TECHNICAL
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SECTION - 1

SCOPE AND GENERAL TECHNICAL CONDITIONS

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Section 1

1.1 GENERAL INFORMATION

The material covered in this specification shall be used in route length of 132KV D/C Kahilipara-Kamakhya-AIIMS Transmission line

1.2 SCOPE

The scope of work covered under package shall include complete Design, Engineering, Type Testing, Manufacture, Transportation to Site, Insurance, Storage, Erection, Testing & Commissioning De-Stringing/Dismantling as detailed below on single source responsibility.

1.2.1

a) The supply of major equipments includes:

i. High Temperature Low Sag (HTLS) conductor with Composite Carbon Core.

ii. Hardware fittings suitable for offered HTLS conductor.

iii. Clamps & connectors for Hardware fittings suitable for offered HTLS conductor.

iv. Accessories for HTLS conductor.

v. 11KV Anti-fog insulators**.**

b) Design, manufacture, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, and Hotline stringing of HTLS Conductor as per BoQ

c) The installation & hotline re-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/manufacturer. The manufacturer's recommendation should be followed during erection and commissioning of HTLS conductor.

d) The supplier shall supervise the stringing at site as per the approved stringing procedure. Site visit for supervision shall be carried out as per instruction of AEGCL. Charges for supervision of installation and stringing of offered HTLS conductor shall be for complete scope of work as per the technical specification.

e) The rates quoted shall include minor details which obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

1.2.2 It is also responsibility of the Contractor to obtain any road permits and any other permits or licenses to execute the works.

1.2.3 Dismantling of existing conductor of all the circuits, re rolling on empty drums, removing of hardware fittings, insulators and accessories, loading and unloading, transportation to AEGCL store shall be carried out by the contractor.

1.2.4 Dismantling of existing clamps and connectors and re-connection of clamps & connectors suitable for HTLS conductor shall be carried out for the above transmission lines. Design, Manufacture, testing at manufacturer's works, supply and erection of connectors, clamps and other accessories suitable for offered HTLS conductor shall be carried out by the transmission line contractor under supervision of HTLS conductor supplier.

1.2.5. HEALTH, SAFETY AND ENVIRONMENT (HSE) PLAN

1.2.5.1. General

The contractor/subcontractor should adhere to the Environmental and Social Management Plan (ESMP). The payment is linked towards compliance to responsibility specified under the generic ESMP attached in Annexure-E. The overall responsibility for compliance of ESMP will stand with the Project Manager with support of the Environmental, Health and safety Specialist. The contractor must abide to comply with the project specific ESMPs which can be issued by AEGCL to contractor during the complete tenure of project.

Refer to Section 6 of Volume I for Personnel Requirement.

Within one month of award of contract, the Contractor shall produce an HSE Plan in accordance with the generic ESMP for the contract and submit for the approval of AEGCL. The HSE Plan is described in the following sections. The same is to submitted to CGM (PP&D) and ESIA Consultant for approval.

The primary objective of the HSE Plan is for the contractor to demonstrate that he has the capability to carry out the contract work in a cost-effective manner, giving due consideration to the Health, Safety and Environmental and Social management of both his own employees, those of the Employer and anyone who may be affected by his activities and in full compliance with the ESMP.

Special arrangements shall be made to accommodate for gender-inclusive engagements and participation of vulnerable people, to ensure the implementation of the social development and gender relevant features included in the design of the project, including monitoring of occupational and community health and safety, community awareness activities, compliance of core labour standards, prevention of Gender-based violence (GBV) and Sexual exploitation (SE) risks.

1.2.5.2. Content of HSE Plan

The general structure of the HSE Plan is outlined in 1.9.8.3. The HSE Plan will comprise two parts i.e.:
Part: I: Sections 1 to 5, covering general HSE management and controls. The following would be attached as appendices, where appropriate:

- Organisation chart showing the proposed Contractors HSE organisational structure
- The CV‟s, duties and responsibilities of the following personnel:
    - (i) Contract Manager
    - (ii) Contractors Site Representatives
    - (iii) Environmental, Social, Health and Safety Officer
    - (iv) Site Environmental, Social, Health and Safety Officers

Part: II: Section 6, providing a summary of hazards and controls.

1.2.5.3. General structure of HSE Plan

The HSE Plan shall conform to the following general structure:

1. Contractors Policy Statement
2. Health

2.1 First Aid
2.2 Primary health care
2.3 Occupational and Community health

3. Safety

3.1 Objectives and targets
3.2 Organisation and responsibilities
3.3 HSE meetings
3.4 Motivation, communication and community awareness
3.5 HSE training
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4 Environment

4.1 Waste management
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4.11 Protection of Fisheries
4.12 Construction Camp Management
4.13 Cultural and Religious Issues
4.14 Critical areas
4.15 Subcontractors
4.16 Summary of hazards and controls

1.2.5.4 Section 6 of HSE Plan

In addition to general hazards and their controls, the following hazards have been identified as specific to this contract and therefore the contractor should demonstrate that he is capable of providing the necessary controls for the work:

- Working within a Permit to Work system
- Working adjacent to live high voltage equipment
- Working adjacent to, and in the vicinity of, live high voltage overhead lines
- Working at elevation
- Lifting operations
- Use of explosives
- Use of heavy machinery including cranage, pile rigs and concrete mixers
- Excavation works
- Work in confined spaces
- Working with insulating oil
- Working with compressed gas
- Rotating machinery

The Contractor should demonstrate his understanding of these hazards by either proposing specific controls for each of them or by giving supporting documentation which demonstrates that such controls already exist.

1.3 SERVICE CONDITIONS

1.3.1 The plant and materials supplied shall be suitable for operation under the following climatic and other conditions:

a.	Peak ambient day temperature in still air		: 45°C
b.	Minimum night temperatures		: 0°C
c.	Reference ambient day temperature		: 45°C
d.	Relative Humidity a)	Maximum	: 100 %
		b) Minimum	: 10%
e.	Altitude		: 1000 m above MSL
f.	Isokeraunic level		: 100/Year
g.	Maximum wind pressure		: As per IS: 802 latest code.
h.	Seismic Intensity		: ZONE-V as per IS 1893.
i.	Wind Velocity		: 0.50 m/sec
J.	Solar Radiation		:1200w/m^2

1.4 Electrical System Data

Nominal Voltage	220kV
Highest system voltage	245kV
Power frequency withstand voltage (kV rms)	460
Lightning Impulse withstand voltage (kV peak)	1050
Short circuit level (kA) per one second	40
Frequency 1) Normal (Hz)	50
2) Maximum (Hz)	51.5
3) Minimum (Hz)	47
Minimum Corona extinction voltage at 50 Hz AC system under dry condition, kV (rms) phase to earth.	154 (Min)
Radio interference voltage at one MHz for	1000 (Max)

phase to earth voltage of 154 KV under dry condition, Micro Volts	

Nominal Voltage	132kV
Highest system voltage	145kV
Power frequency withstand voltage (kV rms)	275
Lightning Impulse withstand voltage (kV peak)	650

1.5 TYPE TEST REPORTS

1.5.1 HTLS conductors with composite carbon core and related Hardware fittings which have never been tested for critical performance shall not be accepted. In such cases, a promise or agreement by a bidder to have the equipment tested after award of a contract is acceptable, provided that the tests are carried out by the OEM free of cost to AEGCL.

1.5.2 All Bids must be accompanied by the full Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if: -

Tests are conducted in an independent and well-known testing laboratory, *or*

Tests are conducted in manufacturer's own laboratory. In this case the laboratory must have ISO 9000 (or its equivalent) series certification

1.5.3 Type Test Reports older than five (5) years on the date of Technical bid opening shall not be accepted.

1.6 GUARANTEED TECHNICAL PARTICULARS

1.6.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in the prescribed Schedules of the Section-6 with the Technical Bid. The Bidder shall also furnish any other information's as in their opinion is needed to give full description and details to judge the item(s) offered by them.

1.6.2 The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (as per the requirement of the specification) required. A Bidder may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum/maximum value required as per the technical specification. No preference what so ever shall be given to the bidder offering better/more stringent values than those required as per specification except where stated otherwise.

1.7 DRAWINGS

1.7.1 All drawings submitted by the Supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

1.7.2 Each drawing submitted by the Supplier shall be clearly marked with the name of the Owner, the unit designation, the Specification title, the Specification number and the name of the Project. All titles, noting, markings and in writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units.

1.7.3 The drawings submitted by the Supplier shall be reviewed by the Owner as far as practicable and shall be modified by the Supplier if any modifications and/or corrections are required by the Owner in compliance with Specifications. The Supplier shall incorporate such modifications and or corrections

and submit the final drawings for approval. Any delays arising out of failure by the Supplier to rectify the drawings in good time shall not alter the Contract completion date.

1.7.4 The drawings shall be submitted for approval to the Owner.

1.7.5 Further, work by the Supplier shall be strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Owner, if so required.

1.7.6 All manufacturing and fabrication work in connection with the equipment/material prior to the approval of the drawings shall be at the Supplier's risk.

1.8 DELIVERY SCHEDULE

1.8.1 The delivery schedule shall be as specified in the bidding documents.

1.9 WEIGHTS AND MEASURES

All weights and measures shall be in System International (S.I.) units. All fasteners shall be of Metric size only.

1.10 GENERAL TECHNICAL CONDITIONS

1.10.1 The following provisions shall supplement all the detailed technical specifications and requirements brought out in the accompanying Technical Specifications. The Bidder's proposal shall be based on the use of equipment and materials complying fully with the requirements, specified herein. The Bidder shall furnish clause-by-clause commentary (with detailed technical data as required) on the Technical Specifications demonstrating the goods substantial responsiveness to the specifications or deviations and exceptions to the provisions of the Technical Specification.

1.10.2 Equipment Performance Guarantee

The performance requirements of the items are detailed separately in this Specification. These guarantees shall supplement the general performance guarantee provisions covered under General Terms and Conditions of Contract in clause entitled guarantee'.

1.10.3 Liquidated damages for not meeting specified performance shall be assessed and recovered from the Supplier. Such liquidated damages shall be without any limitation whatsoever and shall be in addition.

1.11 QUALITY ASSURANCE

1.11.1 To ensure that the equipment under the scope of this Contract whether manufactured within the Supplier's Works or at his Sub-Supplier's premises is in accordance with the specifications, the Supplier shall adopt suitable Quality Assurance Programme to control such activities at all points necessary. Such programmed shall be outlined by the Supplier and shall be finally accepted by the Owner after discussions before the award of Contract. A Quality Assurance Programme of the Supplier shall generally cover but not limited to the following:

a) His organisation structure for the management and implementation of the proposed Quality Assurance Programme.

(b) Documentation control system.

(c) Qualification data for key personnel;

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

(e) System for shop manufacturing including process controls.

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

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

(h) Inspection and test procedure for manufacture.

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

(j) System for quality audits.

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

(I) System for maintenance of records.

(m) System for handling, storage and delivery and

n) A Quality Plan detailing out the specific quality control procedure adopted for controlling the

quality characteristics of the product. The Quality Plan shall be mutually discussed and approved by the Owner after incorporating necessary corrections by the Supplier as may be required.

1.11.2 QUALITY ASSURANCE DOCUMENTS

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

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

SECTION 2

TECHNICAL SPECIFICATIONS OF HTLS CONDUCTOR WITH COMPOSITE CARBON CORE

Technical Specifications of HTLS Conductor with Non-Metallic Solid Core

This Section contains the Technical Requirements and supplementary information that describe the Goods and Related Services

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TECHNICAL SPECIFICATION OF HTLS CONDUCTOR WITH COMPOSITE CARBON CORE

2.1 GENERAL REQUIREMENTS

2.1.1 The offered HTLS Conductor with composite carbon core which is wrapped with trapezoidal shaped aluminium strands shall be capable of providing the specified maximum ampacity of 875 (132kV) and 1200 (220kV) 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 2.1.6. and 2.2.

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

2.1.2 Maximum Conductor sag for 320m (132kV) and 350m (220kV) span at steady state conductor temperature and no wind corresponding to 50 Hz alternating current of 875 (132kV) and 1200 (220kV) Amperes per conductor under ambient conditions specified at clause no. 2.1.1 will be such that the statutory ground clearance will be maintained throughout the route keeping (erection) tension at 25% of UTS of conductor.

2.1.3 **The calculations for Ampacity shall be based on IEEE Standard 738. The bidder in his bid shall furnish calculations for the ampacity based on the above Standard for the proposed HTLS conductor.**

2.1.4 The design of conductor shall be suitable for operation at a steady state conductor temperature experienced for AC current flow of 875 (132kV) and 1200 (220kV) Amperes 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.

2.1.5 Each conductor / sub conductor in the bundle of HTLS conductor shall be suitable to carry minimum specified 50 Hz alternating current 875 (132kV) and1200 (220kV) Amperes of 50 Hz alternating current under the ambient conditions & maximum conductor sag specified below while satisfying other specified technical requirements/ parameters as mentioned in the Service condition above.

2.1.6 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.

Technical Particulars of HTLS Conductor

The HTLS conductor shall meet the following minimum requirements:

Overall diameter of complete conductor	Not exceeding 21.00mm (132kV) & 28.14 mm (220kV)
Approx. mass of complete conductor (kg/km)	Less than or equal to 974kg/kM (132kV) & 1280 kg/km (220kV)
Direction of lay of outer layer	Right Hand

2.1.7 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 1200 amperes at specified ambient conditions (maximum continuous operating temperature).

The bidder shall submit the supporting calculations for the AC resistance at 875 (132kV), 1200 (220kV) Amperes and at 437 (132kV), 600 (220kV) Amperes 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.

2.2 Sag-Tension Requirements

2.2.1 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 (corresponding to 1200 amperes and ambient conditions specified above)	≤ 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

2.2.2 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.

2.2.3 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.

2.2.4 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 and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year & 10 year creep at everyday tension & at maximum continuous operating temperature.

2.3 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 current under 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 are less than those, stated in the GTP.

2.4 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 of reaction with trapped rain water etc.), dirt, gritetc.

2.5 Joints in Wires

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

2.5.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints are permitted in the inner layer(s) 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 Alloy 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.

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

2.5.4 **Composite Carbon 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.

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

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

2.6.1 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.

2.6.2 Non-Metallic Solid Core

Hybrid carbon and glass fiber composite core which utilizes a high-temperature epoxy resin matrix to bind hundreds of thousands of individual fibers into a unified load-bearing tensile member will be acceptable. The central carbon fiber core shall be surrounded by high-grade boron-free glass fibers to improve flexibility and toughness while preventing galvanic corrosion between the carbon fibers and the aluminum strands. Stranded core design is also acceptable subject to fulfillment of all the type test reports.

Bidder shall furnish properties and composition of the core in the GTP schedule. The composite material for core shall be of such proven quality that its properties are not deteriorated by the normal operating conditions of 220KV 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.

2.7 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 than 12.5% 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.

2.8 Supervision in Stringing

2.8.1 The installation & hotline restringing 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 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.

2.8.2 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 above conditions including mechanical/ structural safety of the towers, are maintained or not.

2.8.3 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 submitted by the bidder along with bid.

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

2.9 Tests and Standards

2.9.1 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
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. 2.9.1 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 5 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.

In the case of composite core conductors, the tests specified under clause 2.9.1 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.

2.9.2 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.	

2.9.3 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

2.9.4 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

As indicated in Clause no 2.9.1, 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.

2.10 Additional Tests

2.10.1. 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.

2.10.2. 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

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

2.17 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.

2.18 Standards (Whichever applicable to Annealed Al. non-metallic solid core HTLSConductor)

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.		Design Validation Tests on Composite Core	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.

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.

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.

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.

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 the shaker.

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: -

- Mechanical tension, 20 % RBS, marks on the conductor at the edge of the conductor.
- 100 cycles from room temperature up to maximum temperature. Hold at design maximum temperature ± 2.5 deg. C for 5 minutes.
- After the above mentioned 100 cycles, the mechanical tension shall be increased up to 70 % RBS at room temperature and kept at this tension for 24 H. Thereafter release to 20 % RBS.
- This cycling test shall be repeated 5 times.
- During the test, temperature of connectors, conductor and resistance are recorded according to ANSI C 119.
- 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.

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)

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 3600 kgs. 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 and thickness 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 show that 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.

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.

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 temperature recorded.

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.

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 be not more than 50 times the dia of composite core. After completion of the test, the core shall withstand UTS test and dye penetration test.

1.34 Chemical Analysis of Aluminium/ Aluminium Alloy and Composite core/ INVAR Core Wires

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

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.

SECTION - 3

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES

SECTION – 3 (A)

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 220kV VOLTAGE LEVEL

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SECTION – 3 (A)

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 220kV VOLTAGE LEVEL

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 of complete 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 socket fittings 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 maintenance shall 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 shall be 520 mm. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing. An adjustment of 150 mm minimum shall be possible with 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 International 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 at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

3.16.3 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 be provided 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 size up-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 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 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 withoutfouling.

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 with accessories 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. 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 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 at suspension 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 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 of hot line technique. In addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

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.

3.24.1 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 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 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 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 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 goodperformance.

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 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 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 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 the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost 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, inclusion rating & magnetic particle inspection for forgings/castings : As per Annexure-B 1

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) Clause 5.4
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 to depute 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 material shall 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 inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

3.33.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such 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 and subsequent 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 132kV VOLTAGE LEVEL

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SECTION – 3 (B)

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 132Kv VOLTAGE LEVEL

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 panther 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.

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 3.16, 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 socket fittings 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 maintenance shall 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 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

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 shall be 520 mm. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing. An adjustment of 150 mm minimum shall be possible with 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 International 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 at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

3.16.3 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 be provided 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 size upto 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 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 withoutfouling.

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 with accessories 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. 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 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 at suspension 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 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 of hot line technique. In addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

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/ Phosphor 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 the Extra 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 goodperformance

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 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 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 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 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 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 the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost 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

f. Clamp Slip strength Vs Torque test for suspension clamp : As per Annexure-B 2
g. Shore hardness test of elastomer cushion for AG suspension clamp : As per Annexure-B 2
h. Bend test for armour rod set : As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
i. Resilience test for armour rod set : As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
j. 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

i. Slip strength test for dead end assembly : As per IS:2486 (Part-I) Clause 5.4
j. Ageing test on filler (if applicable) : As per Annexure-C 2

3.28.4 On Mid Span Compression Joint for Conductor

e. Visual examination and dimensional verification : As per IS:2121 (Part-II), Clause 6.2, 6.37 6.7

f. Galvanizing test : As per Annexure-B 2
g. Hardness test : As per Annexure-C 2
h. 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

b. 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
iii. On messenger cable : As per Annexure-B 2
k. Verification of resonance frequencies : As per Annexure-C 2
l. Clamp slip test : As per Annexure-C 2
m. Clamp bolt torque test : As per Annexure-C 2
n. Strength of the messenger cable : As per Annexure-C 2
o. Mass pull off test : As per Annexure-C 2
p. 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

d. Chemical analysis of Zinc used for galvanizing : IS 2486-(Part-I)
e. Chemical analysis mechanical metallographic test and : As per Annexure-B 2 magnetic particle inspection for malleable castings
f. Chemical analysis, hardness tests and magnetic particle : As per Annexure-B 2 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 to depute 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 material shall 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 inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also, the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

3.33.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such 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 and subsequent 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 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 units to 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 by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.5 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 and 350 m ruling span) for a span ranging from 50 m to 1100.

ii) The self damping factor and flexural stiffness (El) 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 and vibration 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 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 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. 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 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.

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 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-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 units to 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 by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.5 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.

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.

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 0.762f 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 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 and 320 m ruling span) for a span ranging from 50 m to 1100.

ii) The self-damping factor and flexural stiffness (El) 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 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.

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 STRING INSULATORS

Section – 4

Technical Specification of long rod porcelain string Insulators

Contents

Sr. No.	Description
4.1	Scope
4.2	Long Rod Porcelain Insulator/String Insulator General Technical Requirement
4.3	Ball and Socket Designation
4.4	Ball and socket designation
4.5	Interchangeability
4.6	Maintenance
4.7	Bid Drawing
4.8	Test and Standards
4.9	Additional Test
4.10	Guarantee
4.11	Test Reports
4.12	Inspection
4.13	Packing and Marking
4.14	Standards
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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 with hardware 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 maintenance technique 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 cross sectional view of the insulator shell. The drawing shall include but not limited to the following information:

a) Major Dimensions with manufacturing tolerances
Number 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 witnessed by 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 tests shall 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 (dry) — As per IEC:60383

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 used for 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 the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost 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 of Standardization 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.

1.5 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.

1.6 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 OF HTLS CONDUCTOR WITH CARBON CORE

Section-5

Content

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5.3	Environmental Conditions
5.4	Span and clearances
5.5	Electrical Clearances
5.6	Maximum Tension
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5.18	Final checking, Testing and Commissioning

5.1 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.

5.2 Site Inspection

5.2.1 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.

5.2.2 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.

5.2.3 The detailed procedure for carrying out the reconductoring shall be submitted to the site Engineer-in-charge before taking up the work

5.2.4 Suggestions regarding location for setting up stores during line construction in consultation with Employer representative shall also be provided by the contractor.

5.2.5 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 way leave problems and compensation payable shall be stated by the Contractor.

5.2.6 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.

5.2.7 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.

5.3 Environmental Conditions

5.3.1 Forest

The line route passing through forest stretches if any shall be indicated to the successful Bidder.

5.3.2 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 42°C and the minimum temperature in the winter shall be of the order of 0°C. Normal everyday temperature is 32°C.

5.3.3 Statutory Regulations and Standards

5.3.3.1 **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.

5.3.3.2 **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.

5.4 Span and clearances

4.3.1 Normal Span

The normal ruling span of the line on panther conductor is 350 m.

4.3.2 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.

4.3.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower.

5.5 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.

5.6 Maximum Tension

5.6.1 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.

5.6.2 Limiting Tensions of conductor

The ultimate tension of conductor shall not exceed 70% of the ultimate tensile strength

5.7 Stringing of Conductor and Installation of Line Materials

5.7.1 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, and loss 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.

5.7.2 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.

5.7.3 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.

5.7.4 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/suspension towers.

5.7.5 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.

5.8 Handling of Conductor

5.8.1 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.

5.8.2 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.

5.8.3 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.

5.8.4 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.

5.8.5 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.

5.8.6 The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms/energized lines.

5.9 Running Blocks

5.9.1 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.

5.9.2 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 and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

5.10 Repairs to Conductors

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

5.10.2 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.

5.10.3 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.

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

5.11 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 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.

5.12 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.

5.13 Supervision in Stringing

5.13.1 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.

5.13.2 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 above conditions including mechanical/ structural safety of the towers, are maintained or not.

5.13.3 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 of Site-In charge the complete details of stringing methods he proposes to follow.

5.13.4 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.

5.13.5 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 for the approval of the Employer.

5.13.6 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.

5.14 Jointing

5.14.1 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils 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.

5.14.2 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

5.14.3 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.

5.14.4 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 or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

5.14.5 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.

5.15 Tensioning and Sagging Operations

5.15.1 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.

5.15.2 Dynamometer shall be employed for measuring tension in the conductor. Dynamometers employed shall be periodically checked and calibrated with the standard Dynamometer.

5.15.3 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.

5.15.4 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.

5.15.5 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.

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

5.16 Clipping In

5.16.1 Clipping of the conductors into position shall be done in accordance with the manufacturer's recommendations.

5.16.2 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 found necessary, to restrict jumper swing to design values.

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

5.17 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.

5.18 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:

5.18.1 The stringing of the conductors has been done as per the approved sag and tension charts and desired clearances are clearly available;

5.18.2 All conductor accessories are properly installed;

5.18.3 The original tracings of profile are submitted to the Employer for reference and record.

5.18.4 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.

5.18.5 The line is tested satisfactorily for commissioning purpose.

5.18.6 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.
The contractor should also fulfill the requirements of pre commissioning.

5.18.8 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.

5.18.9 The contractor shall make all arrangements for such tests and the contractor shall provide necessary labour, transport and equipment.

5.18.10 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 WITH CARBON CORE

Section-6

Content

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6.3	Environmental Conditions
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6.12	Stringing of HTLS conductor
6.13	Supervision in Stringing
6.14	Jointing
6.15	Tensioning and Sagging Operations
6.16	Clipping In
6.17	Fixing of Conductors Accessories
6.18	Final checking, Testing and Commissioning

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 way leave 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 in the 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 minimum temperature 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, and loss 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 and under 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 carried out 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 for the approval of the Employer.

6.13.6 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.

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 stringing operations 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. The Contractor 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 or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

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 found necessary, 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 be energised at full operating voltage before handing over.

SECTION – 7

TECHNICAL DATA SHEET

Technical Data Sheets

(To be filled up by each Manufacturer)

Contents

Schedule – 1	HTLS conductor
Schedule – 2	Suspension Clamp for HTLS Conductor
Schedule – 3	Dead End clamp for HTLS Conductor
Schedule – 4	Mid Span Compression Joint for HTLS Conductor
Schedule – 5	Repair sleeve for HTLS Conductor
Schedule – 6	Vibration Dampers for HTLS Conductor
Schedule—7	Porcelain Disc Insulator for HTLS Conductor
Schedule—8	Porcelain Long Rod Porcelain Insulator for HTLS Conductor

SCHEDULE -1

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR WITH COMPOSITE CARBON CORE

(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 content 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		
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^{O}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

Page 1 of 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: (Signature)……

Place: (Printed Name) …….

(Designation)…….

(Common Seal) …….

SCHEDULE -3

Page 1 of 2

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 a percentage 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

Page 1 of 2
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.)

Page 2 of 2
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. °C	……

(Signature)……
Date: …
Place:
(Printed Name)
……
……..
(Designation)……
….
(Common Seal)……..

SCHEDULE -5

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	……	

SCHEDULE -6 (CONTD.)

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 with 10 KV(RMS) of each disc insulator (microvolts)	

SCHEDULE-8

GUARANTEED TECHNICAL PARTICULARS OF LONG ROD PORCELAIN INSULATOR FOR HTLS 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 extinction voltage of each disc insulator KV(rms)	
8	Maximum RIV for string including corona rings at 154 kV rms.	

Date:

(Signature)…… (Printed Name)……

(Designation)……

……

Place:

(Common Seal)……

SECTION – 8

HEALTH, SAFETY AND ENVIRONMENT PLAN

Section-8

Content

Sr. No.	Description
8.1	General
8.2	Content of HSE Plan
8.3	Environmental Conditions
8.4	Span and clearances

Section 8: Health, Safety and Environment Plan

8.1. General

The contractor/subcontractor should adhere to the Environmental and Social Management Plan (ESMP). The payment is linked towards compliance to responsibility specified under the generic ESMP attached in Annexure-E (in separate file). The overall responsibility for compliance of ESMP will stand with the Project Manager with support of Health and safety Specialist. The contractor is abide to comply with the project specific ESMP which can be issued by AEGCL to contractor during the complete tenure of project.

Within one month of award of contract the Contractor shall produce a HSE Plan for the contract and submit for the approval of AEGCL. The HSE Plan is described in the following sections. The same is to submitted to CGM (PP&D) and ESIA Consultant for approval.

The primary objective of the HSE Plan is for the contractor to demonstrate that he has the capability to carry out the contract work in a cost effective manner, giving due consideration to the Health, Safety and Environmental and social management of both his own employees, those of the Employer and anyone who may be affected by his activities and in full compliance with ESMP.

Special arrangements shall be made to accommodate for gender-inclusive engagements and participation of vulnerable people, to ensure the implementation of the social development and gender relevant features included in the design of the project, including monitoring of occupational and community health and safety, community awareness activities, compliance of core labour standards, prevention of Gender-based violence (GBV) and Sexual exploitation (SE) risks.

8.2. **Content of HSE Plan**

The general structure of the HSE Plan is outlined in 1.26.3. The HSE Plan will comprise two parts i.e.:
Part: I: Sections 1 to 5, covering general HSE management and controls. The following would be attached as appendices, where appropriate:

- Organization chart showing the proposed Contractors HSE organizational structure
- The CV"s, duties and responsibilities of the following personnel:
  - (i) Contract Manager
  - (ii) Contractors Site Representatives
  - (iii) Environment, Social. Health and Safety Officer
  - (iv) Site Environment, Social. Health and Safety Officers

Part: II: Section 6, providing a summary of hazards and controls.

8.3. **General structure of HSE Plan**

The HSE Plan shall conform to the following general structure:

1. Contractors Policy Statement
2. Health
   - 2.1 First Aid
   - 2.2 Primary health care
   - 2.3 Occupational and community health
3. Safety
   - 3.1 Objectives and targets
   - 3.2 Organisation and responsibilities
   - 3.3 HSE meetings
   - 3.4 Motivation, communication and community awareness.
   - 3.5 HSE training
   - 3.6 Audits and inspections
   - 3.7 Emergency response
   - 3.8 Safety function
   - 3.9 Accident investigating and reporting
   - 3.10 Standards
   - 3.11 Personal protective equipment
4. Environment
   - 4.1 Waste management
   - 4.2 Chemicals management
   - 4.3 Environmental impacts on Air, Noise, and Waterbody

4.4 Fuels and Hazardous Substances Management
4.5 Water Resources Management
4.6 Drainage Management
4.7 Soil Quality Management
4.8 Topography and Landscaping
4.9 Borrow Areas Management
4.10 Protection of Flora and Fauna
4.11 Protection of Fisheries
4.12 Construction Camp Management, including GBV and SE risk prevention measures
4.13 Cultural, Religious Issues, Chance find procedures
4.14 Critical areas
4.15 Subcontractors
4.16 Summary of hazards and controls

8.4 **Section 6 of HSE Plan**

In addition to general hazards and their controls, the following hazards have been identified as specific to this contract and therefore the contractor should demonstrate that he is capable of providing the necessary controls for the work:

- Working within a Permit to Work system
- Working adjacent to live high voltage equipment
- Working adjacent to, and in the vicinity of, live high voltage overhead lines
- Working at elevation
- Lifting operations
- Use of explosives
- Use of heavy machinery including cranage, pile rigs and concrete mixers
- Excavation works
- Work in confined spaces
- Working with insulating oil
- Working with compressed gas
- Rotating machinery

The Contractor should demonstrate his understanding of these hazards by either proposing specific controls for each of them or by giving supporting documentation which demonstrates that such controls already exist.