.

1.15 Compression test on aluminium clad wires (if applicable)

A sample of aluminium clad core strand 10 mm in length is to be compressed by a plate with a load of 3600kgs. The aluminium and core strand should not break.

1.16 Coefficient of linear expansion for core/ corewires

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15 degree C from 15 degree C to maximum continuous operating temperature corresponding to rated current (875 for 132kV & 1200 A for 220kV) by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.17 Strand Brittle fracture test (for polymer composite core only)

The sample shall be tensioned to approx. 25 % of UTS with simultaneous application of 1NHNO3 acid directly in contact with naked polymer composite core for 96 hrs. The contact length of acid shall not be less than 40mm andthickness around the core not less than 10mm.The rod shall withstand UTS test after 96 hours.

1.18 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the approved drawings.

1.19 **Visual Check for Joints, Scratches etc**.

Conductor drums shall be rewound in the presence of the Employer. The Employer shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Employer's representative.

1.20 Dimensional Check on Core Wires and Aluminium/ Aluminium Alloy Wires

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.21 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the guaranteed values furnished by the Contractor.

1.22 Galvanizing Test

The test procedure shall be as specified in IEC: 888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.23 Aluminum thickness on aluminum clad wires (if applicable)

The thickness of aluminium of the specimen shall be determined by using suitable electrical indicating instruments operating on the direct measurement. Measurements shall be read to three decimal places, and number rounded to two decimal places is considered as measured thickness. For reference purposes, direct measurement shall be used to determine aluminium thickness on specimens taken from the end of the coils.

1.24 Torsion and Elongation Tests on Composite Core

In case of composite core HTLS conductor, the following procedure shall be applicable: -

Elongation Test: - The elongation of the composite core sample at shall be determined using extensometer. The load along the core shall be gradually increased. The elongation achieved on reaching the tensile strength of the core shall not be less than the value guaranteed in the GTP.

Torsion Test: The purpose of the test is to determine the resilience of the composite core to twisting and to showthat after the composite core has experienced the prescribed twisting, it will not crack or have a loss in tensile strength due to the twisting. A sample length that is 170 times the diameter of the composite core being tested is mounted in the gripping fixtures. One grip shall then be fixed so that it does not twist and the other end shall be twisted a full 360 degrees and then fixed in this position for 2 minutes. Once the twist time is completed, the core is untwisted an inspected for any crazing or other damage. If no damage is observed, the composite core is then tensile tested to failure and the

final load recorded. For the test to be accepted, the composite core must withstand at least 100% of its rated tensile strength. Two samples need to be completed in order to satisfy the testing requirement.

CEA Guidelines shall be referred.

1.25 Breaking load test on Aluminium/ Aluminium Alloy & Composite core and D.C Resistance test on Aluminium/ Aluminium Alloy wire

The above tests shall be carried out as per IEC: 888/889 and the results shall meet the requirements of the specification. CEA Guidelines shall be referred.

1.26 **Wrap test on Core wires (Applicable for steel/Al clad Steel/invar core only**)

The wrap test on core strands shall be meet the requirements of IEC: 888. In case of aluminium clad core wire, the same shall be wraped around a mandel of diameter of five times that of the strand to form a helix of eight turns. The strand shall be unwrapped. No breakage of strand shall occurred.

1.27 Minimum conductivity test on thermal resistant aluminium alloy wire

Resistivity test as per IEC-468/IEC 889 shall be conducted to confirm minimum conductivity as per specification requirement

1.28 **Procedure Qualification test on welded Aluminium/ Aluminium Alloy wire**.

Two Aluminium/ Aluminium Alloy wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

1.29 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 45 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperaturerecorded.

1.30 Aluminium conductivity test on aluminium clad wire (if applicable)

Resistivity test as per IEC-468 shall be conducted to confirm minimum conductivity as per specification requirement.

1.31 Glass Transition Temperature Test (for polymer composite core only)

Test method shall be as per ASTM D7028, A Standard Test Method for Glass Transition Temperature of Polymer Matrix Composites by Dynamic Mechanical Analysis. The glass transition temperature shall be greater than the maximum continuous operating temperature of the offered Composite Carbon Core HTLS Conductor+ 35 deg C. CEA Guidelines shall be referred.

1.32 Flexural Strength Test (for polymer composite coreonly)

Test method shall be as per ASTM D7264, ASTM D4475 or ISO14125.

1.33 Bending Test on Composite Core:

A composite core sample shall be wrapped 180 degree around a cylindrical mandrel, and the specimen brought to 15 % of the rated tensile strength of the composite core and held for 1 min. The mandrel diameter shall benot more than 50 times the dia of composite core. After completion of the test, the core shall withstand UTStest and dye penetration test. CEA Guidelines shall be referred.

1.34 **Chemical Analysis of Aluminium/ Aluminium Alloy and Composite core/ INVAR Core Wire**s

Samples taken from the Aluminium /Aluminium Alloy and core coils/ strands shall be

chemically/spectrographically analyzed. The same shall be in conformity to the particulars guaranteed by the bidder so as to meet the requirements stated in this Specification. CEA Guidelines shall be referred.

1.35 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

Note: Any other type test required as per relevant IS/IEC/other standards shall be submitted along with the bid for the offered HTLS conductor.

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES

SECTION – 3 (A)

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 220kV VOLTAGELEVEL

Technical Description of Hardware Fittings

3.1 General

This section details technical particulars of hardware fittings and suspension clamps & compression type dead end clamps for the HTLS Conductor to be proposed and supplied for replacement of ASCR zebra conductor by the bidder. Each fitting shall be suitable for HTLS conductor and to be supplied for satisfactory performance ofcomplete conductor system for continuous operation at the designed maximum temperature specified by them for the conductor.

3.2. Hardware Fittings

The hardware fittings shall be suitable for use with long rod porcelain /string insulators having ball and socket fittings. Each hardware fitting shall be supplied complete in all respects and shall include the following hardware parts:

3.2.1 Suitable arcing horn as specified in clause 3.11 hereinafter.

3.2.2 Suitable yoke assemblies with the arrangement of fixing a set of arching horn and complying with the specifications given hereinafter.

3.2.3 Bolts, Nuts, washers, split pin etc.

3.2.4 Suspension, tension clamps and dead-end assembly to suit conductor size as detailed in clause 3.3, 3.4 and 3.11, hereinafter.

3.2.5 Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make the hardware fittings complete.

3.2.6 2.5% extra fasteners.

3.3 Suspension Clamp

The suspension clamps shall be made of malleable iron or aluminium alloy, hot dip galvanised and shall be suitable to accommodate the conductor together with one set of standard preformed armour rods. Suitable sheet aluminium liners shall be provided. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor. The lips shall be rounded off and the seating and the bell mouths shall be smooth to avoid corona and radio interference noises. The suspension clamps shall be suitable to carry the bottom part of the arcing horn and to receive the fittings of the long rod porcelain insulator/insulator string.

The suspension clamps shall be such that the conductor should not slip at a load of 25% of the breaking load of the conductor. The ultimate strength of the clamp for vertical load shall not be less than the failing load of the Insulators.

3.4 Strain Clamp

The strain clamps shall also be made of malleable iron or aluminium alloy; hot dip galvanised, lined with sheet aluminium liners and shall be suitable to accommodate the conductor with necessary binding tapes etc. The lips shall be rounded off carefully and conductor seating and the ball mouth shall be smooth to avoid corona and radio interference noises. Suitable attachment for receiving both side of arcing horns and for connecting to the porcelain long rod insulator/insulator strings shall be provided.

The strain clamps shall be such that the conductor should not slip at a load of 90% of the breaking load of the conductor. The ultimate strength of the clamp for horizontal load shall not be less than the ultimate strength of the conductor.

3.5 Clamps fittings

The clamp fittings shall be suitable for attachment to suspension and tension porcelain long rod insulator/insulator strings along with hardware fittings for normal stretches as well as river crossing stretches and shall include 2.5 % extra fasteners. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the designed maximum temperature specified by them for the conductor.

3.6 Dimensions of long rod porcelain /Insulator String Along with Hardware Fitting

The various limiting dimensions of the long rod porcelain insulator/insulator strings shall generally be in conformity with the dimensions of the hardware fittings. The Contractor shall be required to verify the dimensions of the long rod porcelain insulator/insulator strings and shall ensure that the fittings are generally conforming to the dimensions of the hardware fittings.

3.7 Interchangeability

The hardware for long rod porcelain insulator/insulator strings with disc insulators together with ball and socketfittings shall be of standard design, so that this hardware are inter- changeable with each other and suitable for use with insulators of any make conforming to relevant Indian/International Standard

3.8 Maintenance

The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenanceshall be generally bare hand method & hot stick method.

3.9 Designation

3.9.1 Ball and Socket Designation

The dimension of the ball and socket shall be 20mm for 120kN and 160KN Disc insulator. The designation should be in accordance with the standard dimensions stated in IS: 2486-(Part-II)/IEC: 60120. The dimensions shall be checked by the appropriate gauge after **galvanising only.**

3.10 Security Clips and Split Pins

3.10.1 Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking of the coupling as per IS: 2486-(Part-III)/ IEC: 60372. The legs of the security clips shall be spread after assembly in the works to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall the locking devices allow separation of fittings.

3.10.2 The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall not be less than 50 N (5 kg) or more than 500 N (50 kg)

3.10.3 Split pins shall be used with bolts & nuts.

3.11 Arcing Horn

1.11.1 The arcing horn / shall be either ball ended rod type or tubular type.

1.11.2 The arcing horn shall be provided generally as per existing fitting and shall conform to specification requirements

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

3.12 Yoke Plates

The strength of yoke plate shall be adequate to withstand the minimum ultimate tensile strength as specified.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for long rod porcelain insulator/disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing arcing horn. All the corners and edges should be rounded off with a radius of at least 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the contractor. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No.10.2.4.2 of IS: 800-2007.

3.13 Turn Buckle

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

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

3.14 Suspension Assembly

3.14.1 The suspension assembly shall be suitable for the HTLS Conductor, the bidder intends to supply. The technical details of the conductor shall be as proposed by the bidder.

3.14.2 The suspension assembly shall be made of aluminium alloy and shall be suitable to accommodate the conductor together with standard preformed armour rods or armour grip suspension clamp. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor.

3.14.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

3.14.4 The suspension clamp shall be designed for continuous operation at the temperature specified by the bidder for conductor.

3.14.5 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

3.14.6 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

3.15 Standard Preformed Armour Rod Set.

The Preformed Armour Rods Set shall be used to minimise the stress developed in the conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

3.15.1 The preformed armour rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

3.15.2 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer

layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

3.15.3 The length and diameter of each rod shall be furnished by the bidder in the GTP. The tolerance in lengthof the rods between the longest and shortest rod in complete set should be within the limits specified in relevantIndian/International Standards. The ends of armour rod shall be parrot billed.

Standards. Each rod shall be marked in the middle with paint for easy application on the line.

3.15.5 The armour rod shall not lose their resilience even after five applications.

3.15.6 The conductivity of each rod of the set shall not be less than 40% of the conductivity of theInternational Annealed Copper Standard (IACS).

3.16 Dead end Assembly

3.16.1 The dead-end assembly shall be suitable for the offered HTLS Conductor.

3.16.2 The dead-end assembly shall be of compression type with provision for compressing jumper terminal atone end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area ofbearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not bemore than 75% of the resistance of equivalent length of Conductor.

3.16.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words _COMPRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead-end assembly is designed for intermittent die compressions it shall bear identification marks _COMPRESSION ZONE' AND _NON- COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead-end assembly before & after compression along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. These shall be guaranteed in the relevant schedules of bid.

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

3.16.5 Jumper bolting arrangement between jumper terminal/cone and terminal pad/plate of dead-end assembly of tension hardware fittings shall be designed to suit the specification requirement of 1050A/800A, as the case may be, current and shall conform to the relevant Indian/International standards

3.16.6 For composite core HTLS conductor, dead end assembly shall inter-alia include collets, collet housing, inner sleeve etc., suitable for the offered design of HTLS conductor.

3.17 Fasteners: Bolts, Nuts and Washers

3.17.1 All bolts and nuts shall conform to IS 6639. All bolts and nuts shall be galvanized as per IS 1367 (Part-13)/IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

3.17.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should beprovided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.

3.17.3 Nuts should be double chamfered as per the requirement of IS 1363 Part- III 1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for sizeup-to M16.

3.17.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

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

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

3.17.7 The Contractor shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

3.17.8 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

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

3.17.10 To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc, in- house. The manufacturer should also have proper Quality Assurance system which should be in line with the requirement of this specification and IS-.14000 services Quality System standard.

3.17.11 Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolt shall be 5.6.

3.18 Accessories for the HTLS Conductor

- This portion details the technical particulars of the accessories for Conductor.
- 2.5% extra fasteners, filler plugs and retaining rods shall be provided.
- The supplier shall be responsible for satisfactory performance of complete conductor system along withaccessories offered by him for continuous operation at temperature specified for the HTLS Conductor.

3.19 Mid Span Compression Joint

3.19.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistively less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor. It must be able to withstand the continuous design temperature of conductor.

3.19.2 The dimensions of mid span compression joint before & after compression along with tolerances shall be shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. For composite core conductor, suitable sleeve, collets, collet housing shall be used for core jointing.

3.20 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium / aluminium alloy and shall have a smooth surface. It shall be able to withstand the continuous maximum operating temperature of conductor. Therepair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions of Repair sleeve along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

3.21 Vibration Damper

3.21.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s are installed in the

existing line atsuspension and tension points on each conductor in each span to damp out aeolian vibration as well as sub- span oscillations. One damper minimum on each side per conductor for suspension points and two dampers minimum on each side per conductor for tension points shall be used for a ruling design span of 320 meters.

3.21.2 The bidder shall offer damping system including Stockbridge type dampers for proposed HTLS Conductor for its protection from wind induced vibrations which could cause conductor fatigue /strand breakage near a hardware attachment, such as suspension clamps. Alternate damping systems with proven design offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents including type test reports to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid. The damper shall be designed to have resonance frequencies to facilitate dissipation of vibration energy through inter-strand friction of the messenger cable and shall be effective in reducing vibration over a wide frequency range (depending upon conductor dia) or wind velocity range specified above. The vibration damper shall meet the requirement of frequency or wind velocity range and also have mechanical impedance closely matched with the offered HTLS conductor. The vibration dampers shall be installed at suitable positions to ensure damping effectiveness across the frequency range. The power dissipation of the vibration dampers shall exceed the wind power so that the vibration level on the conductoris reduced below its endurance limit i.e 150 micro strain. The bidder shall clearly indicate the method for evaluating performance of dampers including analytical and laboratory test methods. The bidder shall indicate the type tests to evaluate the performance of offered damping system.

3.21.3 The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

3.21.4 The messenger cable shall be made of high strength galvanized steel/stain less steel with a minimum strength of 135 kg/sqmm. It shall be of preformed and post formed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS: 4826 for heavily coated wires.

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

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

messenger cable under all service conditions.

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

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

3.21.9 The contractor 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.

3.21.10 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	**Description**	**Technical particulars**
1.	Span length in meters Ruling design span	350 meters
2.	Configuration	Double Circuit single Conductor per phase in vertical Configuration.
3.	Tensile load in Conductor at temperature of 0 deg. C and still air	As per Sag – tension calculations
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible dynamic strain i.e. endurance limit.	+/- 150 micro strains

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

3.21.12 The damper placement charts shall include the following

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

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

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

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

3.22 PG Clamp, Come Along Clamp, T-Clamp, CVT Clamp, CB Clamp, CT&PT clamp, Pad clamp for substation Bay stringing by HTLS conductor.

a. Standard Specification and tests shall be as per IS:5561.

b. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanised.

c. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.

d. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.

e. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.

f. No part of a clamp shall be less than 15 mm thick for fittings suitable for HTLS conductor, All sharp edges and corners shall be blurred and rounded off.

g. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

h. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

3.23 Corona and RI Performance.

Sharp edges and scratches on all the hardware fittings shall be avoided. All surface must be clean, smooth, without cuts and abrasions or projections. The Supplier shall be responsible for satisfactory corona and radio interference performance of the materials offered by him.

3.24 Materials

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

The details of materials for different component are listed as in Table No-1 (a).

TABLE-1 (a)

(Details of Materials)

Sr. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS- 1385	
2	**For Free Centre /Envelope type clamps/PG Clamp/Come along clamp**				
a.	Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	
b.	Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
c.	U Bolts	Stainless Steel or High Strength Al Alloy 6061/65032	Forged & & Heat treated	AISI 302 or 304-L ASTM B429	
d.	P. A. Rod	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Heat treatment during manufacturing	ASTM-B429	Min. tensile strength of35 kg/mm^2
3	**For AGS type clamp**				
(a)	Supporting House	High Strength Corrosion resistant Al.Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	S:617or ASTM- B429	
(b)	Al insert & Retaining strap	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged I & Heat treated	S:617or ASTM- B429	High Strength Al. Alloy 4600/ LM-6 or 6061/65032
(c)	Elastomer	Molded on Al. reinforcement			
4.	**For Dead End Assembly**				
(a)	Outer Sleeve	EC grade Al of purity not less than99.50%			
(b)	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-2062	
5.	Ball & Socket Fittings,	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
6.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
7.	Corona Control ring/ t Grading ring	High Strength Al. Alloy tube (6061/6063/ 1100 ype or 65032/ 63400	Heat treated Hot dipgalvanized	ASTM-B429 or as per IS	Mechanical strength ofwelded joint shall not be lessthan 20 kN

8.	Supporting than 20 Brackets & Mounting Bolts	High strength Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dipgalvanized	ASTM-B429 or as per IS:226 or S:2062	

Note: *Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparison of material offered viz a viz specified in the bid or else the bids are liable to be rejected*.

3.24 Workmanship

3.24.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 220 kV transmission lines and will give continued good performance.

3.24.2 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings / accessories under simulated service condition corresponding to operation of conductor at maximum (emergency) operating temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/performance test certificates as per applicable standards/product specifications to confirm suitability of the offered material.

3.24.3 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

3.24.4 All ferrous parts including fasteners shall be hot dip galvanised, after all machining has been completed.Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS 2629 / IS 1367 (Part-13) and shall satisfy the tests mentioned in IS 2633. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalent to 600 gm/sqm., shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard Preece test for galvanizing.

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

3.24.6 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209.

3.24.7 Pin balls shall be checked with the applicable —GO‖ gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90^{o} to this line. "NO GO" gauges shall not pass in any direction.

3.24.8 Socket ends, before galvanising, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS: 2486/IEC: 120.

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

3.24.9 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.

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

3.24.11 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

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

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

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

3.25 Bid Drawings

3.25.1 The Bidder shall furnish full description and illustrations of materials offered.

3.25.2 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished in three copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

i) Attachment of the hanger or strain plate.
ii) Suspension or dead-end assembly.
iii) Arcing horn attachment to the string as specified this technical Specification.
iv) Yoke plates
v) Hardware fittings of ball and socket type for inter connecting units to the top and bottom Yoke plates.

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

The drawings shall include:

i) Dimensions and dimensional tolerance.
ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
iii) Catalogue No.
iv) Marking
v) Weight of assembly

vi) Installation instructions

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

viii) Withstand torque that may be applied to the bolt or cap screw without failure ofcomponent parts.

ix) The compression die number with recommended compression pressure.

x) Placement charts for damper.

xi) All other relevant terminal details.

3.25.4 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in four (4) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Contractor shall submit ten (10) more copies of the same drawings to the Owner for further distribution and field use at Employer's end.

3.26 Compression Markings

Die compression areas shall be clearly marked, on each equipment designed for continuous die compressions and shall bear the words ‗COMPRESS FIRST' ‗suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks

‗COMPRESSION ZONE' and ‗NON-COMPRESSION ZONE' distinctly with arrow marks, showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

3.27 Test and Standards

3.27.1 Type Test

3.27.1.1 On the complete Disc Insulator Strings with Hardware Fittings

a)	Power frequency voltage withstand test with arcing horns under wet condition	: As per IEC:60383
b)	Impulse voltage withstand test under dry condition	: As per IEC:60383
c)	Mechanical Strength test	: As per Annex-B 1
d)	Voltage distribution test	: As per Annex-B 1
e)	Vibration test	: As per Annex-B 1

Note: 1) All the type test given in Clause No. 3.27.1.1 shall be conducted on complete single suspension & Single Tension insulator unit.

2) All the type tests given under Clause No. 3.27.1.1 (a) to (e) shall also be conducted on Single I Pilot, Double I Suspension & Double Tension insulator unit

3.27.2 On Hardware Fittings

a. Mechanical Strength Test on Tension Hardware fitting : As per Annex-B 1

b. Mechanical Strength Test on Suspension Hardware fitting : As per Annex-B 1

3.27.3 On Suspension Clamp

a. Magnetic power loss test : As per Annexure-B 1

b. Clamp slip strength Vs torque test : As per Annexure-B 1

c. Ozone Test on elastomer : As per Annexure-B 1

d. Vertical damage load & Failure load test : IEC: 61284

3.27.4 On Dead end Tension Assembly

a. Electrical resistance test for dead end Assembly : As per IS:2486-(Part-I)
b. Heating cycle test for dead end Assembly : As per Annexure-B 1
c. Slip strength test for dead end assembly : As per IS:2486-(Part-I)
d. Ageing test on filler (if applicable) : As per Annexure-B 1

3.27.5 Mid Span Compression Joint for Conductor

a. Chemical analysis of materials : As per Annexure-B 1
b. Electrical resistance test :As per IS:2121 (Part-II)
c. Heating cycle test :As per Annexure-B 1
d. Slip strength test : As per Annexure-B 1
e. Corona extinction voltage test (dry) : As per Annexure-B 1
f. Radio interference voltage test (dry) : As per Annexure-B 1

3.27.6 Repair Sleeve for Conductor

a. Chemical analysis of materials : As per Annexure-B 1
b. Corona extinction voltage test (dry) : As per Annexure-B 1
c. Radio interference voltage test (dry) : As per Annexure-B 1

3.27.7 Vibration Damper for Conductor

a. Chemical analysis of materials : As per Annexure-B 1
b. Dynamic characteristics test* : As per Annexure-B 1
c. Vibration analysis : As per Annexure-B 1
d. Clamp slip test : As per Annexure-B 1
e. Fatigue tests : As per Annexure-B 1
f. Magnetic power loss test : As per Annexure-B 1
g. Damper efficiency test : As per IS:9708
h. Corona extinction voltage test (dry) : As per Annexure-B 1
i. Radio interference voltage test (dry) : As per Annexure-B 1

3.27.8 Type tests specified under Clause 3.27.1 to 3.27.7 shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) Central/State Power Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with therequirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extracost to the Employer/ Employer/ Employer.

3.28 Acceptance Tests

3.28.1 On Both Suspension clamp and Tension Assembly

Visual Examination : As per IS:2486-(Part-I)
Verification of dimensions : As per IS:2486-(Part-I)
Galvanising/Electroplating test : As per IS:2486-(Part-I) Mechanical

strength test of each component : As per Annexure-B 1 Mechanical
strength test for arcing horn : As per BS:3288(Part-I)
Test on locking device for ball and socket coupling : As per IEC:372 (2) Mechanical
Strength test of welded joint : As per Annexure-B 1 Chemical
analysis, hardness tests, grain size, : As per Annexure-B 1
inclusion rating & magnetic particle
inspection for forgings/castings

3.28.2 On Suspension Clamp only

a. Clamp Slip strength Vs Torque test for suspension clamp : As per Annexure-B 1
b. Shore hardness test of elastomer cushion for
AG suspension clamp : As per Annexure-B 1
c. Bend test for armour rod set : As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
d. Resilience test for armour rod set : As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
e. Conductivity test for armour rods set : As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11

3.28.3 On Tension Hardware Fittings only

a. Slip strength test for dead end assembly : As per IS:2486 (Part-I) Clause5.4
b. Ageing test on filler (if applicable) : As per Annexure-C 1

3.28.4 On Mid Span Compression Joint for Conductor

a. Visual examination and dimensional verification : As per IS:2121 (Part-II), Clause 6.2, 6.37 6.7
b. Galvanizing test : As per Annexure-B 1
c. Hardness test : As per Annexure-C 1
d. Ageing test on filler (if applicable) : As per Annexure-C 1

3.28.5 Repair Sleeve for Conductor

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

3.28.6 Vibration Damper for Conductor

a. Visual examination and dimensional verification : As per IS: 2121(Part-II) Clause 6.2, 6.3 7 6.7
b. Galvanizing test : As per Annexure-B 1
i. On damper masses : As per Annexure-B 1
ii. On messenger cable : As per Annexure-B 1
c. Verification of resonance frequencies : As per Annexure-C 1
d. Clamp slip test : As per Annexure-C 1
e. Clamp bolt torque test : As per Annexure-C 1
f. Strength of the messenger cable : As per Annexure-C 1
g. Mass pull off test : As per Annexure-C 1
h. Dynamic characteristics test* : As per Annexure-C 1

* Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 3.27), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.29 Routine Tests

3.29.1 For Hardware Fittings

a. Visual examination :IS 2486-(Part-I)
b. Proof Load Test : As per Annexure-B 1

3.29.2 For conductor accessories

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

3.29.3 Tests During Manufacture on all components as applicable

a. Chemical analysis of Zinc used for galvanizing : IS 2486-(Part-I)
b. Chemical analysis mechanical metallographic test and : As per Annexure-B 1 magnetic particle inspection for malleable castings
c. Chemical analysis, hardness tests and magnetic particle : As per Annexure-B 1 inspection for forging

3.30 Testing Expenses

3.30.1 As indicated in clause 3.27 no type test charges shall be payable.

3.30.2 In case type testing is required due to non-availability of type test reports, or type test on the complete insulator string, the Contractor has to arrange similar insulators at his own cost.

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

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

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

3.30.6 The Contractor shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance of the scheduled date of testing during which the Owner will arrange todepute his representative to be present at the time of carrying out the tests.

3.31 Schedule of Testing and Additional Tests

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

i. Submission of drawing for approval.

ii. Submission of Quality Assurance programme for approval.

iii. Offering of material for sample selection for type tests.

iv. Type testing.

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

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

3.32 Test Reports

3.32.1 Copies of type test report shall be furnished in at least six copies along with one original. One copy shall be returned, duly certified by the Owner, only after which the commercial production of the concerned materialshall start.

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

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

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

3.33 Inspection

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

3.33.2 The material for final inspection shall be offered by the Contractor only under packed condition.
The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

3.33.3 The Contractor shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.

3.33.4 Material shall not be dispatched from its point of manufacture before it has been satisfactorily inspectedand tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

3.33.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility formeeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such materials

are later found to be defective.

3.34 Packing and Marking

3.34.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

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

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

3.34.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.

3.34.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture. However, in such type of component/item, which consists of many parts and are being supplied in assembled condition (suspension clamp, vibration damper, etc.), the complete assembly shall be legibly and indelibly marked on main body/on one of the parts.

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

3.35 Standards

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

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

Sl. No.	**Indian Standard**	**Title**	**International Standard**
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage	IEC:1089-1991 BS:215-1970
3.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS : 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	

5.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
6.	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
7.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.		Ozone test on Elastomer	ASTM- D1 171
9.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
10.	IS:4826	Galvanised Coating on Round Steel Wires	ASTM A472-729 BS:443-1969
11.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO: 1460 (E)
12.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437, NEMA:107 CISPR
13.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
14.	IS:9708	Specification for Stock Bridge Vibration Dampers for Overhead Power lines	

SECTION – 3 (B)

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 145Kv VOLTAGELEVEL

Technical Description of Hardware Fittings

3.1 General

This section details technical particulars of hardware fittings and suspension clamps & compression type dead end clamps for the HTLS Conductor to be proposed and supplied for replacement of ACSR Zebra conductor by the bidder. Each fitting shall be suitable for proposed HTLS conductor and to be supplied for satisfactory performance of complete conductor system for continuous operation at the designed maximum temperature specified by them for the conductor.

Note: The hardware fittings, clamps and connectors and other related accessories shall be provided to suit zebra equivalent HTLS conductors of minimum 1500A capacity.

3.2. Hardware Fittings

The hardware fittings shall be suitable for use with long rod porcelain /string insulators having ball and socket fittings. Each hardware fitting shall be supplied complete in all respects and shall include the following hardwareparts:

3.2.1 Suitable arcing horn as specified in clause 3.11 hereinafter.

3.2.2 Suitable yoke assemblies with the arrangement of fixing a set of arching horn and complying with the specifications given hereinafter.

3.2.3 Bolts, Nuts, washers, split pin etc.

3.2.4 Suspension, tension clamps and dead-end assembly to suit conductor size as detailed in clause 3.3, 3.4 and 3.16, hereinafter.

3.2.5 Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make the hardware fittings complete.

3.2.6 2.5% extra fasteners.

3.3 SUSPENSION CLAMP

The suspension clamps shall be made of malleable iron or aluminium alloy, hot dip galvanised and shall be suitable to accommodate the conductor together with one set of standard preformed armour rods. Suitable sheet aluminium liners shall be provided. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor. The lips shall be rounded off and the seating and the bell mouths shall be smooth to avoid corona and radio interference noises. The suspension clamps shall be suitable to carry the bottom part of the arcing horn and to receive the fittings of the long rod porcelain insulator/insulator string.

The suspension clamps shall be such that the conductor should not slip at a load of 25% of the breaking load of the conductor. The ultimate strength of the clamp for vertical load shall not be less than the failing load of the Insulators.

3.4 STRAIN CLAMP

The strain clamps shall also be made of malleable iron or aluminium alloy; hot dip galvanised, lined with sheet aluminium liners and shall be suitable to accommodate the conductor with necessary binding tapes etc. The lips shall be rounded off carefully and conductor seating and the ball mouth shall be smooth to avoid corona and radio

interference noises. Suitable attachment for receiving both side of arcing horns and for connecting to the porcelain long rod insulator/insulator strings shall be provided.

The strain clamps shall be such that the conductor should not slip at a load of 90% of the breaking load of the conductor. The ultimate strength of the clamp for horizontal load shall not be less than the ultimate strength of the conductor.

3.5 Clamps fittings

The clamp fittings shall be suitable for attachment to suspension and tension porcelain long rod insulator/insulator strings along with hardware fittings for normal stretches as well as river crossing stretches and shall include 2.5 % extra fasteners. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the designed maximum temperature specified by them for the conductor.

3.6 Dimensions of long rod porcelain /Insulator String Along with Hardware Fitting

The various limiting dimensions of the long rod porcelain insulator/insulator strings shall generally be in conformity with the dimensions of the hardware fittings. The Contractor shall be required to verify the dimensions of the long rod porcelain insulator/insulator strings and shall ensure that the fittings are generally conforming to the dimensions of the hardware fittings.

3.7 Interchangeability

The hardware for long rod porcelain insulator/insulator strings with disc insulators together with ball and socketfittings shall be of standard design, so that this hardware are inter- changeable with each other and suitable for use with insulators of any make conforming to relevant Indian/International Standard

3.8 Maintenance

The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenanceshall be generally bare hand method & hot stick method.

3.9 Designation

3.9.1 Ball and Socket Designation

The dimension of the ball and socket shall be 16mm designation for 70 and 90KN and 20mm for 120kN Disc insulator. The designation should be in accordance with the standard dimensions stated in IS: 2486- (Part-II)/IEC: 60120. The dimensions shall be checked by the appropriate gauge after **galvanising only.**

3.10 Security Clips and Split Pins

3.10.1 Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking of the coupling as per IS: 2486-(Part-III)/ IEC: 60372. The legs of the security clips shall be spread after assembly in the works to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall the locking devices allow separationof fittings.

3.10.2 The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall not be less than 50 N (5 kg) or more than 500 N (50 kg)

3.10.3 Split pins shall be used with bolts & nuts.

3.11 Arcing Horn

3.11.1 The arcing horn / shall be either ball ended rod type or tubular type.

3.11.2 The arcing horn shall be provided generally as per existing fitting and shall conform to specification requirements

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

3.12 Yoke Plates

The strength of yoke plate shall be adequate to withstand the minimum ultimate tensile strength as specified.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for long rod porcelain insulator/disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the contractor. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No.10.2.4.2 of IS: 800-2007.

3.13 Turn Buckle

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

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

3.14 Suspension Assembly

3.14.1 The suspension assembly shall be suitable for the HTLS Conductor, the bidder intends to supply. The technical details of the conductor shall be as proposed by the bidder.

3.14.2 The suspension assembly shall be made of aluminium alloy and shall be suitable to accommodate the conductor together with standard preformed armour rods or armour grip suspension clamp. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor.

3.14.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

3.14.4 The suspension clamp shall be designed for continuous operation at the temperature specified by the bidder for conductor.

3.14.5 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

3.14.6 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

3.15 Standard Preformed Armour Rod Set.

The Preformed Armour Rods Set shall be used to minimise the stress developed in the conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

3.15.1 The preformed armour rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

3.15.2 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

3.15.3 The length and diameter of each rod shall be furnished by the bidder in the GTP. The tolerance in length of the rods between the longest and shortest rod in complete set should be within the limits specified in relevant Indian/International Standards. The ends of armour rod shall be parrot billed.

3.15.4 The number of armour rods in each set shall be as per supplier's design to suit HTLS Conductor offered Standards. Each rod shall be marked in the middle with paint for easy application on the line.

3.15.5 The armour rod shall not lose their resilience even after five applications.

3.15.6 The conductivity of each rod of the set shall not be less than 40% of the conductivity of the InternationalAnnealed Copper Standard (IACS).

3.16 Dead end Assembly

3.16.1 The dead-end assembly shall be suitable for the offered HTLS Conductor.

3.16.2 The dead-end assembly shall be of compression type with provision for compressing jumper terminal atone end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area ofbearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not bemore than 75% of the resistance of equivalent length of Conductor.

3.16.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words _COMPRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead-end assembly is designed for intermittent die compressions it shall bear identification marks _COMPRESSION ZONE' AND _NON- COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead-end assembly before & after compression alongwith tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. These shall be guaranteed in the relevant schedules of bid.

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

3.16.5 Jumper bolting arrangement between jumper terminal/cone and terminal pad/plate of dead end assembly of tension hardware fittings shall be designed to suit the specification requirement of 1050A/800A, as the case may be, current and shall conform to the relevant Indian/International standards

3.16.6 For composite core HTLS conductor, dead end assembly shall inter-alia include collets, collet housing, inner sleeve etc., suitable for the offered design of HTLS conductor.

3.17 Fasteners: Bolts, Nuts and Washers

3.17.1 All bolts and nuts shall conform to IS 6639. All bolts and nuts shall be galvanized as per IS 1367 (Part-13)/IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

3.17.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should beprovided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.

3.17.3 Nuts should be double chamfered as per the requirement of IS 1363 Part- III 1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for sizeupto M16.

3.17.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

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

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

3.17.7 The Contractor shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

3.17.8 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

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

3.17.10 To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc., in- house. The manufacturer should also have proper Quality Assurance system which should be in line with the requirement of this specification and IS-.14000 services Quality System standard.

3.17.11 Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolt shall be 5.6.

3.18 Accessories for the HTLS Conductor

3.22.1 This portion details the technical particulars of the accessories for Conductor.

3.22.2 2.5% extra fasteners, filler plugs and retaining rods shall be provided.

3.22.3 The supplier shall be responsible for satisfactory performance of complete conductor system along withaccessories offered by him for continuous operation at temperature specified for the HTLS Conductor.

3.19 Mid Span Compression Joint

3.19.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistively less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor. It must be able to withstand the continuous design temperature of conductor.

3.19.2 The dimensions of mid span compression joint before & after compression along with tolerances shall be shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. For composite core conductor, suitable sleeve, collets, collet housing shall be used for core jointing.

3.20 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium / aluminium alloy and shall have a smooth surface. It shall be able to withstand the continuous maximum operating temperature of conductor. Therepair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions of Repair sleeve along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

3.21 Vibration Damper

3.21.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s are installed in the existing line atsuspension and tension points on each conductor in each span to damp out aeolian vibration as well as sub- span oscillations. One damper minimum on each side per conductor for suspension points and two dampers minimum on each side per conductor for tension points shall be used for a ruling design span of 320 meters.

3.21.2 The bidder shall offer damping system including Stockbridge type dampers for proposed HTLS Conductor for its protection from wind induced vibrations which could cause conductor fatigue /strand breakage near a hardware attachment, such as suspension clamps. Alternate damping systems with proven design offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents including type test reports to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid. The damper shall be designed to have resonance frequencies to facilitate dissipation of vibration energy through inter-strand friction of the messenger cable and shall be effective in reducing vibration over a wide frequency range (depending upon conductor dia) or wind velocity range specified above. The vibration damper shall meet the
requirement of frequency or wind velocity range and also have mechanical impedance closely matched with theoffered HTLS conductor. The vibration dampers shall be installed at suitable positions to ensure damping effectiveness across the frequency range. The power dissipation of the vibration dampers shall exceed the wind power so that the vibration level on the conductor is reduced below its endurance limit i.e 150 micro strain. The bidder shall clearly indicate the method for evaluating performance of dampers including analytical and laboratory test methods. The bidder shall indicate the type tests to evaluate the performance of offered damping system.

3.21.3 The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

3.21.4 The messenger cable shall be made of high strength galvanized steel/stain less steel with a minimum strength of 135 kg/sqmm. It shall be of preformed and post formed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS: 4826 for heavily coated wires.

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

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

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

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

3.21.9 The contractor 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.

3.21.10 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	Description	Technical particulars
1.	Span length in meters Ruling design span	325 meters

2.	Configuration	Double Circuit single Conductor per phase in vertical Configuration.
3.	Tensile load in Conductor at temperature of 0 deg. C and still air	As per Sag – tension calculations
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible dynamic strain ie endurance limit.	+/- 150 micro strains

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

3.21.12 The damper placement charts shall include the following

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

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

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

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

3.22 PG Clamp, Come Along Clamp, T-Clamp, CVT Clamp, CB Clamp, CT&PT clamp, Pad clamp for substation Bay stringing by HTLS conductor.

a. Standard Specification and tests shall be as per IS:5561.

b. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electro-galvanised.

c. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.

d. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.

e. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.

f. No part of a clamp shall be less than 15 mm thick for fittings suitable for offered HTLS conductor, All sharp edges and corners shall be blurred and rounded off.

g. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

h. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

3.23 Materials

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

3.23.1 The details of materials for different component are listed as in Table No-1 (b).

TABLE-1 (b)

(Details of Materials)

Sr. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS- 1385	
2	**For Free Centre /Envelope type clamps/PG Clamp/Come along clamp**				
a.	Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	
b.	Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
c.	U Bolts	Stainless Steel or High Strength Al Alloy 6061/65032	Forged & & Heat treated	AISI 302 or 304-L ASTM B429	
d.	P. A. Rod	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Heat treatment during manufacturing	ASTM-B429	Min. tensile strength of 35 kg/mm^2
3	**For AGS type clamp**				
(a)	Supporting House	High Strength Corrosion resistant Al.Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	S:617or ASTM-B429	
(b)	Al insert & Retaining strap	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged I & Heat treated	S:617or ASTM-B429	High Strength Al. Alloy 4600/ LM-6 or 6061/65032
(c)	Elastomer	Molded on Al. reinforcement			
4.	**For Dead End Assembly**				
(a)	Outer Sleeve	EC grade Al of purity not less than99.50%			
(b)	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-2062	
5.	Ball & Socket Fittings,	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	

6.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
7.	Corona Control ring/ t Grading ring	High Strength Al. Alloy tube (6061/6063/ 1100 ype or 65032/ 63400	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20 kN
8.	Supporting than 20 Brackets & Mounting Bolts	High strength Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or S:2062	

Note: *Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparison of material offered viz a viz specified in the bid or else the bids are liable to be rejected*.

3.24 Workmanship

3.24.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in theExtra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 132 kV transmission lines and will give continued good performance

3.24.2 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings / accessories under simulated service condition corresponding to operation of conductor at maximum (emergency) operating temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/performance test certificates as per applicable standards/product specifications to confirm suitability of the offeredmaterial.

3.24.3 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

3.24.4 All ferrous parts including fasteners shall be hot dip galvanised, after all machining has been completed.Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS 2629 / IS 1367 (Part-13) and shall satisfy the tests mentioned in IS 2633. Fasteners shall withstand four dips while spring washers shall withstand three dips of one minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalentto 600 gm/sqm., shall be guaranteed to withstand at least six successive dips each lasting one (1) minute underthe standard Preece test for galvanizing.

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

3.24.6 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209.

3.24.7 Pin balls shall be checked with the applicable —GO‖ gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90^{o} to this line. "NO GO" gauges shall not pass in any direction.

3.24.8 Socket ends, before galvanising, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions of high spots. The internal contours of socket endsshall be concentric with the axis of the fittings as per IS: 2486/IEC: 120.
The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.

3.24.9 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.

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

3.24.11 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

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

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

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

3.25 Bid Drawings

3.25.1 The Bidder shall furnish full description and illustrations of materials offered.

3.25.2 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished in three copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

i) Attachment of the hanger or strain plate.
ii) Suspension or dead-end assembly.
iii) Arcing horn attachment to the string as specified this technical Specification.
iv) Yoke plates
v) Hardware fittings of ball and socket type for inter connecting units to the top and bottom Yoke plates.

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

The drawings shall include:

i) Dimensions and dimensional tolerance.

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

iii) Catalogue No.

iv) Marking

v) Weight of assembly

vi) Installation instructions

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

viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.

ix) The compression die number with recommended compression pressure.

x) Placement charts for damper.

xi) All other relevant terminal details.

3.25.4 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in four (4) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Contractor shall submit ten (10) more copies of the same drawings to the Owner for further distribution and field use at Employer's end.

3.26 Compression Markings

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

3.27 Test and Standards

3.27.1 Type Test

3.27.1.1 On the complete Disc Insulator Strings with Hardware Fittings

a)	Power frequency voltage withstand test with arcing horns under wet condition	: As per IEC:60383
b)	Impulse voltage withstand test under dry condition	: As per IEC:60383
c)	Mechanical Strength test	: As per Annex-B 2
d)	Voltage distribution test	: As per Annex-B 2
e)	Vibration test	: As per Annex-B 2

Note: 1) All the type test given in Clause No. 3.27.1.1 shall be conducted on complete single suspension & Single Tension insulator unit.

2) All the type tests given under Clause No. 3.27.1.1 (a) to (e) shall also be conducted on Single I

3.27.2 On Hardware Fittings

a. Mechanical Strength Test on Tension Hardware fitting : As per Annex-B 2
b. Mechanical Strength Test on Suspension Hardware fitting : As per Annex-B 2

3.27.3 On Suspension Clamp

a. Magnetic power loss test : As per Annexure-B 2
b. Clamp slip strength Vs torque test : As per Annexure-B 2
c. Ozone Test on elastomer : As per Annexure-B 2
d. Vertical damage load & Failure load test : IEC: 61284

3.27.4 On Dead end Tension Assembly

a. Electrical resistance test for dead end Assembly : As per IS:2486-(Part-I)
b. Heating cycle test for dead end Assembly : As per Annexure-B 2
c. Slip strength test for dead end assembly : As per IS:2486-(Part-I)
d. Ageing test on filler (if applicable) : As per Annexure-B 2

3.27.5 Mid Span Compression Joint for Conductor

a. Chemical analysis of materials : As per Annexure-B 2
b. Electrical resistance test :As per IS:2121 (Part-II)
c. Heating cycle test :As per Annexure-B 2
d. Slip strength test : As per Annexure-B 2
e. Corona extinction voltage test (dry) : As per Annexure-B 2

3.27.6 Repair Sleeve for Conductor

a. Chemical analysis of materials : As per Annexure-B 2

3.27.7 Vibration Damper for Conductor

a. Chemical analysis of materials : As per Annexure-B 2
b. Dynamic characteristics test* : As per Annexure-B 2
c. Vibration analysis : As per Annexure-B 2
d. Clamp slip test : As per Annexure-B 2
e. Fatigue tests : As per Annexure-B 2
f. Magnetic power loss test : As per Annexure-B 2
g. Damper efficiency test : As per IS:9708

3.27.8 Type tests specified under Clause 3.27.1 to 3.27.7 shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of thecountry where laboratory is located) or witnessed by the representative (s) Central/State Power Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with therequirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extracost to the Employer/ Employer/ Employer.

3.28 Acceptance Tests

3.28.1 On Both Suspension clamp and Tension Assembly

Visual Examination	: As per IS:2486-(Part-I)
Verification of dimensions	: As per IS:2486-(Part-I)
Galvanising/Electroplating test	: As per IS:2486-(Part-I) Mechanical
strength test of each component	: As per Annexure-B 2 Mechanical
strength test for arcing horn	: As per BS:3288(Part-I)
Test on locking device for ball and socket coupling	: As per IEC:372 (2) Mechanical
Strength test of welded joint	: As per Annexure-B 2 Chemical
analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings	: As per Annexure-B 2

3.28.2 On Suspension Clamp only

a.	Clamp Slip strength Vs Torque test for suspension clamp	: As per Annexure-B 2
b.	Shore hardness test of elastomer cushion for AG suspension clamp	: As per Annexure-B 2
c.	Bend test for armour rod set	: As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
d.	Resilience test for armour rod set	: As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
e.	Conductivity test for armour rods set	: As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11

3.28.3 On Tension Hardware Fittings only

a.	Slip strength test for dead end assembly	: As per IS:2486 (Part-I) Clause5.4
b.	Ageing test on filler (if applicable)	: As per Annexure-C 2

3.28.4 On Mid Span Compression Joint for Conductor

a.	Visual examination and dimensional verification	: As per IS:2121 (Part-II), Clause 6.2, 6.37 6.7
b.	Galvanizing test	: As per Annexure-B 2
c.	Hardness test	: As per Annexure-C 2
d.	Ageing test on filler (if applicable)	: As per Annexure-C 2

3.28.5 Repair Sleeve for Conductor

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

3.28.6 Vibration Damper for Conductor

a.	Visual examination and dimensional verification	: As per IS: 2121(Part-II) Clause 6.2, 6.3 7 6.7
	b. Galvanizing test	: As per Annexure-B 2
	i. On damper masses	: As per Annexure-B 2
	ii. On messenger cable	: As per Annexure-B 2

c. Verification of resonance frequencies : As per Annexure-C 2

d. Clamp slip test : As per Annexure-C 2

e. Clamp bolt torque test : As per Annexure-C 2

f. Strength of the messenger cable : As per Annexure-C 2

g. Mass pull off test : As per Annexure-C 2

h. Dynamic characteristics test* : As per Annexure-C 2

* Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 3.27), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.29 Routine Tests

3.29.1 For Hardware Fittings

a. Visual examination :IS 2486-(Part-I)

b. Proof Load Test : As per Annexure-B 2

3.29.2 For conductor accessories

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

3.29.3 Tests During Manufacture on all components as applicable

a. Chemical analysis of Zinc used for galvanizing : IS 2486-(Part-I)

b. Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings : As per Annexure-B 2

c. Chemical analysis, hardness tests and magnetic particle inspection for forging : As per Annexure-B 2

3.30 Testing Expenses

3.30.1 As indicated in clause 3.27 no type test charges shall be payable.

3.30.2 In case type testing is required due to non-availability of type test reports, or type test on the complete insulator string, the Contractor has to arrange similar insulators at his own cost.

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

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

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

3.30.6 The Contractor shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance of the scheduled date of testing during which the Owner will

arrange todepute his representative to be present at the time of carrying out the tests.

3.31 Schedule of Testing and Additional Tests

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

i. Submission of drawing for approval.

ii. Submission of Quality Assurance programme for approval.

iii. Offering of material for sample selection for type tests.

iv. Type testing.

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

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

3.32 Test Reports

3.32.1 Copies of type test report shall be furnished in at least six copies along with one original. One copy shall be returned, duly certified by the Owner, only after which the commercial production of the concerned materialshall start.

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

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

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

3.33 Inspection

3.33.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub- Contractor's works raw materials. manufacturers of all the material and for conducting necessary tests as detailed herein.

3.33.2 The material for final inspection shall be offered by the Contractor only under packed condition.
The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

3.33.3 The Contractor shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.

3.33.4 Material shall not be dispatched from its point of manufacture before it has been satisfactorily inspectedand tested unless the inspection is waived off by the Owner in writing. In the latter case also, the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

3.33.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility

formeeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such materials are later found to be defective.

3.34 Packing and Marking

3.34.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

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

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

3.34.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.

3.34.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture. However, in such type of component/item, which consists of many parts and are being supplied in assembled condition (suspension clamp, vibration damper, etc.), the complete assembly shall be legibly and indelibly marked on main body/on one of the parts.

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

3.35 Standards

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

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

Sl. No.	**Indian Standard**	**Title**	**International Standard**
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced for Extra High Voltage	IEC:1089-1991 BS:215-1970
3.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS : 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines:	
		Mid-span Joints and Repair Sleeves for Conductors	
5.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal	

		Voltage greater than 1000 V: General Requirements and Tests	
6.	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
7.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.		Ozone test on Elastomer	ASTM- D1 171
9.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
10.	IS:4826	Galvanised Coating on Round Steel Wires	ASTM A472-729 BS:443-1969
11.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO: 1460 (E)
12.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437, NEMA:107 CISPR
13.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
14.	IS:9708	Specification for Stock Bridge Vibration Dampers for Overhead Power lines	

ANNEXURE – B 1

Tests on Complete Insulator with Hardware Fittings

1.1 Mechanical Strength Test

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

1.2 Voltage Distribution test

The voltage across each insulator unit shall be measured by sphere gap method. The result obtain shall be converted into percentage. The voltage across any disc shall not exceed 9% for suspension insulator strings and 10% for tension insulator strings.

1.3 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 metres. In the case of suspension string a load equal to 600kg shall be

applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and four sub-conductors (each tensioned at 43kN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string(more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than 1000/f1.8 where f is the frequency of vibration in cycle/sec. The insulator string shall be vibrated for not less than 10million cycles without any failure. After the test the disc insulator shall be examined for looseness of pins and cop or any crack in the cement. The hardware shall be

examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration ofproperties of hardware components and composite long rod/disc insulators after the vibration test.

The composite long rod insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

The Disc insulators shall be subjected to the following tests as per relevant standards.

Sl.no.	**Test**	**Percentage of insulator unitsto be tested**
1	Temperature cycle test followed by mechanical performance test	60
2	Puncture test/steep wave front test (Only for glass insulators)	40

1.4 Mechanical Strength Test for Suspension/Tension Hardware Fittings

The complete string without insulators excluding arcing horn, corona control rings/grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the string component shall not show any visual deformation and it shall be possible to disassemble them byhand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.5 Magnetic Power Loss Test for Suspension Assembly

Two hollow aluminium tubes of 32 mm diameter for the conductor shall be placed 450 mm apart respectively. An alternating current over the range of 1000 to 1500 amperes shall be passed through each tube. The reading of the wattmeter with and without suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to 875 (132Kv) 1200 amperes shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

1.6 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS: 2486-(Part-1) except that both uniformity of zinc coating and standard preecee test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.7 Mechanical Strength Test of Each Component

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

1.8 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ ultrasonic test. There shall not be any crack at the welded portion.

1.9 Clamp Slip Strength Vs Torque Test for Suspension Clamp

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

1.10 Heating Cycle Test

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

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

1.11 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

1.12 Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly

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

1.13 Proof Load Test

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

1.14 Tests for Forging Casting and Fabricated Hardware

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as in the Quality Assurance programme.

1.15 Ozone Test for Elastomer

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

2.0 Tests on Accessories for Conductor

2.1 Mid Span Compression Joint for Conductor

a. Slip Strength Test

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

b. Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2121 (Part-II-1981) with following modifications: -

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

2.2 Vibration Damper for Conductor

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 ranging from 5 to 40 Hz for damper for conductor. The damper assembly shall be vibrated vertically with a + 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 without dampers.

Acceptance criteria for vibration damper.

i. The above dynamic characteristics test on five dampers shall be conducted. The above dynamic characteristics test on five dampers shall be conducted.
ii. The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
iii. The above mean reactance response curve should lie within 0.191 f to 0.762 f Kgf/mm limits where f is frequency in Hz.
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 are to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

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

i) The analysis shall be done for single conductor without armour rods as per the parameters given of this part of the Specification. The tension shall be taken from Sag & Tension calculation (o deg. C & no wind condition and350 m ruling span) for a span ranging from 50 m to 1100.

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

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

iv) Examine the 66aeolian vibration level of the conductor with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency andvibration energy input.

v) From vibrationanalysis of conductor withoutdamper, anti-nodevibrationamplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

vi) From vibration analysis of conductor with damper/dampers installed at the recommended location, the dynamic strain level, at the clamped span extremities, damper attachment point and the antinodes on the conductor shall be determined. In addition to above damper clamp vibration amplitude and anti-node vibration amplitudesshall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Clamp Slip and Fatigue Tests

i) Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 0 deg & no wind condition and ruling span 350 from sag –tension calculation and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. Thereshall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

ii) Clamp Slip test

The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer‘s specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

iii) Fatigue Test

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

influencing damper movement.

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

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

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

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

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

a. There shall not be any frequency shift by more than +2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.

b. The force response curve shall generally lie within guar anteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Contractor.

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

2.3 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than154 kV rms line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731- 1971.

2.4 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 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV rms line to ground under dry condition. The test procedure shall be in accordance with IS:8263.

2.5 Tests on All components (As applicable)

2.5.1 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%.

2.5.2 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 Employer in Quality Assurance Programme.

2.5.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat

number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

ANNEXURE – B 2

Tests on Complete Insulator with Hardware Fittings

1.1 Mechanical Strength Test

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

1.2 Voltage Distribution test

The voltage across each insulator unit shall be measured by sphere gap method. The result obtain shall be converted into percentage. The voltage across any disc shall not exceed 9% for suspension insulator strings and 10% for tension insulator strings.

1.3 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 metres. In the case of suspension string a load equal to 600kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and four sub- conductors (each tensioned at 43kN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub- conductor 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/f1.8 where f is the frequency of vibration in cycle/sec. The insulator string shall be vibrated for not less than 10million cycles without any failure. After the test the disc insulator shall be examined for looseness of pins and cop 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 composite long rod/disc insulators after the vibration test.

The composite long rod insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

The Disc insulators shall be subjected to the following tests as per relevant standards.

Sl.no.	**Test**	**Percentage of insulator unitsto be tested**
1	Temperature cycle test followed bymec	60
2	Puncture test/steep wave front test (Only for glass insulators)	40

1.4 Mechanical Strength Test for Suspension/Tension Hardware Fittings

The complete string without insulators excluding arcing horn, corona control rings/grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the string component shall not show any visual deformation and it shall be possible to disassemble them byhand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.5 Magnetic Power Loss Test for Suspension Assembly

One hollow aluminium tubes of 29mm diameter for the conductor shall be used for 132KV. An alternating current over the range of 300 amps to 700 shall be passed through the tube. The reading of the wattmeter with and without suspension assemblies alongwith 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 300 Amperes shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

1.6 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS: 2486-(Part-1) except that both uniformity of zinc coating and standard preecee test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.7 Mechanical Strength Test of Each Component

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

1.8 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-penetratration/ ultrasonic test. There shall not be any crack at the welded portion.

1.9 Clamp Slip Strength Vs Torque Test for Suspension Clamp

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

1.10 Heating Cycle Test

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

i. Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.

ii. Number of cycles: 100

iii. Slip strength test shall also be carried out after heating cycle test.

CEA Guidelines shall be referred.

1.11 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

1.12 Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly

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

1.13 Proof Load Test

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

1.14 Tests for Forging Casting and Fabricated Hardware

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as in the Quality Assurance programme.

1.15 Ozone Test for Elastomer

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

2.0 Tests on Accessories for Conductor

2.1 Mid Span Compression Joint for Conductor

a. Slip Strength Test

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

(a) Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2121 (Part-II-1981) with following modifications: -

i. Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.

ii. Number of cycles: 100

iii. Slip strength test shall also be carried out after heating cycle test.

CEA Guidelines shall be referred.

2.2 Vibration Damper for Conductor

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 ranging from 5 to 40 Hz for damper for conductor. The damper assembly shall be vibrated vertically with a + 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at ± 0.5mm to determine following characteristicswith 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 without dampers.

Acceptance criteria for vibration damper.

i. The above dynamic characteristics test on five dampers shall be conducted. The above dynamic characteristics test on five dampers shall be conducted.
ii. The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
iii. The above mean reactance response curve should lie within 0.191 f to 0.762f Kgf/mm limits where f is frequency in Hz.
iv. The above mean phase angle response curve shall be between 25^{o} to 130^{o} within thefrequency 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 are to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

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

i) The analysis shall be done for single conductor without armour rods as per the parameters given of this part of the Specification. The tension shall be taken from Sag & Tension calculation (o deg. C & no wind condition and 320 m ruling span) for a span ranging from 50 m to 1100.

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

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

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

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

vi) From vibration analysis of conductor with damper/dampers installed at the recommended location,

the dynamic strain level, at the clamped span extremities, damper attachment point and the antinodes on the conductor shall be determined. In addition to above damper clamp vibration amplitude and anti-node vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Clamp Slip and Fatigue Tests

i) Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 0 deg & no wind condition and ruling span 320 from sag –tension calculation and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

ii) Clamp Slip test

The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer‘s specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

iii) Fatigue Test

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

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

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

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

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

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

a. There shall not be any frequency shift by more than +2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.

b. The force response curve shall generally lie within guar anteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Contractor.

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

2.3 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 105 kV rms line to ground under dry condition. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731- 1971.

2.4 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 microvolts at one MHz when subjected to 50 Hz AC voltage of 154 kV rms line to ground under dry condition. The test procedure shall be in accordance with IS:8263.

2.5 Tests on All components (As applicable)

2.5.1 Chemical Analysis of Zinc used for Galvanizing

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

2.5.2 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 Employer in Quality Assurance Programme.

2.5.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally 74ecognized 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 Employer in Quality Assurance Programme.

ANNEXURE – C 1

Acceptance Tests

1. Mid Span Compression Joint for Conductor

a. Hardness Test

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

2. Vibration Damper for Conductor

a. Verification of Resonance Frequencies

The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of +/- 0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lowerthan 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

b. Clamp Slip Test

Same as Clause 2.2 I (ii) of Annexure-B.

c. Clamp Bolt Torque Test

The clamp shall be attached to a section of the conductor/earthwire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.2 I (i), Annexure-B.

d. Strength of the Messenger Cable

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor.

e. Mass Pull off Test

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

f. Dynamic Characteristics Test

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

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

The acceptance criteria will be as follows

i. The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of 5 Hz to 40 Hz.

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

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

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

b. Similar averaging shall be done for phase angle.

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

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

ANNEXURE – C 2

Acceptance Tests

1. Mid Span Compression Joint for Conductor

a. Hardness Test

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

2. Vibration Damper for Conductor

a. Verification of Resonance Frequencies

The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of +/-0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a

frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

b. Clamp Slip Test

Same as Clause 2.2 I (ii) of Annexure-B.

c. Clamp Bolt Torque Test

The clamp shall be attached to a section of the conductor/earthwire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.2 I (i), Annexure-B.

d. Strength of the Messenger Cable

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor.

e. Mass Pull off Test

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

f. Dynamic Characteristics Test

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

Vibration Damper of - 1 Sample for 1000 Nos. & below Conductor

- 2 Samples for lot above 1000 & up to 5000 nos
- Additional 1 sample for every additional 1500 technical specifications pieces above 5000.

The acceptance criteria will be as follows

i. The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of 5 Hz to 40 Hz.

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

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

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

b. Similar averaging shall be done for phase angle.

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

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

Section-4
Technical Specification of long rod porcelain Insulator Unit

4.1 Scope

4.1.1 This Section of the specification covers design, manufacture, testing, inspection, packing and dispatch of suspension and tension long rod porcelain/string insulator assemblies consists of ball and socket type porcelain disc insulator for a three phase, 50Hz, effectively earthed D/C 220 kV transmission lines to be restringing with HTLS conductor. Ball and socket type long rod porcelain/disc insulator and insulator string shall be suitable for HTLS conductor and to be supplied for satisfactory performance of complete conductor system for continuous operation at the designed maximum temperature specified by them for the conductor.

4.2 Long Rod Porcelain Insulator/ Strings Insulator

4.2.1 TYPE OF INSULATORS:

All suspension and tension long rod porcelain/tension strings insulators shall consist of centre ball and socket type porcelain insulators with all the exposed porcelain parts fully glazed.

4.2.2 DIMENSION AND STRENGTH OF THE INSULATORS:

The size of long rod porcelain/disc insulator, minimum creepage distance, number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware fittings shall be as follows:

a. For Long rod Insulators (For both Suspension and Tension)

Sl.no.	Type of string	Minimum creepage distance(mm)	Electromechanical strength of insulator disc(kN)	Mechanical strength of insulator string along withhardware fittings(kN)
1	Single Suspension	3625	90	90
2	Double Suspension	3625	90	180
3	Single tension	3625	120	120
4	Double tension	3625	120	240

4.3 General Technical Requirement

4.3.1 Materials used

A. Porcelain

The porcelain used in the manufacture of the insulators shall be of the best quality and shall be manufactured by the wet process. The porcelain used shall be non-porous of high dielectric, mechanical and thermal strength homogeneous, free from stress blisters, laminations, voids, foreign matter, flaws etc. and well finished making it impervious to moisture. The glaze shall be brown colour and shall cover all the porcelain parts of the insulator except these areas necessarily left unglazed for the purpose of assembly. The cement used in the construction of the insulators shall not cause fracture by expansion or loosening and shall not give rise to any chemical reaction with the metal fittings. Porcelain shall remain unaffected by climatic conditions, ozone, acid, alkalies, zinc or dust.

B. Cement

Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.

4.3.2 The design of the insulator Long Rods shall be such that all the stresses due to expansion or contraction in any part of the insulator under rapid temperature fluctuation, which may be created due to variation in the loads or fault of any nature, while in service shall not lead to any type of deterioration. Flat surface and
corners shall not be allowed and shall be completely rounded off.

4.3.3 Corona and radio interference voltage (riv) performance

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The metal parts and porcelain shall not produce any noise generating corona under all operating conditions

4.3.4 Security clip

Security clip shall be made of good quality stainless steel or phosphor bronze as per IEC 60372. 2.5% extra security clip shall be provided.

4.4 Ball and socket designation

The dimensions of the balls and socket shall be of following designation for different insulators in accordance with the standard dimensions stated in IS 2486-(Part-II)/IEC:120: -

Sl. No.	Rating of Insulators	Designation of Ball & socket as per IEC: 120
1	70KN	16 mm, AltB
2	90 KN	16 mm, AltB
3	120 KN	20 mm

4.5 Interchangeability

The Long Rod porcelain/ disc insulators string with ball and socket fittings shall be of standard design, suitable for use with hardware fittings of any make conforming to relevant Indian/International Standard

4.6 Maintenance

a) The Long Rod porcelain/disc insulators offered shall be suitable for employment of hot line maintenancetechnique so that usual hot line operations can be carried out with ease, speed and safety.

b) Bidders shall indicate the methods generally used in the routine hot and dead line maintenance of EHV lines for which similar disc insulators have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.

4.7 Bid Drawings

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

4.7.2 The Bidder shall furnish along with the bid the outline drawing of each insulator unit including a crosssectional view of the insulator shell. The drawing shall include but not limited to the following information:

a) Major Dimensions with manufacturing tolerancesNumber of sheds

b) Minimum Creepage distance with positive tolerance

c) Protected creepage distance

d) Unit mechanical and electrical characteristics

e) Size and weight of ball and socket parts

f) Weight of unit insulator disc

h) Materials

4.7.3 After placement of award, the Supplier shall submit full dimensioned insulator drawings containing all the details as given in Clause No. 4.7.2 above, in four (4) copies to Purchaser for approval. After getting approval from Purchaser, the Supplier shall submit 10 more copies of the same drawing along with a soft copy to the Purchaser for further distribution and field use at Purchaser's end.

4.7.4 After placement of award the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators.

4.8 TEST AND STANDARDS

Type Tests

The required type tests on individual standard Long Rod porcelain/disc insulators, components, materials or complete strings are stipulated hereunder.

The specified type tests under the following clause shall not be required to be carried out if a valid test certificate is available for a similar design. The tests certificate shall be considered valid if:

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

(ii) Tests have been conducted not prior to 5 (five) years from the date of bid opening.

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

4.8.1 A. **Type test On unit Long Rod Porcelain Insulator (120kN)**

a) Verification of dimensions test — As per IEC:60383

b) Thermal mechanical performance test — As per IEC:60383

c) Power frequency voltage withstand and flashover test under i) Dry — As per IEC:60383

ii) Wet condition

d) Impulse voltage withstand and flashover test — As per IEC:60383 (dry)

e) Visible Discharge test(dry) — As per IS:731, cl. 10.2

f) RIV test(dry) — As per IEC:60437

g) Residual strength test — As per IEC:797

h) Steep wave front test — As per Annexure D

i) Impact test — ANSI-C29.2 clause 8.2.8

B. On the complete Insulator String/ Long Rod Porcelain Insulator with Hardware Fittings:

Sl. No.	Tests	Ref	Strings on which test to be conducted*.
a)	Power frequency / DC voltage withstand test with arcing horns & corona control rings under wet condition	IEC: 60383-1993/ IEC:60-1	All strings
b)	Corona & RIV test under dry condition	IEC: 60383	All strings
c)	Switching surge voltage withstand test under wet condition	IEC:60383-1993	All strings
d)	Impulse voltage withstand test under dry condition	IEC:60383-1993	All strings
e)	Impulse voltage flash over test under dry condition	IEC:60383-1993	All strings
f)	Voltage distribution test	As per Annex-D	
g)	Mechanical Strength test	As per Annex-D	
h)	Vibration test	As per Annex-D	
h)	Salt –Fog pollution withstand test	As per Annex-D	

4.8.2 Acceptance tests

4.8.2 For Long Rod Porcelain Insulator

a) Visual examination :As per IEC 60383
b) Verification of dimension :As per IEC 60383
c) Temperature cycle test :As per IEC 60383
d) Galvanising test :As per IEC 60383
e) Mechanical performance test :As per IEC 60575 cl 4.0
f) Test on locking device for ball and socket coupling :As per IEC 60372
g) Eccentricity test: : As per IEC 60383
h) Residual strength test :As per IEC 797 cl 4.4$ 4.5
i) Electro-mechanical strength test :As per annexure
j) Porosity test :As per IEC 60383
k) Puncture test :As per IEC 60383

4.8.3 Routine tests For Disc Insulators/ Long Rod Porcelain Insulator

a) Visual inspection :As per IS 731
b) Mechanical routine test :As per IS 731
c) Electrical routine test :As per IS 731

4.8.4 Test During Manufacture

1	Chemical analysis of Zinc usedfor Galvanising	As per relevant IS with latest Amendment
2	Chemical Analysis of Porcelain	-Do-
3	Chemical Analysis of steel used	-Do_

4.8.5 Type tests specified under Clause 4.8.1 to 4.8.3 shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) Central/State Power Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with therequirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extracost to the Employer/ Employer/ Employer.

4.9 Additional Tests

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

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

4.10 Guarantee

The Supplier of insulators shall guarantee overall satisfactory performance of the insulators and insulator strings.

4.11 Test Reports

Copies of type test reports shall be furnished in at least six (6) copies along with one original. One copy shall be returned duly certified by the Purchaser only after which the commercial production of the concerned material shall start.

Copies of acceptance test reports shall be furnished in at least six (6) copies. One copy shall be returned duly certified by the Purchaser, only after which the material shall bedispatched.

Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser‘s representative.

Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Purchaser.

4.12. Inspection

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

The material for final inspection shall be offered by the Supplier only under packed condition as detailed in clause

No. 4.12 of the specification. The Purchaser shall select samples at random from the packed lot for carrying out acceptance tests. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

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

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

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

4.13 Packing and Marking

All insulators shall be packed in suitable PVC/ plastic tubes of at least 3 mm thickness or water-resistant packing material and the packaging shall not break during storage & transportation even in overhang condition during transportation. Further, last 20% quantity of insulators shall be packed in PVC/ plastic tubes only to ensure long storage of about 5 years. The packing shall provide protection against rodent. The Supplier shall furnish detailed design of the packing. For marine transportation, crates shall be palleted.

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

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

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

The Supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation, handling, storage and installation due to improper packing.

4.14 Standards

The insulator strings and its components shall conform to the following Indian / International Standards which shall mean latest revision, with amendments /changes adopted and published, unless specifically stated otherwise in the Specification.

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

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

3.	IS:731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS:137- (I&II) IEC:60383
4.	IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS:2486 Part- I- 1993 Part- II- 1989 Part- III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	BS:3288 IEC:60120 IEC:60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	
9		Characteristics of string insulator units of the long rod type	IEC Publication 433-1969 ISO:1460-1973
10	IS: 2486(partIV)	Mechanical Performance test	IEC: 575

The standards mentioned above are available from:

Reference Abbreviation	**Name and Address**
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND, UK
IEC/CISPR	International Electro technical Commission,Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Beureau Of Indian Standards.ManakBhavan, 9, Bahadur Shah ZafarMarg, New Delhi - 110001.INDIA
ISO	International Organisation for Standardization. Danish Board ofStandardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK

NEMA	National Electric Manufacture Association,155, East 44th Street. New York, NY 10017U.S.A.
ASTM	American Society for Testing and Materials, 1916 Race St. Philadelphia, PA19103 USA

ANNEXURE - D

Tests on Complete Strings with Hardware Fittings

1.1 Mechanical Strength Test

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

1.2 Electro-mechanical failing load test as per IS:731 on string insulator unit.

1.3 Voltage Distribution test

The voltage across each insulator unit shall be measured by sphere gap method. The result obtain shall be converted into percentage. The voltage across any disc shall not exceed 9% for suspension insulator strings and 10% for tension insulator strings.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meter. 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 specified no. of sub-conductors each tensioned at 25 % of UTS of the conductor shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than 1000/f 1.8 where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the 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 insulators after the vibration test. The insulators shall be subjected to the following test for a tension of 25 KN (132kV line) as per relevant standards:

1.5 Power-Arc Test

This test shall be performed on the complete string in accordance with IEC Technical Report IEC:61467-1997 with the following test series:

Test Circuit	Short circuit current	Number and duration of test

B	$I_n=I_{sys}=35KA$	Two of $t_n=0.2s$ and one of $t_n=0.5s$

The acceptance criteria after the completion of test series shall be following.

a. Insulation separation not permitted

b. Burning/melting of metal components, breakage of insulator sheds, glaze removal is permitted.

c. The compete insulator string along with its hardware fitting excluding arching horn, corona control ring/grading ring shall withstand 80% of UTS.

1.6 AC Salt-fog pollution withstand test

This test shall be carried out in accordance with IEC: 60507. The salinity level for composite long rod insulators shall be 160Kg/m3 NACL.

1.7 DC pollution withstand test

This test shall be carried out as per IEC-61245 with solid layer method. The D.C. pollution withstand voltage (negative) shall be 500kV for +/-500kV HVDC insulators as applicable at average ESDD of 0.1 mg / sq. cm.

2 On disc Insulator Unit

2.1 Steep wave front Test

Following test shall be performed on 10 insulator units in case of disc insulators selected at random from the lot offered for selection of sample for type test.

a. Each insulator unit shall be subjected to five successive positive and negative impulse flashovers with a wave having minimum effective rate of rise of 2500kV per microsecond.

b. Each unit shall then be subjected to three dry power frequency voltage flashovers.

Acceptance criteria--

An insulator shall be deemed to have met the requirement of this test if, having been successfully subjected to the ten impulse flashovers, the arithmetic mean of the three subsequent dry/power frequency voltage flashover values equals or exceeds 95% of the rated dry power frequency flashover voltage.

An insulator shall be deemed to have failed to meet the requirement of above testing if,

a. It has not flashover when the oscillogram or peak voltage indicator shows a marked reduction in voltage.

Or

b. Any one of the subsequent three dry power frequency voltage flashover value is less than 80% of the value specified.

Failure of any one unit either in the steep wave front or subsequent low frequency voltage test shall cause for testing on double number of units.

3 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

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

3.2 Tests for Forgings

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

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

3.4 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.

SECTION – 5
TECHNICAL SPECIFICATIONS FOR HOTLINE RESTRINGING ACTIVITIES OFHTLS CONDUCTOR

General

The scope of erection work shall include installation of necessary hardware, hoisting of insulator strings, installing & stringing of HTLS Conductor including fixing of conductor accessories, the cost of all labour, tools and plant and all other incidental expenses in stringing work. The contractor shall have to string with the equivalent HTLS Conductor section wise and restore the line in original conditions as per program finalized in co-ordination with site. Stringing of the line shall be carried out under induced voltage condition i.e. one circuit under charged condition. Adequate safety measures and precautions shall be taken by the Contractor during this erection work.

5.1 Site Inspection

5.1.1 Site Inspection Report

The contractor shall visit the site to inspect the transmission line and collect observations/information which would be useful for stringing activity & bidding. Complete BOQ of each transmission line for reconductoring shall be furnished in the report & is to be got approved.

5.1.2 All observations/ information which the Contractor thinks would be useful to implement the re-conductoring of the existing transmission line mentioned under scope of work are to be reported & timely.

5.1.3 The detailed procedure for carrying out the reconductoring shall be submitted to the site Engineer- in-charge before taking up the work

5.1.4 Suggestions regarding location for setting up stores during line construction in consultation with Employerrepresentative shall also be provided by the contractor.

5.1.5 Working months available during various seasons along the transmission line, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of wayleave problems and compensation payable shall be stated by the Contractor.

5.1.6 Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Electricity Boards and Zonal railways, Divisional Forest Authorities etc.

5.1.7 All the requisite data for processing the case of statutory clearances such as Forest and Railway shall be provided along with the report.

Six copies of survey reports shall be furnished by the contractor to the Employer.

5.2 Environmental Conditions

5.2.1 Forest

The line route passing through forest stretches if any shall be indicated to the successful Bidder.

5.2.2 General Climatic Conditions

Climatic conditions shall be of tropical nature having summer period for 8 months and winter period for 4 months in a year. Working season shall be approximately 9 months/year and balance 3 months shall be monsoon period.

The maximum temperature during summer shall be of the order of 42°C and the minimum temperature inthe winter shall be of the order of 0°C. Normal everyday temperature is 32°C.

5.2.3 Statutory Regulations and Standards

5.2.3.1 Statutory Regulations

The Contractor is required to follow local statutory regulations stipulated in Electricity (Supply) Act 1948, Indian Electricity Rules, 1956 as amended and other local rules and regulations referred in this Specification.

5.2.3.2 Reference Standards

The Codes and/or standards referred to in the specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions, amendments/changes adopted and published by the relevant agencies.

Other internationally accepted standards which ensure equal or better performance than those specified shall also be accepted, subject to prior approval by the Employer.

5.3 Span and clearances

5.3.1 Normal Span

The normal ruling span of the line on panther conductor is 350 m.

5.3.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

5.3.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower.

5.4 Electrical Clearances

5.5.1. Ground Clearance

The minimum ground clearance from the bottom conductor is not to be less than 6100mm for 132kV and 7000 mm for 220KV line, at the maximum sag conditions corresponding to maximum continuous operating temperature and still air.

5.5 Maximum Tension

5.5.1 Maximum tension shall be based on either

a. at 0^0 C with 36% of full wind pressure, or

b. at 32^0 C with full wind pressure whichever is more stringent.

5.5.2 Limiting Tensions of conductor

The ultimate tension of conductor shall not exceed 70% of the ultimate tensile strength

5.6 Stringing of Conductor and Installation of Line Materials

5.6.1 The Contractor shall be responsible for transportation to site of all the materials to be provided by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the Employer. Similarly, the Contractor shall be responsible for proper storage, safe custody, andloss or damage of all Employer's supplied items, if any, as well as its transportation to site for incorporation in the lines and shall maintain and render proper account of all such materials at all times.

5.6.2 The Contractor shall reimburse the cost of any of the materials lost or damaged during storage and erection beyond the limits permitted under this specification.

5.6.3 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Employer.

5.6.4 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/suspension towers.

5.6.5 The complete work including installation of line materials (insulator strings, hardware and accessories for conductor) shall be supervised by a team of supplier/Contractor's engineers / supervisory staff/ workmen already experienced in stringing work associated with the type of HTLS Conductor being supplied. The contractor shall furnish experience details of the engineers /supervisory staff proposed to be deployed along with the bid document.

5.7 Handling of Conductor

5.7.1 Running Out of the Conductors

The conductors shall be run out of the drums form the top in order to avoid damage. The Contractor shall be entirely responsible for any damage to tower or conductors during stringing.

5.7.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.

5.7.3 The sequence of running out shall be from the top down. Unbalanced loads on towers shall be

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avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outerphases is taken up.

5.7.4 As tower is not designed for one sided stringing, tower shall be well guyed and step taken by contractor to avoid damage. Guying proposal along with necessary calculation shall be submitted by the contractor to Employer for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

5.7.5 The Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors during stringing operations. These precautions include measures taking into account the other circuit on the line under live conditions.

5.7.6 The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms/energized lines.

5.8 Running Blocks

5.8.1 The groove of the running blocks shall be of such a design that the seat is semicircular and larger than the diameter of the conductor and it does not slip over or rub against the slides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

5.8.2 The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

5.9 Repairs to Conductors

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

5.9.2 Repairs to conductor where no more than two strands in the outermost layer are broken shall be carried out with repair sleeve with approval of Engineer-Incharge.

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

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

5.10 Crossings

Derricks or other equivalent methods ensuring that normal services need not be interrupted nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines have to be crossed. In case of railway crossings, shutdown might not be available and therefore, contractor shall be required to carry out re-conductoring under such condition i.e.without any shutdown of railways. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor and accessories in the field.

5.11 Stringing of HTLS Conductor

The stringing of the equivalent HTLS conductor shall be done by the standard stringing method suitable for the type of HTLS Conductor offered.

5.12 Supervision in Stringing

5.12.1 The installation & hotline restringing of the offered HTLS conductor for the above 132 & 220 kV transmission line shall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier or Qualified Bidder itself. Bidder‘s responsibility is to provide Sag- Tension chart based on existing site conditions. It may be noted that AEGCL will not consider any modifications (tower extensions etc) on existing tower/span.

5.12.2 The circuit on which the existing ASCR conductor is strung shall be kept under charged condition during the execution. The installation & stringing of the offered HTLS conductor for the above transmission line shall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier or Qualified Bidder is self shall string the circuit with the HTLS conductor section by section and restore the line in original conditions as per program finalized in co-ordination with site. The bidder‘s engineers are to supervise whether appropriate safety measures along with necessary safety tools and equipment‘s to carry out stringing operations under the aboveconditions including mechanical/ structural safety of the towers, are maintained or not.

5.12.3 The Contractor shall deploy appropriate tools/ equipments/ machinery to ensure that the stringing operation is carried out without causing damage too conductor and the conductor is installed at the prescribed sag tension as per the approved stringing chart. Prior to taking up stringing work the contractor shall submit for approval ofSite-In charge the complete details of stringing methods he proposes to follow.

5.12.4 If any special tools and tackles other than those generally used for stringing of ASCR conductors are deployed for stringing of HTLS Conductor by the contractor, a set of those tools & tackles shall be supplied by the contractor to the Employer, on completion of the project, at no extra cost. The quantity of such tools & tackles shall be sufficient to carry out stringing operations of the longest section (from angle tower to angle tower) of the existing transmission line.

5.12.5 The contractor shall submit, for approval of site in-charge, the complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the conductor showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines for the approval of the Employer.

5.12.6 Conductor creep is to be compensated by over tensioning the conductor at an appropriate temperature lower than the ambient temperature based on creep calculations to be furnished by the Contractor.

5.13 Jointing

5.13.1 When approaching the end of a drum length at least three coils shall be left in place when the stringingoperations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the approved drawing and procedures recommended by the manufacturer of joints.

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

5.13.3 All the joints on the conductor shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc., and be properly greased with anti- corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors. For HTLS Conductor suitable sleeve, collets, collet housing shall be used for jointing of core as per the offered design and methodology applicable for similar type of design/application.

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

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

5.14 Tensioning and Sagging Operations

5.14.1 The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables.

The —initial‖ stringing chart shall be used for the conductor. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps.

5.14.2 Dynamometer shall be employed for measuring tension in the conductor. Dynamometers employed shall be periodically checked and calibrated with the standard Dynamometer.

5.14.3 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

5.14.4 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

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

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

5.15 Clipping In

5.15.1 Clipping of the conductors into position shall be done in accordance with the manufacturer‘s recommendations.

5.15.2 Jumpers at section and angle towers shall be formed to parabolic shape as per existing tower line diagrams to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if foundnecessary, to restrict jumper swing to design values.

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

5.16 Fixing of Conductors Accessories

Conductor accessories including vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer‘s instruction within 24 hours of the conductor clamping. While installing the conductor accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Vibration Dampers, Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied.

5.17 Final checking, Testing and Commissioning

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

5.17.1 The stringing of the conductors has been done as per the approved sag and tension charts and desired

clearances are clearly available;

5.17.2 All conductor accessories are properly installed;

5.17.3 The original tracings of profile are submitted to the Employer for reference and record.

5.17.4 The insulation of the line as a whole is tested by the Supplier through provision of his ownequipment, labour etc., to the satisfaction of the Employer.

5.17.5 The line is tested satisfactorily for commissioning purpose.

5.17.6 Any defect found as a result of testing shall be rectified by the contractor forthwith to the satisfaction of the Employer without any extra charges.

The contractor should also fulfill the requirements of pre commissioning.

5.17.7 In addition to the above, the contractor shall arrange for testing of the total and relative sags of the conductors and shall be responsible to maintain the values within specified tolerances.

5.17.8 The contractor shall make all arrangements for such tests and the contractor shall providenecessary labour, transport and equipment.

5.17.9 After satisfactory tests on the line and on approval by the Employer the line shall be energised at full operating voltage before handing over.

SECTION – 6

TECHNICAL SPECIFICATIONS FOR RESTRINGING ACTIVITIES OF HTLS CONDUCTOR

6.1 General

The scope of erection work shall include installation of necessary hardware, hoisting of insulator strings, installing & stringing of HTLS Conductor including fixing of conductor accessories, the cost of all labour, tools and plant and all other incidental expenses in stringing work. The contractor shall have to string with the equivalent HTLS Conductor section wise and restore the line in original conditions as per program finalized in co-ordination with site. Stringing of the line shall be carried out under induced voltage condition i.e. one circuit under charged condition. Adequate safety measures and precautions shall be taken by the Contractor during this erection work.

6.2 Site Inspection

6.2.1 Site Inspection Report

The contractor shall visit the site to inspect the transmission line and collect observations/information which would be useful for stringing activity & bidding. Complete BOQ of each transmission line for reconductoring shall be furnished in the report & is to be got approved.

6.2.2 All observations/ information which the Contractor thinks would be useful to implement the reconductoring of the existing transmission line mentioned under scope of work are to be reported & timely.

6.2.3 The detailed procedure for carrying out the reconductoring shall be submitted to the site Engineer- in-charge before taking up the work

6.2.4 Suggestions regarding location for setting up stores during line construction in consultation with Employer representative shall also be provided by the contractor.

6.2.5 Working months available during various seasons along the transmission line, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of wayleave problems and compensation payable shall be stated by the Contractor.

6.2.6 Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Electricity Boards and Zonal railways, Divisional Forest Authorities etc.

6.2.7 All the requisite data for processing the case of statutory clearances such as Forest and Railway shall be provided along with the report.

Six copies of survey reports shall be furnished by the contractor to the Employer.

6.3 Environmental Conditions

6.3.1 Forest

The line route passing through forest stretches if any shall be indicated to the successful Bidder.

6.3.2 General Climatic Conditions

Climatic conditions shall be of tropical nature having summer period for 8 months and winter period for 4 months in a year. Working season shall be approximately 9 months/year and balance 3 months shall be monsoon period.

The maximum temperature during summer shall be of the order of 45°C and the minimum temperature inthe winter shall be of the order of 0°C. Normal everyday temperature is 32°C.

6.3.3 Statutory Regulations and Standards

6.3.3.1 Statutory Regulations

The Contractor is required to follow local statutory regulations stipulated in Electricity (Supply) Act 1948, Indian Electricity Rules, 1956 as amended and other local rules and regulations referred in this Specification.

6.3.3.2 Reference Standards

The Codes and/or standards referred to in the specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions, amendments/changes adopted and published by the relevant agencies.

Other internationally accepted standards which ensure equal or better performance than those specified shall also be accepted, subject to prior approval by the Employer.

6.4 Span and clearances

6.4.1 Normal Span

The normal ruling span of the line on panther conductor is 320 m.

6.4.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

6.4.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower.

6.5 Electrical Clearances

6.5.1. Ground Clearance

The minimum ground clearance from the bottom conductor is not to be less than 6100 mm for 132KV line, at the maximum sag conditions corresponding to maximum continuous operating temperature and still air.

6.6 Maximum Tension

6.6.1 Maximum tension shall be based on either

a. at 0^0 C with 36% of full wind pressure, or

b. at 32^0 C with full wind pressure whichever is more stringent.

6.6.2 Limiting Tensions of conductor

Conductor tension at everyday temperature and without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:

Initial unloaded tension: 35% Final

unloaded tension: 25%

Provided that the ultimate tension under everyday temperature and 100% design wind pressure or minimumtemperature and 36% design wind pressure does not exceed 70% of the ultimate tensile strength of conductor. The ultimate tension of conductor shall not exceed 70% of the ultimate tensile strength

6.7 Stringing of Conductor and Installation of Line Materials

6.7.1 The stringing of the HTLS conductors shall be done in a most standard method used for such lines, which shall be indicated in the tender. The Contractor shall give complete details of the stringing method they propose to follow and indicate its adaptability and advantages. They shall also indicate the tools and equipment required for stringing by the method proposed by them. The contractor shall use his own stringing and erection tools and other equipment.

6.7.2 The contractor shall be entirely responsible for any damage to the towers or the conductors during stringing.

6.7.3 The Contractor shall be responsible for transportation to site of all the materials to be provided by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the Employer. Similarly, the Contractor shall be responsible for proper storage, safe custody, andloss or damage of all Employer's supplied items, if any, as well as its transportation to site for incorporation in the lines and shall maintain and render proper account of all such materials at all times.

6.7.4 The Contractor shall reimburse the cost of any of the materials lost or damaged during storage and erection beyond the limits permitted under this specification.

6.7.5 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Employer.

6.7.6 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/suspension towers.

6.7.7 The complete work including installation of line materials (insulator strings, hardware and accessories for conductor) shall be supervised by a team of supplier/Contractor's engineers / supervisory staff/ workmen already experienced in stringing work associated with the type of HTLS Conductor being supplied. The contractor shall furnish experience details of the engineers /supervisory staff proposed to be deployed along with the bid document.

6.8 Handling of Conductor

6.8.1 Running Out of the Conductors

The conductors shall be run out of the drums form the top in order to avoid damage. The Contractor shall be entirely responsible for any damage to tower or conductors during stringing.

6.8.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.

6.8.3 The sequence of running out shall be from the top down. Unbalanced loads on towers shall be avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outer phases is taken up.

6.8.4 As tower is not designed for one sided stringing, tower shall be well guyed and step taken by contractor to avoid damage. Guying proposal along with necessary calculation shall be submitted by the contractor to Employer

for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

6.8.6 The Contractor shall take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms/energized lines.

6.9 Running Blocks

6.9.1 The groove of the running blocks shall be of such a design that the seat is semicircular and larger than the diameter of the conductor and it does not slip over or rub against the slides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

6.9.2 The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work andunder the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

6.10 Repairs to Conductors

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

6.10.2 Repairs to conductor where no more than two strands in the outermost layer are broken shall be carriedout with repair sleeve with approval of Engineer-Incharge.

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

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

6.11 Crossings

Derricks or other equivalent methods ensuring that normal services need not be interrupted nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines have to be crossed. In case of railway crossings, shutdown might not be available and therefore, contractor shall be required to carry out reconductoring under such condition i.e. without any shutdown of railways. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor and accessories in the field.

6.12 Stringing of HTLS Conductor

The stringing of the equivalent HTLS conductor shall be done by the standard stringing method suitable for the type of HTLS Conductor offered.

6.13 Supervision in Stringing

6.13.1 The installation and restringing of the offered HTLS conductor for the above 132kV transmission line shall be carried out by the transmission line contractor under supervision of the HTLS conductor supplier or Qualified Bidder itself. The bidder‘s engineers are to supervise whether appropriate safety measures along with necessary safety tools and equipment‘s to carry out stringing operations under the above conditions including mechanical/ structural safety of the towers, are maintained or not. Bidder‘s responsibility is to provide Sag-Tension chart based on existing site conditions. It may be noted that AEGCL will not consider any modifications (tower extensions etc)

on existing tower/span.

6.13.2 The Contractor shall deploy appropriate tools/ equipment/ machinery to ensure that the stringing operation is carried out without causing damage to conductor and the conductor is installed at the prescribed sag tension as per the approved stringing chart. Prior to taking up stringing work the contractor shall submit for approval of Site- In charge the complete details of stringing methods he proposes to follow.

6.13.3 If any special tools and tackles other than those generally used for stringing of ACSR conductors are deployed for stringing of HTLS Conductor by the contractor, a set of those tools & tackles shall be supplied by the contractor to the Employer, on completion of the project, at no extra cost. The quantity of such tools & tackles shall be sufficient to carry out stringing operations of the longest section (from angle tower to angle tower) of the existing transmission line.

6.13.5 The contractor shall submit, for approval of site in-charge, the complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the conductor showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines forthe approval of the Employer.

6.13.6 Conductor creep is to be compensated by over tensioning the conductor at an appropriate temperaturelower than the ambient temperature based on creep calculations to be furnished by the Contractor.

6.14 Jointing

6.14.1 When approaching the end of a drum length at least three coils shall be left in place when the stringingoperations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the approved drawing and procedures recommended by the manufacturer of joints.

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

6.14.3 All the joints on the conductor shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc., and be properly greased with anti- corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors. For HTLS Conductor suitable sleeve, collets, collet housing shall be used for jointing of core as per the offered design and methodology applicable for similar type of design/application.

6.14.4 All the joints of splices shall be made at least 30 meters away from the tower structures. No joints or splices shall be made in spans crossing over main roads, railways and small river tension spans. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self-centering type orcare shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression

or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

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

6.15 Tensioning and Sagging Operations

6.15.1 The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables. The ―initial‖ stringing chart shall be used for the conductor. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps.

6.15.2 Dynamometer shall be employed for measuring tension in the conductor. Dynamometers employed shall be periodically checked and calibrated with the standard Dynamometer.

6.15.3 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

6.15.4 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

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

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

6.16 Clipping In

6.16.1 Clipping of the conductors into position shall be done in accordance with the manufacturer‘s recommendations.

6.16.2 Jumpers at section and angle towers shall be formed to parabolic shape as per existing tower line diagrams to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if foundnecessary, to restrict jumper swing to design values.

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

6.17 Fixing of Conductors Accessories

Conductor accessories including vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer‘s instruction within 24 hours of the conductor clamping. While installing the conductor accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no

damage occurs to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Vibration Dampers, Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied.

6.18 Final checking, Testing and Commissioning

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

6.18.1 The stringing of the conductors has been done as per the approved sag and tension charts and desired clearances are clearly available;

6.18.2 All conductor accessories are properly installed;

6.18.3 The original tracings of profile are submitted to the Employer for reference and record.

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

6.18.5 The line is tested satisfactorily for commissioning purpose.

6.18.6 Any defect found as a result of testing shall be rectified by the contractor forthwith to the satisfaction of the Employer without any extra charges.

6.18.7 The contractor should also fulfill the requirements of pre commissioning.

6.18.8 In addition to the above, the contractor shall arrange for testing of the total and relative sags of the conductors and shall be responsible to maintain the values within specified tolerances.

6.18.9 The contractor shall make all arrangements for such tests and the contractor shall provide necessary labour, transport and equipment.

6.18.10 After satisfactory tests on the line and on approval by the Employer the line shall beenergised at full operating voltage before handing over.

Technical Data Sheets
(To be filled up by each Manufacturer)

Contents

SCHEDULE -1

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

(Technical Data Sheet needs to be furnished separately by the Bidder for each of the projects)

Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
1.	Name & address of Manufacturer		
2.	Construction of conductor/ Designation of conductor as per IEC:1089		
3.1	**PARTICULARS OF RAW MATERIALS**		
3.1	Outer Layers a) Applicable Standard (if any) b) Type of Aluminum alloy c) Minimum purity of aluminum d) Maximum Copper content e) Zirconium conte nt i) Maximum ii) Minimum e) Other elements---------- i) ----- ii) -----	 % % % % % %	
3.2	Inner core a) Applicable Standard(if any) b) Material of..... core c) Chemical composition of core i) ----- ii) -----	 % %	
4.	OUTER STRANDS AFTER STRANDING		
4.1	Number of outer layers	Nos.	
4.2	Number of strands a) 1st Layer from core b) 2nd Layer from core c) 3rd Layer from core	 Nos. Nos. Nos.	
4.2	Diameter of strands a) Nominal b) Maximum c) Minimum	 mm mm mm	
4.3	Minimum Breaking load of strand a) Before stranding b) After stranding	 kN kN	

4.4	Resistance of 1m length of strand at 20 deg. C	Ohm		
4.5	Final Modulus of elasticity	Kg/sq. mm		
4.6	Final Coefficient of linear expansion	Per °C		
5	INNER CORE			
5.1	Diameter a) Nominal b) Maximum c) Minimum	 mm mm mm		
5.2	Minimum Breaking load of strand/Core a) Before stranding b) After stranding	 kN kN		
5.3	Resistance of 1m length of strand at 20 deg. C	Ohm		
5.4	Final Modulus of elasticity	Kg/sq. mm		
5.5	Final coefficient of linear expansion	Per ^{0} C		
5.6	Carbon-fibre composite core/other core as per CEA			
5.7	Minimum elongation of core which the core will achieve during elongation test	%		
6	FILLER (if applicable)			
6.1	Type & Designation of Filler			
6.2	Chemical composition of Filler			
6.3	Mass of Filler	Kg/km		
7	**COMPLETE HTLS CONDUCTOR**			
7.1	Cross section drawing of the offered conductor enclosed	Yes/No		
7.2	Diameter of conductor a) Nominal b) Maximum c) Minimum	 mm mm mm		
7.3	UTS (minimum) of Conductor	kN		
7.4	Lay ratio of conductor a) 1st layer from center (excluding central wire) b) 2nd Layer c) 3rd Layer d)4th Layer		Maximum 	Minimum
7.5	Minimum Corona Extinction Voltage (line to ground) under Dry condition	kV(rms)		
7.6	RIV at 1MHz and 154 kV (rms) under dry conditions	Micro- volts		
7.7	DC resistance of conductor at 20^{0}C	Ohm/km		
7.8	Final Modulus of elasticity			

	a) Upto transition temperature	Kg/sq.mm	

	b) Above transition temperature	Kg/sq. mm	
7.9	Coefficient of linear expansion		
	a) Upto transition temperature	Per deg C	
	b) Above transition temperature	Per deg C	
7.10	Calculation for transition temperature enclosed	Yes/No	
7.11	Transition temperature (corresponding to 350m ruling span and tension at ruling condition)	Deg C	
7.12	Maximum permissible conductor temperature for continuous operation	Deg C	
7.13	Maximum permissible conductor temperature for short term operation	Deg C	
7.14	Permissible duration of above short term operation	Minutes	
7.15	Steady state conductor temperature at conductor current of 1200A and under Ambient conditions detailed in Section-1		
7.16	AC resistance at maximum continuous operating temperature corresponding to specified maximum operating current (1200 A under ambient condition enclosed as per relevant clause under Section-1)	Ohm/km	
7.17	AC resistance at continuous operating temperature corresponding to specified operating current of [**Value of Normal Current in the conductor**] (under ambient condition enclosed as per relevant Clause of Section-1 of Bid document)	Ohm/km	
7.18	Details of Creep characteristic for HTLS conductor enclosed (as per Clause 1.5.5 of Section-3 of the bid document)	Yes/No	
7.19	Sag Tension Calculation		
7.19.1	Sag Tension Calculation enclosed (as per Clause 1.5.5 of Section-1 of the bid document)	Yes/No	
7.19.2	Tension at 32 deg. C & no wind	Kg	
7.19.3	Sag & tension at maximum continuous operating temperature (corresponding to current of 1200 A and Ambient conditions detailed in Clause 1.5.5 of Section-3 of the bid document.	Meters & Kgs	

i)	Tension at 32 deg. C & full wind for following wind pressure:		
a.	Wind Pressure: 50 kg/m2	kg	
ii)	Tension at 0 deg. C ,2/3 wind pressure: 34.7 kg/m2	kg	
7.17.4	Tension at transition temperature	kg	
7.18	Direction of lay for outside layer		
7.19	Linear mass of the Conductor a) Standard b) Minimum c) Maximum	 Kg/km Kg/km Kg/km	
7.20	Standard length of conductor	M	
7.21	Maximum length of conductor that can be offered as single length	M	
7.22	Tolerance on standard length of conductor	%	
7.23	Drum is as per specification	Yes/No	
7.24	No. of cold pressure butt welding equipment available at works	Nos.	

Date:
Place:

(Signature)……
(Printed Name) ……
(Designation)……
(Common Seal) ……

SCHEDULE -2

Bidder's Name.....

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name & address of Manufacturer		.....
2.	Address of Manufacturer		.....
3.	Drawing enclosed	Yes/No	
4.	Maximum magnetic power loss of suspension clamp at conductor current of 1200 amperes	Watt	....
5.	Slipping strength of suspension assembly (c!amp torque Vs slip curve shall be enclosed)	kN	....
6.	**Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension Assembly**		
	a) No. of rods per set	No.	.....
	b) Direction of lay		.....
	c) Overall length after fitting on conductor	mm	.....
	d) Actual length of each rod along its helix	mm	.....
	e) Diameter of each rod	mm	.....
	f) Tolerance in		
	i) Diameter of each rod	±mm	.....
	ii) Length of each rod	±mm	.....
	iii) Difference of length between the longest and shortest rod in a set	±mm	.....
	g) Type of Aluminium alloy used for manufacture of PA rod set		.....
	h) UTS of each rod	Kg/mm^2	.....
7.	**Particulars of Elastomer (For AGS Clamp only)**		
	a) Supplier of elastomer		.....
	b) Type of elastomer		.....
	c) Shore hardness of elastomer		.....
	d) Temperature range for which elastomer is designed		.....
	e) Moulded on insert		Yes/No
8.	UTS of suspension clamp		Yes/No

9.	Purity of Zinc used for galvanising	%	……
10.	Maximum permissible continuous operating		
	temperature of		
	i) Clamp body		
	ii) Standard/AGS preformed rods		
11.	Minimum corona extinction voltage under dry condition	kV (rms)	
12.	Radio interference voltage at 1 Mhz for phase to earth voltage of 154 kV (dry condition)	Micro- volts	

Date:

Place:

(Signature)……

(Printed Name) ……

(Designation)……

(Common Seal) ……

SCHEDULE -3

Bidder's Name.....

Specification No.....

GUARANTEED TECHNICAL PARTICULARS OF DEAD-END ASSEMBLY /TENSION HARDWARE FITTINGS

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		.....	
2.	Address of Manufacturer		.....	
3.	Drawing enclosed		Yes/ No	
4.	Purity of aluminum used for aluminum Sleeve	%	.....	
5.	**Material for steel sleeve**			
	(i) Type of material with chemical composition		.....	
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From .....to	
	(iii) Weight of zinc coating	gm/m^2	.....	
			Aluminium/ Alloy	Steel
6.	**Outside** diameter of sleeve **before** compression	mm	.....	.....
7.	**Inside** diameter of sleeve **before** compression	mm	.....	.....
8.	Length of sleeve before compression		.....	.....
9.	Dimensions of sleeve **after** compression			
	(a) Corner to Corner		.....	.....
	(b) Surface to Surface		.....	.....
10.	Length of sleeve **after** compression		.....	.....
11.	**Weight of sleeve**			
	(a) Aluminium/ aluminum Alloy	kg	.....	

	(b) Steel	kg	.....
	(c) Total	kg	.....

Sl.	Description	Unit	Value guaranteed by the Bidder
12.	Electrical resistance of dead end assembly as apercentage of equivalent length of Conductor	%	... .
13.	Slip strength of dead end assembly	kN	... .
14.	UTS of dead end assembly	kN	... .
15.	Purity of Zinc used for galvanizing	%	... .
16.	Minimum corona extinction voltage under dry condition	kV (rms)	
17.	Radio interference voltage at 1 Mhz for phase to earth voltage of 154 kV (dry condition)	Micro- volts	

Date:

Place:

(Signature).....
.....
(Printed Name)
.....
(Designation).....
.....
.....
(Common Seal)
.....

SCHEDULE -4

Bidder's Name.....

Specification No.....

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR

HTLS CONDUCTOR (Non-Metallic Core)

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**	
1.	Name of Manufacturer		.....	
2.	Address of Manufacturer			
3.	Drawing enclosed		Yes/No	
4.	Suitable for conductor size	Mm	.....	
5.	Purity of aluminium used for aluminium Sleeve	%	.....	
6.	**Material for steel sleeve**			
	(i) Type of material with chemical composition		.....	
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From .....to	
	(iii) Weight of zinc coating	gm/m^2	.....	
			Aluminium/ alloy	Steel
7.	**Outside** diameter of sleeve **before** compression	Mm	.....	.....
8.	**Inside** diameter of sleeve **before** compression	Mm	.....	.....
9.	Length of sleeve before compression		.....	.....
10.	Dimensions of sleeve **after** compression			
	(a) Corner to Corner		.....	.....
	(b) Surface to Surface		.....	.....
11.	Length of sleeve **after** compression		.....	.....

SCHEDULE -4 (CONTD.)

Bidder's Name……..

Specification No……..

Sl.	Description	Unit	Value guaranteed by the Bidder
12.	**Weight of sleeve**		
	(a) Aluminium	Kg	……
	(b) Steel	Kg	……
	(c) Total	Kg	……
13.	Slip strength	kN	……
14	Minimum Corona extinction voltage under dry condition	kV (rms)	
15	Radio interference voltage at 1 MHz for phase to earth voltage of 154 kV under dry condition	Microvolt	
16.	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	……
17.	Maximum permissible continuous operating temperature of mid span compression joint	Deg. ℃	……

(Signature)……

……

…

Date:

Place:

(Printed Name)

……

…

……..

(Designation)……

……

….

(Common Seal)……..

Bidder's Name.....

Specification No.....

GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR HTLS CONDUCTOR

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		.....
2.	Address of Manufacturer		
3.	Drawing enclosed		Y es/No
4.	Suitable for conductor size	Mm	.....
5.	Purity of Aluminium / Al Alloy type	%	.....
6.	Dimension of sleeve before compression		
	i) Inside diameter of sleeve	Mm	.....
	ii) Outside dimensions of sleeve	Mm	.....
	iii) Length of sleeve	Mm	.....
7.	Dimension of sleeve after compression		
	i) Corner to Corner	Mm	.....
	ii) Surface to Surface	Mm	....
	iii) Length of sleeve	Mm	
8.	Weight of sleeve	Kg	.....
9.	Minimum Corona extinction voltage under dry condition	kV (rms)	
10	Radio interference voltage at 1 MHz for phase to earth voltage of 154 kV dry condition)	µV	
11.	Maximum permissible continuous operating temperature of Repair Sleeve	Deg. C	

Date:

Place:

(Signature).....

...

(Printed Name).....

(Designation).....

(Common Seal).....

SCHEDULE -6

Bidder's Name.....

Specification No.....

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR HTLS CONDUCTOR (IF APPLICABLE)

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		.....	
2.	Address of Manufacturer			
3	**Drawing enclosed**			
	(a) Design Drawing		YES / NO	
	(b) Placement Chart		YES / NO	
4.	Suitable for conductor size	Mm	.....	
5.	Total weight of one damper	Kg		
			Right	Left
6.	Diameter of each damper mass	Mm	.....	.....
7.	Length of each damper mass	Mm	.....	.....
8.	Weight of each damper mass	Kg	.....	.....
9.	Material of damper masses		....	
10.	Material of clamp		....	
11.	Material of the stranded messenger cable			
12.	Number of strands in stranded messenger cable		....	

13.	Lay ratio of stranded messenger cable		.....
14.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	.....
15.	Slip strength of stranded messenger cable (mass pull off)	kN	.....

Bidder's Name……..
Specification No……..

Sl.	Description	Unit	Value guaranteed by the Bidder	
			Right	Left
16.	Resonance frequencies			
	(a) First frequency	Hz	.....	.....
	(b) Second frequency	Hz	.....	.....
17	Designed clamping torque	Kg-m	....	
18.	Slipping strength of damper clamp			
	(a) Before fatigue test	kN	....	
	(b) After fatigue test	kN	....	
19.	Magnetic power loss per vibration damper watts for [Value of Normal Current in thr conductor] amps, 50 Hz Alternating Current	Watts	....	
20.	Minimum corona Extinction voltage kV (rms) under dry condition	kV		
21.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 154 kV (rms) Microvolts under dry condition	µV		
21.	Maximum permissible continuous operating temperature of Vibration Damper	Deg. C		
22.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test	%	....	
23.	Percentage variation in power dissipation after fatigue test in	%	....	

	comparison with that before fatigue test		.....

SCHEDULE-7

Bidder's Name.....

Specification No.....

GUARANTEED TECHNICAL PARTICULARS OF DISC INSULATOR FOR HTLS CONDUCTOR (IF APPLICABLE)

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

Sl. No	Details	90/120KN
1	Type	Ball & Socket
2	Height – mm	
3	Diameter – mm	
4	Creepage – mm (Minimum) c) Total d) Protected	
5	Ball Diameter – mm	
6	Colour	
7	Surface	
8	Materials a) Socket Cap b) Ball Pin c) Security Clip d) Zinc Sleeve e) Insulator	
9	Shape and material of Security Clip	
10	Minimum Failing Load	
11	Minimum Electro Mechanical strength – KN	
12	Visible Discharge Test Voltage – KV (Min.)	
13	Dry Impulse Flash Over Voltage – KV (Min. +ve	
14	Power Frequency Flash Over Voltage – KV (RMS – Min.) a) Dry b) Wet	
15	Power Frequency Withstand Voltage – KV (RMS – Min.) c) Dry d) Wet	
16	Power Frequency Puncture Voltage – KV(RMS – Min.)	

17	Net weight(approx)	
18	Minimum corona extinction voltage of each disc insulator KV(rms)	
19	Maximum RIV with10 KV(RMS) of each disc insulator (microvolts)	

SCHEDULE-8

GUARANTEED TECHNICAL PARTICULARS OF LONG ROD PORCELAIN INSULATOR FORHTLS CONDUCTOR (IF APPLICABLE)

(Guaranteed Technical particulars needs to be furnished separately by the Bidder for each of the projects)

A. GENERAL		
1	Voltage level kV	
2	Type (Ball & Socket)	
3	Material of Disc	
4	Colour	
5	Surface	
6	Type of Locking device and its material (Clip of ss/phos. Bronze or better)	
7	Size	
8	Ball/Socket dia (in mm)	
9	No. of units per single string	
10	Length of insulator string (in mm)	
11	Total length with hardware (in mm)	
12	Guaranteed mechanical failing load (in KN)	
B. ELECTRICAL		
1	Total Min. creep age distance (in mm)	
2	Power frequency withstand voltage- dry KV (peak)	
3	Power frequency withstand voltage – wet KV (peak)	
4	Impulse withstand voltage (+/-) 1.2x50 micro-second KV (peak)	
5	Visible discharge Voltage KV	
6	Standard Applicable	
7	Minimum corona extinctionvoltage of each disc insulator KV(rms)	
8	Maximum RIV for stringincluding corona rings at 154	

	kV rms.	

Date:

(Signature)…… (Printed Name)…….

(Designation)……

.....

Place:

(Common Seal)……