ASSAM ELECTRICITY GRID CORPORATION LIMITED

BIDDING DOCUMENT

FOR

"Reconductoring of 132kV Rangia-Nalbari S/C Transmission Line with HTLS conductor and associated works"

(E Tender)

VOLUME-2

TECHNICAL SPECIFICATIONS

BID IDENTIFICATION NO:
AEGCL/MD/Tech-377/O&M(LAR)/Augmentation/HTLS/RNG-NAL/BID (R)

TECHNICAL SPECIFICATION

CONTENTS

SECTION – 1

Scope of Works

1.1.1. **The scope of works covers "Reconductoring of 132kV Rangia-Nalbari S/C Transmission Line with HTLS conductor and associated works"**

The brief description of the scope covered under this bidding document is furnished below:

a) Design, manufacture, testing, supply, and delivery of 132KV HTLS conductor as per Bill of Quantity and bid specification.

b) Design, manufacture, testing, supply, and delivery of 132KV Current Transformers and Isolators as per Bill of Quantity and bid specification.

c) Supply of insulators, conductor accessories, vibration dampers, clamps & connectors, and hardware fittings etc suitable with offered HTLS conductor as per BoQ and bid specification

d) Survey & profiling of existing line route, lowering of existing ACSR Panther conductor along with accessories, Re-rolling on empty drums and transportation to store as per BoQ

e) Stringing of HTLS conductor along with accessories as per Bill of Quantity and bid specification

f) Sag adjustment/correction of existing OPGW of 132kV Rangia-Nalbari Transmission line (as per site condition) shall be in the scope of the contractor.

g) Minor Modification in transmission line tower (if required) as per site condition shall be in the scope of the contractor.

h) Dismantling of existing 132KV Current Transformers and Isolators at 220KV/132KV Rangia GSS and 132KV Nalbari GSS as per BoQ

i) Erection, Testing, and commissioning of supplied 132KV Current Transformers and Isolators at 220KV/132KV Rangia GSS and 132KV Nalbari GSS as per Bill of Quantity and bid specification

j) Freight and Transit Insurance, storage at site and site insurance of all material at site shall be in the scope of the contractor.

k) Any permits required for supply of materials shall be arranged by the contractor

l) Arrangement of RoW clearances and payment of compensation (if any) shall be in the scope of the Contractor.

1.1.2. The Bill of Quantities for indicative purposes is furnished in Price Schedules of Section-2 (Vol-I) of this bidding document. The BOQ is as per BOQ Schedules attached in the online e-tender document.

1.1.3. The quantities in the above Annexure are provisional in nature and for bid comparison purpose only. Quantities may vary to the extent of (+) 20 % to (-) 20% in terms of Contract Price.

1.1.4. The bidder on its own responsibility must visit and examine the Site of Works and its surroundings and obtain information that may be necessary for preparing the bid. Any permits or licenses that may be required to execute the works should also be obtained by the contractor.

1.1.5. **The items mentioned in these Annexures shall only be used while quoting the bid prices. Any other items not specifically mentioned in the specification but which are required for installation, testing, commissioning and satisfactory operation of the cable as per Indian Standards/IE Rules/IE Act and concerned authority regulations are deemed to be included in the scope of the specification and no deviation in this regard shall be accepted**

No modifications/additions/ deletions shall be made by the bidder to the items and quantities given in these schedules.

1.2.0 Contractor to Inform Himself Fully

1.2.1. The contractor should ensure that he has examined the Specifications and Schedules as brought out in this Section as well as other Sections of The Bidding document and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.

1.2.2. The Employer shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Employer.

1.3.0 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	:	Below 1000 M above MSL
f) Maximum wind pressure	:	As per IS: 802 latest code.
g) Seismic Intensity	:	ZONE-V as per IS 1893.

1.4.0 Conformity with Indian Electricity Rules & Other Local Regulations

1.4.1. The Contractor shall note that all substation works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, about the rules and regulations that may be applicable.

1.4.2. The Contractor shall also comply with the Minimum Wages Act 1948 and the payment of Wages Act (both. Of the Government of India and State of Assam) and the rules made there under in respect of any employee or workman employed or engaged by him or his Sub-Contractor.

1.4.3. All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor.

1.5.0 Contractor's Requirement

1.5.1. **The Contractor should be in possession of a up to-date valid Labour License, ESIC registration, EPFO certificate, Electrical Contractor Licence and Electrical Supervisory Licence issued by the Chief Electrical Inspector, Govt. of Assam, as per the provision of Law.** Attested copy of each of the aforementioned Licence must be handed over to the Owner for his record prior to handing/taking over of sites.

1.5.2. **All the works shall also be inspected by the Chief Electrical Inspector, Govt. of Assam or his authorize representatives. It is the responsibility of the Contractor to obtain pre-requisite commissioning clearance of any equipment from the said Inspectorate. The Contractor will pay necessary fees to the Inspectorate, which it may levy. Concerned supervising authority of AEGCL will provide all necessary assistance in this regard.**

1.6.0 Standards

1.6.1. The equipment covered under this bidding document shall, unless otherwise stated be designed, constructed
and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory authorities.

1.6.2. In case of any conflict between the standards and this specification, this specification shall govern.

1.6.3. Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance than that specified under Clause 3.6.0 above shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid.

1.7.0 Engineering Data

1.7.1. The furnishing of engineering data by the Contractor shall be in. accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

1.7.2. All engineering data submitted by the Contractor after review by the Employer shall or part of the contract
document.

1.8.0 Drawings and Documents for Approval

1.8.1. All necessary drawings and documents required for completion of the project is to be submitted by the contractor for approval. The drawings provided with bid (if any) are for indicative purpose only and fresh drawings are to be prepared by the contractor as per actual site condition after survey. The drawings and documents are to be approved by AEGCL before procurement or commencement of work.

1.8.2 All drawings submitted by the Contractor including those submitted at the time of Bid shall be with 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 these specifications.

1.8.3. Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

1.8.4. **The drawings submitted for approval to the Employer shall be in quadruplicate**. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections". The contractor shall there upon furnish the Employer additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

1.8.5. The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

1.8.6. All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the
drawings shall be at the Contractor's risk. The contractor may make any changes in the design which are necessary to conform to the provisions and intent of the contractor and such changes will again be subject to approval by the Employer.

1.8.7. The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that:
a) The Contractor has completed the part of the Works covered by the subject document (i.e. confirmation of progress of work).
b) The Works appear to comply with requirements of Specifications.
In no case the approval by the Employer of any document does imply compliance with neither all technical
requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

1.8.8. All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be acceptable. After final approval all the drawings shall be submitted to the Employer in readable CD's

1.8.9. The following is the general list of the documents and drawings that are to be approved by the Employer:
a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
b) General Layout of Switchyard: Plan and Sections.
c) Detail design calculations and drawings for Control Room including elevation, sections etc.
d) Earthing layout and details.
e) Cable Trench Layout and details.

f) Foundation layouts and details of main and auxiliary structures
g) Detail design calculations and drawings for structures, equipment supports and foundations including transformer pad.
h) Cable Schedule, as applicable
i) For equipment and items in the scope of supply:
(i) General arrangement drawing with full dimensions.
(ii) Electrical schematic diagram, where applicable.
(iii) Wiring diagram, where applicable.

1.8.10. All Designs/Drawings/Calculations/Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts /
works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

1.9.0 Final Drawings and Documents

1.9.1. The successful Contractor shall require to provide following drawings and documents for each bay constructed in printed form:
(a) All approved drawings (AS BUILD) of equipment and works related to a particular bayin three (3) copies.
(b) Instruction manuals of all equipment related to a particular bay in three (3) copies.
These instruction manuals shall generally consist of-
(i) Operation Manuals,
(ii) Maintenance Manuals and
(iii) Spare Parts Bulletins.
(c) Copies of routine test reports (in triplicate) of relevant equipment.
(d) Final Guaranteed and Other technical particulars of relevant equipment.

1.9.2. In addition to the above the Contractor shall provide five (5) sets of all the drawings and documents to Employer in printed form for his reference and record.

1.10.0 Application System Software

1.10.1. Contractor shall provide copies of licensed copies of application software / configuration & system software in the form of CD (in duplicate) for all IEDs, meters, SAS etc.

1.11.0 Quality Assurance, Inspection & Testing

1.11.1. To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub Contractor's premises or at site or at any other place of work are in, accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. A quality assurance programme of the Contractor shall generally cover but not limited to the following:

a) His organization structure for the management and implementation of the proposed quality assurance programme
b) Documentation control System.
c) Qualification data for Contractors key personnel.
d) The procedure for purchases of materials, parts components and selection of sub-Contractors services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
e) System for shop manufacturing including process controls and fabrication and assembly controls.
f) Control of non-conforming items and system for corrective action.
g) Control of calibration and testing of measuring and testing equipment.
h) Inspection and test procedure for manufacture.
i) System for indication and appraisal of inspection status.
j) System for quality audits.

k) System for authorizing release of manufactured product to the Employer.
l) 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 relevant to each item of supply.
The Quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

1.11.2. **Quality Assurance Documents**
The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material.
The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

1.12.0 Employer's Supervision

1.12.1. To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all
matters and questions shall be resolved in accordance with the provisions of this document.

1.12.2. The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the
duties of the Employer, pursuant to the contract, will include but not be limited to the following.
a. Interpretation of all the terms and conditions of these Documents and Specifications.
b. Review and interpretation of all the Contractors drawings, engineering data etc.
c. Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.
d. Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.
e. Issue certificate of acceptance and/or progressive payment and final payment certificate.
f. Review and suggest modification and improvement in completion schedules from time to time, and
g. Supervise the Quality Assurance Programme implementation at all stages of the works.

1.12.3. **Inspection and Inspection Certificate**

1.12.4. The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine thematerials and workmanship of the product during its manufacture.

1.12.5. All routine and acceptance tests whether at the premises or works of, the Contractor or of any Sub Contractor, the Contractor except where otherwise specified shall carry out such tests free of charge. Items such as labour, materials, electricity, fuel, water, stores apparatus and instruments as may be reasonably demanded by the Employer/inspector or his authorized representative to carry out effectively such tests in accordance with the Contract shall be provided by the Contractor free of charge.

1.12.6. If desired by the Employer, the Contractor shall also carry out type tests as per applicable Standards for which Employer shall bear the expenses except in cases where such tests have to be carried out in pursuance to **Clause 3.13.3**. The Contractor is required to quote unit rates of type test charges in a separate
Schedule (if such schedule is provided in the Bidding Document) in pursuance to this Clause. However, these type test charges shall not be taken into account in comparing Price Bid.

1.12.7. The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming part of the contract

1.12.8. **Tests**
The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

i) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.

ii) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

iii) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

iv) Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

v) The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Employer.

1.12.9. The standards and norms to which these tests will be carried out are specified in subsequent Sections of this Specification. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Programme.

1.12.10. For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder or applicable Standards, as applicable.

1.13.0 Type Test Reports

1.13.1. Materials, 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 not acceptable.

1.13.2. All Bids must be accompanied by the Type Test Certificates of materials offered (refer Clause 3.13.5below). Such type test certificates shall be acceptable only if: -

(a) Tests are conducted in an independent **testing laboratory with NABL accreditation**, or

(b) Tests are conducted in manufacturer's own laboratory.

In this case (i) the laboratory must have **NABL accreditation**; and

(ii) tests have been witnessed by technically qualified representatives of earlier clients or purchaser.

1.13.3. **Test reports to be acceptable must be related directly to the equipment offered i.e., it is fully identical in design, rating and construction with the equipment for which the type test certificates have been submitted. Test reports for higher class (by capacity/voltage etc.) of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment after the award of contract.**

1.13.4. **Validity of Type Test Reports of various equipment shall be as per the CEA Guidelines.**

1.14.0 Guaranteed Technical Particulars

1.14.1. The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders with the Technical Bid in the prescribed Schedules attached in Volume-2 of the bidding document. 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.

1.14.2. 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 were stated otherwise.

1.15.0 Construction Tools, Equipment Etc.

1.15.1. The Contractor shall provide all the construction equipment, tools, tackle and scaffoldings required for construction, erection, testing and commissioning of the works covered under the Contract. He shall

submit a list of all such materials to the Employer before the commencement of work at site. These tools and tackle shall not be removed from the site without the written permission of the Employer.

1.16.0 Materials Handling and Storage

1.16.1. All the supplies under the Contract as well as Employer supplied items (if any) arriving at site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

1.16.2. Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection at site. Any demurrage, and other such charges claimed by the transporters, railways etc., shall be to the account of the Contractor.

1.16.3. The Contractor shall maintain an accurate and exhaustive record-detailing out the list of all items received by him for the purpose of erection and keep such record open for the inspection of the Employer.

1.16.4. All items shall be handled very carefully to prevent any damage or loss. The materials stored shall be properly protected to prevent damage. The materials from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such materials at Site.

1.16.5. All the materials stored in the open or dusty location must be covered with suitable weather-proof and flameproof covering material wherever applicable.

1.16.6. The Contractor shall be responsible for making suitable indoor storage facilities, to store all items/materials, which require indoor storage.

1.16.7. The Contractor shall have total responsibility for all equipment and materials in his custody, stored, loose,
semi-assembled and/or erected by him at site. The contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works
from theft, fire, pilferage and any other damages and loss.

1.17.0 Contractor's Materials brought on to Site

1.17.1. The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the work under intimation to the Engineer. All such goods shall, from the time of their being brought vest in the Employer, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Engineer. The Contractor shall nevertheless be solely liable and responsible for any lossor destruction thereof and damage thereto.

1.17.2. The Employers shall have a lien on such goods for any sum or sums, which may at any time, be due or owing to him by the Contractor, under in respect of or by reasons of the Contract. After giving a fifteen (15) days' notice in writing of his intention to do so, the Employer shall be at liberty to sell and dispose of any such goods, in such manner, as he shall think fit including public auction or private treaty.

1.17.3. After the completion of the Works, the Contractor shall remove from the Site under the direction of the Employer's site representative, the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Employer's site representative. If the Contractor fails to remove such materials within fifteen (15) days of issue of a notice by the Employer's site representative, the Employer's site representative shall have the liberty to dispose of such materials as detailed under clause **1.17.2** above and credit the proceeds thereto to the account of the Contractor.

1.18.0 Commissioning Spares

1.18.1. It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

1.18.2. These spares shall be received and stored by the Contractor at least 1 month prior to the schedule date of commencement of commissioning of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of performance and guarantee test shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer's Representative.

1.19.0 Right of Way

Arrangement of all Right of Way (RoW) clearances, including payment of compensation, if any, shall be entirely within the scope of the Contractor.

Section - 2

TECHNICAL SPECIFICATIONS OF HTLS CONDUCTOR

2.1 GENERAL REQUIREMENTS

2.1.1 The offered HTLS Conductor shall be Panther equivalent HTLS conductor and shall be capable of providing minimum 1049A capacity and shall conform to latest CEA "Guidelines for Rationalized use of high performance conductors" at a continuous operating conductor temperature higher than that of not exceeding the maximum permissible operating temperature for continuous operation of the offered HTLS Conductor and without exceeding the level of maximum permissible sag as prescribe in clause no 2.1.6. and 2.2.

The physical and operating performance requirements of the transmission line with HTLS conductor are mentioned below. The bidder shall offer HTLS conductor complying with the specified requirements. The 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.

The following points may be noted: -

- The offered HTLS Conductor shall be Panther equivalent HTLS conductor and shall be capable of providing minimum 1049A capacity (instead of 900A) and shall conform to latest CEA "Guidelines for Rationalized use of high-performance conductors" at a continuous operating conductor temperature higher than that of not exceeding the maximum permissible operating temperature for continuous operation of the offered HTLS Conductor and without exceeding the level of maximum permissible sag.
- The calculations for Ampacity shall be based on latest edition of IEEE Standard 738 as mentioned in CEA Guidelines for Rationalised Use of High-Performance Conductors. The parameters shall be considered accordingly. However, Ambient Temperature of 45 deg C and as per clause no 1.3.0 (Service Conditions) of Vol-II of bid document.
- The HTLS conductor shall meet the sag tension requirements against ruling span of 325m (132kV).
- The validity of the Type Test Report shall be as per CEA Guideline for the Type Tests for Major Equipments in Power Sector January 2026. The validity of type test report for High Temperature Low Sag (HTLS) Conductor shall be 10 Years from the date of bid opening.
- Wind pressure shall be 52 kg/m2 (as per section-2 of Vol-II of Bid document).
- Chemical analysis of core strands (not on polymer composite core) as per CEA Guidelines for Rationalised Use of High-Performance Conductors.
- The material supplied shall be suitable for operation under the following climatic and other conditions:

Parameters	Specifications
1. Ambient temperature 2. Solar Radiation Absorption Coefficient 3. Emissivity Coefficient 4. Wind velocity 5. Solar Radiation 6. Ampacity Calculation as per IEEE 738 – 2012 or 2023? 7. Tension in Kgs for Sag-Tension Calculation	1. 45 degC 2. As per latest edition of IEEE 738 and CEA guidelines 3. As per latest edition of IEEE 738 and CEA guidelines 4. As per latest edition of IEEE 738 and CEA guidelines 5. As per latest edition of IEEE 738 and CEA guidelines 6. As per latest edition of IEEE 738 and CEA guidelines 7. Sag Tension Calculation shall be performed by the EPC contractor based on the following conditions: i. Tension at Everyday condition (32 deg, no wind): Shall not be more than 25% of the UTS of the conductor. ii. Sag at Maximum continuous operating temperature (Corresponding to maximum ampacity & ambient condition): < 7.24 m (132 kV) iii. Tension at 32 deg full wind: <70% of UTS of conductor iv. E/w or OPGW Sag shall not be more than 90% of conductor sag at all ranges of temperature and no wind condition.

2.1.2 Maximum Conductor sag for 325m (132kV) and 350m (220kV) span at steady state conductor temperature and no wind corresponding to 50 Hz alternating current of minimum 1049A 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 rated ampacity under the above ambient conditions based on ampacity calculations mentioned above. The bidder shall also indicate the maximum permissible conductor temperature for continuous operation without any deterioration of its electrical, mechanical & metallurgical properties. The bidder shall also furnish the maximum permissible conductor temperature for short-term operations including permissible duration of such short-term operation.

2.1.5 Each conductor / sub conductor in the bundle of HTLS conductor shall be suitable to carry minimum specified 50 Hz alternating current of 1049A 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 325 (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 requirement

Over all diameter of complete conductor	Not exceeding 21 mm
Approx. mass of complete conductor (kg/km)	Less than or equal to 974 kg/km
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 minimum 1049Amperes at specified ambient conditions (maximum continuous operating temperature).

The bidder shall submit the supporting calculations for the AC resistance at 1049A indicating details & justifications of values of temperature coefficient of resistance & DC to AC resistance conversion factor(s) with due reference to construction / geometry of the conductor.

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

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 350meters(220kV)

Particulars	Limiting value
Tension at every day condition (32°C, no wind)	Not exceeding 25% of UTS of proposed conductor
Sag at maximum continuous operating temp	≤7.24m (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. **The successful bidder must submit physical sag template along with the profile drawing.**

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 insteps of 5 degC.

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 50m to 350m in intervals of 50m.

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 every day 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, grit etc.

2.5 Joints in Wires

2.5.1 Aluminum OR Aluminum Alloy Wires

During stranding no Aluminum/ aluminium 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 Core

There shall be no joint of any kind in the finished core entering in to 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 strand trapezoidal/Z-shaped wire shall only be accepted.

2.6.2 Non-Metallic Solid Core

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

Bidder shall furnish properties and composition of the core in the GTP schedule. The core shall be of such proven quality that its properties are not deteriorated by the normal operating conditions of 145 KV transmission line in tropical environment conditions as experienced by the existing lines. The Bidder shall provide adequate details including specifications, Design Validation test reports as per ASTM B987 and performance certificates etc. in support of the suitability of the offered materials. Care to be taken for internal friction due to different material having different thermal coefficient 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 than12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.

Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

2.8 Supervision in Stringing

2.8.1 The installation & hot line 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 tensions 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	:IEC1089
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 & :IEC1089
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 ASTMB987

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

Type test of Panther equivalent HTLS conductors of minimum 1049A shall only be accepted for this project.

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.

2.9.2 Acceptance Tests (Which ever 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 pe rAnnexure-A
m)	Glass transition temperature test (For Carbon fibre Composite core only) before stranding.	:As pe rAnnexure-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 ASTMB987
Note:	All the above tests shall be carried out on Aluminium/AluminiumAlloy 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 here in 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:

1. Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
2. Standard resistance for calibration of resistance bridges.
3. 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 anddisplacement during transit, storage and subsequent handling and stringing operations in the field. The Suppliershall 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 & a narrow 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 HTLS Conductor)

The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification. In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

Sl.No	Indian Standard	Title	International Standard
1.	IS:209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1982	Specification for Aluminium Conductors for	IEC:1089-1991
		Overhead Transmission Purposes	BS:215-1970
3.	IS:398-1990	Aluminum Conductor Galvanised Steel	BS;215-1970
	Part-II	Reinforced	IEC:1089-1991
4.	IS:398-1992	Aluminum Conductor Galvanised Steel-	
	Part-V	Reinforced for Extra High Voltage (400KV)	IEC:1089-1991
		And above	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.		Method of Testing Uniformity of	
	IS:2633-1992	Coating on Zinc Coated Articles	
9.	IS:4826-1992	Galvanised Coating on Round Steel	IEC:888-1987
		Wires	BS:443-1969
10.	IS:6745-1990	Methods of Determination of Weight of Zinc	BS:433-1969ISO
		Coating of Zinc Coated Iron and	1460-1973
		Steel Articles	
11.		Method of Radio Interference Tests on	IEC:437-1973
	IS:8263-1990	High Voltage Insulators	NEMA:107-1964
			CISPR
12.	IS:9997-1988	Aluminium Alloy Redraw Rods	IEC104-1987
13.		Zinc Coated steel wires for stranded	
		Conductors	IEC:888-1987
14.		Hard drawn Aluminium wire for overhead	
		Line conductors	IEC:889-1987
			IEC:208-1966
15.	IS:398(Part-IV)	Aluminium Alloy stranded conductor	BS-3242-1970
16.		Aluminium clad steel wires	IEC:1232
		Method of measurement of resistivity of	
17.		Metallic materials	IEC:468
18		Ampacity	IEEE738
19.		Design Validation Tests on Composite Core/other core	ASTMB987/relevant IEC standards

SCHEDULE—1(A)

Tower Schedule enclosed

ANNEXURE–A

Tests on Conductors

1. Tests on Conductor (Which ever 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. There after 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 coronaon 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 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 years & 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 ASTMD5117.

1.8 **Axial Impact Test**

The conductor sample shall be suspended vertically and load applied by dropping a 650 Kg from an elevation of 4metersabove the sample. The impact velocity shall be not be less than 8 m/sec. with an initial pre-tension of 200kg. 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 plates. Load shall be held at 350 Kg for 1minute 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 +/-180deg. 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 upto maximum temperature. Hold at design maximum temperature ±2. 5deg.C for 5 minutes.
- After the above mentioned 100 cycles, the mechanical tension shall be increased upto 70% RBS at room temperature and kept at this tension for 24H. There after 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 ANSIC119.
- 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 based on 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**
Upto150deg.C	230degC(+5/-3degC)
Morethan150deg.C&upto210deg.C	280degC(+5/-3degC)
Morethan210deg.C&upto230deg.C	400degC(+5/-3degC)

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

A sample of aluminium clad invar strand measuring 30 cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should

be first 90 degrees left and 90-degree right. After this operation the strand should cut at the bending point. There should be no separation of core and aluminium at the bending point after this operation.

1.15 **Compression test on aluminium clad wires (if applicable)**

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

1.16 **Coefficient of linear expansion for core/core wires**

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 **Aluminium thickness on aluminium 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 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 wrapped 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 occur

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 30minutes. 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 +35degC.

1.32 **Flexural Strength Test (for polymer composite core only)**

Test method shall be as per ASTMD7264, ASTMD4475 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 inconformity to the requirements stated in the Specification.

SECTION-3

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES

SECTION–3

TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS & OTHER ACCESSORIES FOR 145kV 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 Panther conductor by the bidder. Each fitting shall be suitable for HTLS conductor and to be supplied for satisfactory performance of complete conductor system forcontinuous 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 as 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, eyelinks, extension links, ball clevis, socket clevis, cleviseye, 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 theconductor. 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 toverify the dimensions of the longrod 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 discinsulators 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 hotline 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 16 mm designation for 70KN and 90KN and 20mm for 120 kN Disc insulator. The designation shouldbe in accordance with the standard dimensions stated in IS: 2486-(Part-II)/IEC: 60120. The dimensions shall be checked by the appropriate gauge after **galvanizing 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 (50kg)

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 beprovided 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 with in 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 satisfys hearedge 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 150mm minimum shall be possible with turn buckle.

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 powerarcs, 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 incomplete set should be with in 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 the irresilienceeven 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 atone 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 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)/IS2629. 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 IS1363 (Part-1) to ensure proper bearing.

3.17.3 Nuts should be double chamfered as per the requirement of IS1363 Part-III1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm over size 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 firmgripping 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 thewasher 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 betightened with spanners without fouling.

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

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

3.18 Accessories for the HTLS Conductor

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

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

3.22.3 The supplier shall be responsible for satisfactory performance of complete conductor system along with accessories offered by him for continuous operationat 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 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 these at 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-stock bridge 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 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 blow holes 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	Technicalparticulars
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 0deg. 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 IS2629. 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 15mm 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 2mm shall be cast integral with aluminium body.

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

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 fitting stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

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

TABLE-1 (a)

(Details of Materials)

Sr. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS-1385	
2	**For Free Centre/Envelope type clamps/PGClamp/Comealong clamp**				
a.	Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617 or 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-LASTMB429	
d.	P.A. Rod	High Strength Al. Alloy 4600/LM-6 or 6061/65032	Heat treatment during manufacturing	ASTM-B429	Min.tensile strength of 35kg/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:617 or ASTM-B429	
(b)	Al insert & Retaining strap	High Strength Al. Alloy 4600/LM-6 or 6061/65032	Casted or forged I&Heat treated	S:617 or 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 than 99.50%			
(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	Hotdip 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 20kN
8.	Supporting than 20 Brackets & Mounting Bolts	High strength Al Alloy 7061/6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or S:2062	

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

3.24 Workmanship

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

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

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

3.24.4 All ferrous parts including fasteners shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electrogalvanized. 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 600gm/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 flashingon 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 galvanizing 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 a cross the line of die flashing, and the other 90^{o} to this line. "NOGO" 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 beuniform 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 5mm.

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 andmechanical 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 orinclusions.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) Yokeplates
v) Hardware fittings of ball and socket type for interconnecting 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 "COMPRESSIONZONE" and "NON-COMPRESSIONZONE" 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 withstands test under dry condition	: As per IEC:60383
c)	Mechanical Strength test	: As per Annex-B1
d)	Voltage distribution test	: As per Annex-B1
e)	Vibration test	: As per Annex-B1

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.

1) All the type tests given under ClauseNo.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-B1
b. Mechanical Strength Test on Suspension Hardware fitting : As per Annex-B1

3.27.3 On Suspension Clamp

a. Magnetic power loss test : As per Annexure-B1
b. Clamp slip strength Vs torque test : As per Annexure-B1
c. Ozone Test on elastomer : As per Annexure-B1
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-B1
c. Slip strength test for dead end assembly : As per IS:2486-(Part-I)
d. Ageing test on filler (if applicable) : As per Annexure-B1

3.27.5 Mid Span Compression Joint for Conductor

a. Chemical analysis of materials : As per Annexure-B1
b. Electrical resistance test : As per IS:2121(Part-II)
c. Heatingcycle test : As per Annexure-B1
d. Slip strength test : As per Annexure-B1
e. Corona extinction voltage test (dry) : As pe rAnnexure-B1
f. Radio interference voltage test (dry) : As per Annexure-B1

3.27.6 Repair Sleeve for Conductor

a. Chemical analysis of materials : As per Annexure-B1

3.27.7 Vibration Damper for Conductor

a. Chemical analysis of materials : As per Annexure-B1
b. Dynamic characteristics test : As per Annexure-B1
c. Vibration analysis : As per Annexure-B1
d. Clampslip test : As per Annexure-B1
e. Fatigue tests : As per Annexure-B1
f. Magnetic power loss test : As per Annexure-B1
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 testcertificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative(s) Central/State Power Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design /material/manufacturing process change including substitution of components or due to non-compliance with therequirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no 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-B1
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
Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings	: As per Annexure-B

3.28.2 On Suspension Clamponly

a.	Clamp Slip strength Vs Torque test for suspension clamp	: As per Annexure-B1
b.	Shore hardness test of elastomer cushion for AG suspension clamp	:As per Annexure-B1
c.	Bend test for armour rod set	: As per IS:2121 (Part-I), Clause7.5,7,10&7.11
d.	Resilience test for armour rod set	: As per IS:2121(Part-I), Clause7.5,7,10&7.11
e.	Conductivity test for armour rods set	:As per IS:2121 (Part-I), Clause 7.5,7,10 & 7.11

3.28.3 On Tension Hardware Fittings only

a.	Slip strength test for dead end assembly	: As per IS:2486(Part-I) Clause5.4
b.	Ageing test on filler (if applicable)	: As per Annexure-C1

3.28.4 On Mid Span Compression Joint for Conductor

a.	Visual examination and dimensional verification	: As per IS:2121(Part-II), Clause6.2,6.376.7
b.	Galvanizing test	: As per Annexure-B1
c.	Hardness test	: As per Annexure-C1
d.	Ageing test on filler (if applicable)	: As per Annexure-C1

3.28.5 Repair Sleeve for Conductor

Visual examination and dimensional verification : As per IS:2121(Part-II) Clause6.2,6.3

3.28.6 Vibration Damper for Conductor

a. Visual examination and dimensional verification : As per IS:2121 (Part-II) Clause 6.2,6.376.7
b. Galvanizing test : As per Annexure -B1
i. On damper masses : As per Annexure-B1
ii. On messenger cable : As per Annexure-B1
c. Verification of resonance frequencies : As per Annexure-C1
d. Clamp slip test : As per Annexure-C1
e. Clamp bolt torque test : As per Annexure-C1
f. Strength of the messenger cable : As per Annexure-C1
g. Mass pull off test : As per Annexure-C1
h. Dynamic characteristics test* : As per Annexure-C1

* Applicable for 4R stock bridge dampers. For alternate type of vibration dampers (permitted as per clause3.27), 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-B1

3.29.2 For conductor accessories

Visual examination and dimensional verification : As per IS: 2121 (Part-II) Clause 6.2,6.376.7

3.29.3 Tests During Manufacture on all components as applicable

a. Chemical analysis of Zinc used for galvanizing : IS 2486-(Part-I)
b. Chemical analysis mechanical metallographic test and Magnetic particle inspection for malleable castings :As per Annexure-B1
c. Chemical analysis, hardness tests and magnetic particle Inspection for forging :As per Annexure-B1

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

3.32 Test Reports

3.32.1 Copies of type test report shall be furnished in atleast 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 theContractor 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 verificationas and when desired by the Owner.

3.33 Inspection

3.33.1 The Owner 's representative shall always 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 sample sat 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 stage 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 200Kg 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 a ward, 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.	**IndianStandard**	**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.	IS1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS:2121(Part-II)	Specification for Conductor and Earth wire 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 than1000V: 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- D1171
9.		Tests on insulators of Ceramic material or glass for over head lines with a nominal voltage Greater than1000V	IEC:383-1993
10.	IS:4826	Galvanised Coating on Round Steel Wires	ASTMA472-729 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 Powerlines	

ANNEXURE - A

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 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 10Hz) 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 wheref 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 watt meter 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 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 fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be 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 cycle: 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 cycle: 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 25o to 130o within the frequency range of interest.

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

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

(b) Vibration Analysis

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

(i) The analysis shall be done for single conductor without armour rods as per the parameters given of this part of the Specification. The tension shall be taken from Sag & Tension calculation (o deg. C & no wind condition and 320 m ruling span) for a span ranging from 50 m to 1100.

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

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

(iv) Examine the aeolian 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 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 recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme

ANNEXURE – B

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 (c) (ii) of Annexure-A.

   (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 (c) (i), Annexure-A.

   (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 pieces above 5000.

The acceptance criteria will be as follows

i. The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of 5 Hz to 40 Hz.
ii. If all the individual curve for dampers are within the envelope as already mentioned for type test for reactance & phase angle, the lot passes the test.
iii. If individual results do not fall within the envelope, averaging of characteristics shall be done.
   a. Force of each damper corresponding to particular frequency shall be taken & average force of three dampers at the frequency calculated.
   b. Similar averaging shall be done for phase angle.
   c. Average force Vs frequency and average phase Vs frequency curves shall be plotted on graph paper. Curves of best fit shall be drawn for the entire frequency range.

The above curves shall be within the envelope

Section – 4

TECHNICAL SPECIFICATION OF DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS

SCOPE

This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery at site, testing and commissioning for manufacturers of disc Insulators as per technical requirements furnished in this specification. These insulators are to be used in suspension and tension insulator strings for the suspension and anchoring of the conductors on EHV transmission line towers.

45.1.2 Following are the list of documents constituting this package.

(i) Technical specification.

(ii) Technical data sheet.

(iii) Drawings of insulators

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

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

45.2.0 STANDARDS:

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

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 60274 IEC 60383
4.	IS: 2071 Part-(I)	Method of High Voltage Testing.	
	Part-(II) Part-(III)		
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 60120
	Part – III	Locking devices.	IEC: 60372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 60305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963,

			R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 60437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse Test on HV insulators.	IEC: 60506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 60575
16	IEC	Ceramic Long Rod Insulators	IEC: 60433

45.2.2 The standards mentioned above are available from

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

45.3.0 PRINCIPAL PARAMETERS.

45.3.1 DETAILS OF DISC INSULATORS:

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

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

PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-

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

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

45.3.2 SPECIFICATION DRAWINGS:

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

45.4.1 Porcelain glaze:

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

45.4.2 METAL PARTS:

45.4.2.1 Cap and Ball Pins:

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

45.4.2.2 Security Clips:

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

45.4.3 FILLER MATERIAL:

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

45.4.4 MATERIALS DESIGN AND WORKMANSHIP:

45.4.4.1 GENERAL:

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

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

45.4.4.2 INSULATOR SHELL:

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

45.4.4.3 METAL PARTS:

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

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

45.4.4.4 GALVANIZING:

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

45.4.4.5 CEMENTING:

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

45.4.4.6 SECURITY CLIPS (LOCKING DEVICES)

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

45.4.4.7 MARKING:

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

45.4.5 BALL AND SOCKET DESIGNATION:

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

45.4.6-DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

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

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

1.	70 KN/90 KN/120 KN	**145**	As per IS	As per IS
2.	160 KN	170	As per IS	As per IS

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

(45.4.7) GUARANTEED TECHNICAL PARTICULARS FOR ANTIFOG DISC INSULATORS

Sl. No.	DESCRIPTION	70 KN	90 KN	120KN	160 KN
1.	Manufacture"s name &address				
2	Type of Insulator	Ball & Socket	Ball & socket	Ball & socket	Ball & socket
3	Size of ball & socket	16B	16B	20	20
4	Dimensions				
(a)	Disc diameter	255	255	280	305
(b)	Unit spacing	145	145	145	170
(c)	Creepage distance of the single insulator-mm	430	430	430	475
5	Electro-mechanical strength of single insulator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
7	**Electrical value**				
7.1	Power frequency Withstand Voltage Disc				
	(a) Dry-kV (rms)	80	80	85	90
	(b) Wet-kV (rms)	45	45	50	50
7.2	Power frequency Flashover Voltage Disc				
	(a) Dry-kV (rms)	85	85	90	95
	(b) Wet-kV (rms)	50	50	55	55
7.3	Impulse Withstand Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)	125	125	130	135
	(b) Negative – kV(Peak)	125	125	130	135
7.4	Impulse Flashover Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)	135	135	140	145
	(b) Negative – kV(Peak)	130	130	135	140

45.4.8 INTERCHANGEABILITY:

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

45.4.9 CORONA AND RIV PERFORMANCE:

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

45.5.0 SUITABILITY FOR LIVE LINE MAINTENANCE:

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

45.5.1 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

1) Ball pin shake.
2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.
3) Sand fall defects on the surface of the insulator.

45.5.2 INSULATOR STRINGS:

45.5.2.1 TYPE AND RATING:

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

45.5.2.2 STRING SIZE:

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 45.3.1.2.

45.5.3 STRING CHARACTERISTICS

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

Sl. No.	Description.	Suspension.		Tension.	
		132KV	**220kV**	**132KV**	**220KV**
I	Switching surge withstand voltage (dry& wet) KV Peak	-	-	-	-
II	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
III	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
IV.	Corona extinction voltage level KV rms	-	176	-	176
V	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). … hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
VI.	Mechanical failing load for each string (kgf)	6500	11500	11500	15500
VII.	No deformation load for each string (kgf)	-	7705	-	10385
VIII	Max. voltage across any disc.	13%	13%	13%	13%

45.5.3.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

45.5.3.3 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.

Section – 5

Technical Specifications for stringing activities of HTLS Conductor (ACCC equivalent to ACSR Panther)

5.1 Site Inspection

5.1.1 Site Inspection Report

The contractor shall visit the site to inspect the transmission line and collect observations/information which would be useful for stringing activity & bidding. Complete BOQ of the each transmission line for reconductoring shall be furnished in the report & is to be got approved.

a) 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.

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

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

d) 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.

e) 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.

f) All the requisite data for processing the case of statutory clearances such as PTCC, Forest and Railway shall be provided along with the report.

g) Six copies of survey reports shall be furnished by the contractor to the Employer.

5.2 Environmental Conditions

5.2.1 Forest

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

5.2.2 General Climatic Conditions

Climatic conditions shall be of tropical nature having summer period for 8 months and winter period for 4 months in a year. Working season shall be approximately 9 months/year and balance 3 months shall be monsoon period.

The maximum temperature during summer shall be of the order of 50°C and the minimum temperature in the winter shall be of the order of 4°C. Normal everyday temperature is 32°C.

5.2.3 Statutory Regulations and Standards

4.2.3.1 Statutory Regulations

The Contractor is required to follow local statutory regulations stipulated in Electricity (Supply) Act 1948, Indian Electricity Rules, 1956 as amended and other local rules and regulations referred in this Specifications.

4.2.3.2 Reference Standards

The Codes and/or standards referred to in the specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions, amendments/changes adopted and published by the relevant agencies.

Other internationally accepted standards which ensure equal or better performance than those specified shall also be accepted, subject to prior approval by the Employer.

5.3 Span and clearances

5.3.1 Normal Span

The normal ruling span of the line on panther conductor is 320 m..

5.3.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

5.3.3 Weight span

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

5.4 Electrical Clearances

5.4.1. 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.

5.5 Stringing of Conductor and Installation of Line Materials

5.5.1 General

a) The scope of erection work shall include 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.

b) 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. 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.

c) 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.

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

e) 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.

f) The scope of work of the contractor shall inter-alia include the following:-

i. Installation of necessary hardware, hoisting of insulator strings, installing & stringing of HTLS Conductor including fixing of conductor accessories. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components.

5.5.2 Handling of Conductor

a. <u>Running Out of the Conductors</u>

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.

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.

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.

Tower not designed for one sided stringing 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.

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 includes measures taking in account the other circuit on the line under live conditions.

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

b. <u>Running Blocks</u>

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.

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.

c. <u>Repairs to Conductors</u>

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

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.

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

d. **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.

5.5.3 Stringing of Conductor

a. The stringing of the equivalent HTLS conductor shall be done by the standard stringing method suitable for the type of HTLS Conductor offered.

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.
If any special tools and tackles other than those generally used for stringing of AAAC 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.

b. 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.

c. Conductor creep are 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.

5.5.4 Jointing

a. 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.

b. 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.

c. 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.

d. 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.

e. 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.

5.5.5 Tensioning and Sagging Operations

a. 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.

b. 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.

c. 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.

d. 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.

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

5.5.6 Clipping In

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

b. Jumpers at section and angle towers shall be formed to parabolic shape as per existing tower line diagrams to ensure minimum clearance requirements.

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

5.5.7 Fixing of Conductors Accessories

Conductor accessories including spacers, spacer dampers (for bundle conductor) and 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 Dampers/Spacer Dampers, Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied

5.5.8 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:

a) The stringing of the conductors has been done as per the approved sag and tension charts and desired clearances are clearly available;
b) All conductor accessories are properly installed;
c) The original tracings of profile are submitted to the Employer for reference and record.
d) 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.
e) The line is tested satisfactorily for commissioning purpose.

Section – 6

Technical Data Sheet

SCHEDULE -1

GUARANTEED TECHNICAL PARTICULARS OF ACCC HTLS CONDUCTOR WITH HYBRID CARBON AND GLASS FIBER COMPOSITE CORE

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	DC resistance of conductor at 20^{O}C	Ohm/km	
7.6	Final Modulus of elasticity		
	a) Upto transition temperature	Kg/sq. mm	
	b) Above transition temperature	Kg/sq. mm	
7.7	Coefficient of linear expansion		
	a) Upto transition temperature	Per deg C	
	b) Above transition temperature	Per deg C	
7.8	Calculation for transition temperature enclosed	Yes/No	

7.9	Transition temperature (corresponding to 320 m ruling span and tension at ruling condition)	Deg C	
7.10	Maximum permissible conductor temperature for continuous operation	Deg C	
7.11	Maximum permissible conductor temperature for short term operation	Deg C	
7.12	Permissible duration of above short term operation	Minutes	
7.13	Steady state conductor temperature at conductor current of 875A and under Ambient conditions detailed in Section-1		
7.14	AC resistance at maximum continuous operating temperature corresponding to specified maximum operating current (875 A under ambient condition enclosed as per relevant clause under Section-1)	Ohm/km	
7.15	AC resistance at continuous operating temperature corresponding to specified operating current of 437 A (under ambient condition enclosed as per relevant Clause of Section-1 of Bid document)	Ohm/km	
7.16	Details of Creep characteristic for HTLS conductor enclosed (as per Clause 1.5.5 of Section-3 of the bid document)	Yes/No	
7.17	Sag Tension Calculation		
7.17.1	Sag Tension Calculation enclosed (as per Clause 1.5.5 of Section-1 of the bid document)	Yes/No	
7.17.2	Tension at 32 deg. C & no wind	Kg	
7.17.3	Sag & tension at maximum continuous operating temperature (corresponding to current of 875 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: (Signature).....

Place: (Printed Name).....

(Designation).....

(Common Seal).....

SCHEDULE -2

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

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 875 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		

Date: (Signature).....

Place: (Printed Name).....

(Designation).....

(Common Seal).....

SCHEDULE -3

GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS

Sl.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer		.....	
2.	Address of Manufacturer		.....	
3.	Drawing enclosed		Yes/ No	
4.	Purity of 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	%	……. .

Date: (Signature)……

Place: (Printed Name)……

(Designation)……

(Common Seal)……

SCHEDULE -4

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR
HTLS CONDUCTOR (Non Metallic Core)

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		…….	……..

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.	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	……
15.	Maximum permissible continuous operating temperature of mid span joint	Deg. °C	……

(Signature)……

Date:
Place:

(Printed Name)
……..
(Designation)……

(Common Seal)……

SCHEDULE -5

GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR HTLS CONDUCTOR

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.	Maximum permissible continuous operating temperature of Repair Sleeve	Deg. °C	

Date:

Place:

(Signature)……

(Printed Name)……

(Designation)……

(Common Seal)……

SCHEDULE -6

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR HTLS CONDUCTOR

(IF APPLICABLE)

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	……	

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 800 amps, 50 Hz Alternating Current	Watts	……	
20.	Maximum permissible continuous operating temperature of Vibration Damper	Deg. °C		
21.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test	%	……	
22.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	……	

Date:

(Signature)……

Place:

(Printed Name)…….

(Designation)…… (Common Seal)…….