SECTION-1

COMMON TECHNICAL REQUIREMENT

1.01 SCOPE:

1.01.01 The provisions under this section are to supplement common requirements for supply of Transmission Line Materials and Installation work. Section-2 to Section-6 contains technical specification for all the Materials to be used for Construction of Transmission Lines. The bidders shall furnish catalogues, engineering data / technical information, drawing etc. in conformity with the technical specification.

1.01.02 It is not the intent to specify completely herein all details of the design and construction of Material. However, the Material shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing the duties specified herein. The Material offered shall be complete with all components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of Bidder's supply, irrespective of whether these are specifically brought out in this specification or not.

1.02 CLIMATIC CONDITION

The equipments and materials shall be suitable for satisfactory continuous operation under the following climatic conditions:

1	Location in the state of	MADHYA PRADESH
2	Maximum ambient air temperature (^{0}C)	50
3	Minimum temperature in shade (^{0}C)	1
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature (^{0}C)	32° Centigrade
6	ISOCERANIC Level (days/year) (Average number of thunder storm days)	50
7	Average rainfall(mm)	1250
8	Wind Zone as per IS 802(Part-I)- 1995	4
9	Max. Altitudes above mean sea level (meters)	1000
10	Seismic level (Horizontal acceleration)(g)	0.3

NOTE: Moderately hot and humid tropical climate conducive to rust and fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere. Heavy lightening also occurs during June to October.

1.03 STANDARDS:

1.03.01 Bidders may please note that all offered materials shall be manufactured, tested and supplied with all guaranteed technical particulars generally conforming to meet the requirement of technical specification as brought out in various Sections and latest revisions of relevant standards of international electro technical commission or equivalent national standards of India with latest amendments of relevant standards rules and codes. The lists of standards are specified in relevant Sections of bid document.

1.03.02 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules Laws and Regulations of India.

1.03.03 The Contractor shall also note that list of standards presented in this specification is not complete. Wherever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

1.03.04 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

1.04 ACCEPTANCE OF OTHER AUTHORITATIVE STANDARDS :

1.04.01 The lists of Indian standards are specified in individual sections for various materials and Installation work of bid document. However, the Material and Installation work meeting any other authoritative International Standard, which ensures equal or better quality than the Standards mentioned in bid document, shall also be acceptable. **Material for which Indian Standards are not available, any equivalent International Standards will be applicable. Please attach photocopy of all such Standards according to which the material and Installation work have been offered.**

1.04.02 If the material offered by the Bidder conform to any other standards, salient points of comparison between the standards adopted and the specific standards shall be clearly brought out in relevant schedule of deviation. It will be sole responsibility of Bidder to prove that the salient features of offered materials are equivalent or better than Indian standards as indicated in Section-2 to Section- 9 of this document.

1.04.03 The Material and Installation work conforming to standards other than specified in individual sections for various Material and Installation work shall be subject to Employer's approval.

1.05 TYPE TESTS:

1.05.01 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the Material.

1.05.02 The offered Material (except Towers & Tower Accessories) should be fully type tested as per the relevant standards. Bidder shall invariably furnish type test reports from the reputed and approved national/international laboratory/Government approved test houses to prove that specifications of Material to be supplied conform to the relevant standard. Test certificates shall clearly indicate the type and other details etc., so that relevant details of offered Material could be verified. While submitting the bid the details and type etc., shall be clearly indicated. Type test reports so furnished should not pertain to the period earlier than five years from the date of opening of Bid. In case the type tests were carried out earlier than five years, the manufacturer will have to conduct these tests without any extra cost to the Employer. In both the above cases type test certificate must be submitted with the offer. The Bidders have to submit one complete set of Test reports for the offered Material. Further, for any change in the design/type already type tested and the design/type offered against this specification, the Employer reserves the right to demand repetition of tests without any extra cost.

1.06 DISCREPANCY IN TECHNICAL PARTICULARS:

The bidders will have to furnish confirmation in regard to compliance of our entire technical requirement. The bid should clearly describe various technical particulars of the material as per this specification.

1.07 MANUFACTURER'S AUTHORISATION:

The bidders shall have to submit the documentation from the manufacturer of the Material on the format specified in this volume that they are authorised to supply the material indicated in their bids in the employer's country.

1.08 SCHEDULE OF QUANTITIES:

1.08.01 The requirements of various Materials and Installation work are indicated in Price Schedules. In these schedules short description of material has been given. The details of all such description are given in relevant sections of this document. The bidder shall refer these detailed descriptions for clarity.

1.08.02 Although all the quantity of Material and Installation work have been included in the bid as mentioned in Price Schedules. However there may be requirement of some minor nature items required for successful erection / commissioning of transmission line work covered under this Bid. Bidder should include all such items in the bid proposal sheets which are not specifically mentioned but are essential for the execution of the contract. The cost of supply of such item which explicitly may not appear in various schedules and are required for successful commissioning of transmission line shall deemed to be inclusive in the bid price and shall be provided at no extra cost to Employer.

1.09 WORKMANSHIP:

All Material shall be of the best class and quality most suitable for the conditions of operation under the climate conditions as per clause no. 1.02 above for supply of Material. The workmanship shall be of the best grade and the entire construction in accordance with the best modern practice.

1.10 DRAWINGS AND DOCUMENTS:

1.10.01 In addition to those stipulated in Vol. I of bidding document, the following also shall apply in respect of Contractor drawings.

1.10.02 Within one month from the award of contract, the contractor shall submit the drawing of all Material for approval. 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.

1.10.03 The comments/ approval to drawings submitted by the Contractor shall be conveyed by the EMPLOYER as far as practicable within 15 days and shall be modified by the Contractor if any modifications and/or corrections are required by the EMPLOYER. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval with 15 days from date of EMPLOYERs comments. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the Contractual Time Schedule.

1.10.04 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.

1.10.05 The work shall be performed by the Contractor strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the EMPLOYER, if so required.

1.10.06 All manufacturing, fabrication and Installation work under the scope of Contractor, prior to the approval of the drawings shall be at the Contractor's risk. The contractor may incorporate any changes in the design, which are necessary to confirm to the provisions and intent of the contract and such changes will again be subject to approval by the EMPLOYER.

1.10.07 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 documents (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 all technical requirements or 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 for consequences.

1.10.08 All drawings shall be prepared using AutoCAD software. After final approval all the drawings and documents (structural drawings, BOMs, shop sketches, tower accessories drawings and drawings of other materials) shall be submitted to the EMPLOYER in CDs.

A copy of each drawing reviewed will be returned to the Contractor as stipulated herein.

1.10.09 Copies of drawings returned to the Contractor will be in the form of a print with the EMPLOYER's marking.

1.10.10 All rights of the design/drawing for all Material and Installation work drawings shall be strictly reserved with the EMPLOYER only and any designs/drawings/data sheets submitted by the contractor from time to time shall become the property of the EMPLOYER. Under no circumstances, the contractor shall be allowed to user/offer above designs/drawings/data sheets to any other authority without prior written permission of the EMPLOYER. Any deviation to above is not acceptable and may be a cause for rejection of the bid.

1.10.11 The manufacturing of the material shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the EMPLOYER. All manufacturing and fabrication work in connection with the material prior to the approval of the drawing shall be at Contractor's risk.

1.10.12 Approval of drawing/works by EMPLOYER shall not relieve the Contractor of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The plant shall conform in all respect to high standards of engineering, design, workmanship and latest revisions of relevant standards. EMPLOYER shall have the power to reject any work or material, which in his judgment is not in full accordance therewith.

1.11 QUALITY ASSURANCE PROGRAM:

1.11.01 Quality Assurance Program : To ensure that the Material 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 the EMPLOYER's site or at any other place of work are in accordance with the Specifications, the Contractor shall adopt suitable Quality Assurance Program (QAP) with hold points for EMPLOYER's inspection to control such activities at all necessary points. Such program shall be outlined by the Contractor and shall be finally accepted by the EMPLOYER after discussions.

1.11.02 Immediately after award of contract, the contractor shall submit to the EMPLOYER, the quality assurance plan for all major items of Material covering the manufacture and Installation activities of the transmission line. The list of selected sub vendors for supply of minor items like Bolts & Nuts, tower accessories etc. shall also be submitted.

1.11.03 The contractor shall ensure that manufacturer must establish that they are following the accepted quality assurance programme for manufacture of offered equipments.

1.11.04 The contractor shall ensure that manufacturers of major items of Material invariably furnish following information:-

(i) Statement giving list of important raw materials, names of sub supplier for the raw material, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in presence of manufacturers representative, copies of test certificates.

(ii) Information and copies of test certificates as in (i) above in respect of bought out items.

(iii) List of manufacturing facilities available.

(iv) Levels of automation achieved and list of areas where manual processing exists.

(v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.

(vi) Special features provided in the equipment to make it maintenance free.

(vii) List of testing equipment available with the manufacturer for final testing of equipment specified and test plant limitations, if any vis-à-vis type, special, acceptance and routine tests specified in the relevant Indian Standards or equivalent international standard. These limitations shall be very clearly brought out in schedule of deviations from specified test equipments.

1.11.05 The Contractor shall follow the accepted Quality Assurance Plan in true spirit. If desired by the EMPLOYER, he shall give access to all the Specifications, equipments and records so as to satisfy the EMPLOYER that Quality Assurance Plan (QAP) is being followed properly.

1.11.06 All Material shall be subjected to the routine and acceptance tests before dispatch, as specified in this Specification.

1.12 INSPECTION AND TEST CERTIFICATES:

1.12.01 All Material to be supplied will be subject to inspection and approval by the EMPLOYER's representative before despatch. Inspection before despatch will not however relieve the contractor of his responsibility to supply the Material strictly in accordance with the specifications.

1.12.02 For Inspection / testing, the contractor shall intimate the EMPLOYER at least 15 days in advance about readiness of Material as per the scheduled delivery so that action may be taken for getting the Material inspected. While notifying the readiness of the Material, the factory test certificate in respect of offered Material shall invariably be sent. The EMPLOYER will depute authorized representative for inspection of Material or alternatively may issue waiver of inspection.

1.12.03 The contractor will submit a test certificate to the EMPLOYER after inspection of offered Material by EMPLOYER’s authorized representative. These test certificates should be in accordance with latest issue of the relevant Indian Standards or as approved by the order placing authority.

1.12.04 The Material shall not be dispatched unless the test certificates approval and despatch instructions have been issued by the EMPLOYER.

1.12.05 All Material shall conform to provisions of any statutory acts such as the Indian Electricity Act, Indian Factory Act, the Indian Boiler Act, etc. and corresponding rules and regulations as may be applicable.

1.12.06 The EMPLOYER's representatives shall be entitled at all reasonable time during manufacture to inspect, examine and test at the contractor's premises the material and workmanship of the plant to be supplied under this contract.

1.12.07 A copy of the accepted Quality Assurance Plan must be available at the manufacturer's works of the Material for reviewing by inspecting officer of the EMPLOYER.

1.12.08 The acceptance of any quantity of plant shall in no way relieve the Contractor of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such plant is later found to be defective. The Contractor will have to assume the responsibility for free replacement/rectification of such defects.

1.12.09 Testing Expenses:

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified in the bid document shall be treated as included in the quoted unit price of plant.

1.13 SPECIAL REQUIREMENTS:

1.13.01 EMPLOYER expects that participating bidder will take all necessary precautions to supply best quality Material, which may provide trouble free performance and also it is expected that the modern practices for erection and commissioning shall be adopted to ensure timely and trouble free commissioning of installation and also to ensure aesthetic overall view of finished transmission line installation.

Some of the conditions which will have to be essentially accepted and followed by the Bidders for the purpose of participating against the Bid and also for undertaking construction activities are enumerated below for specific confirmation by the Bidders.

1.14 STORE FOR SUPPLY OF MATERIAL:

The Contractor shall supply the Material at selected destination set up by him along the route of the transmission line. The Contractor will set up above site store within one month from the date of contract and inform the EMPLOYER. The Contractor will have to supply above materials and receive them at these places only and the rates quoted by the Bidder should include charges for delivery of such materials at the store set up by him, receipt and proper stacking/ stocking at the store.

1.15 COMMENCEMENT OF ACTIVITIES:

Commencement of following activities is subject to prior and specific approval of the items mentioned against each:-

S. No.	Activity	Items for which prior approval is necessary from Employer
1.	Manufacturing of Conductors Insulators, Hardware fittings & Accessories for Conductor	Submission of Quality Assurance Plan, approval of drawings.
2.	Dispatch of towers, Conductors, Earth wire,	Acceptance test and issue of test certificate approval

S. No.	Activity	Items for which prior approval is necessary from Employer
	Insulators, Hardware fittings & Accessories for Conductor and Earth wire/ OPGW.	
3.	Stringing of Conductor and Earth wire /OPGW.	Stringing chart and stringing method.

1.16 RESPONSIBILITY FOR OBTAINING INFORMATION AND TAKING ACTION IN TIME:

Whenever any information or clarifications in respect of construction of line has to be obtained from various authorities, the Contractor shall be responsible for taking action well in time so that there are no delays on this account. The completion period specified in the bidding document is deemed to include the time taken for such incidental works. Request for extension of the completion date on such ground will not be entertained.

1.17 PERMITS AND PRIORITIES:

1.17.01 Necessary permits, if any, required for the execution of the contract shall be arranged by the Contractor himself. The Contractor shall obtain the necessary license/permission as per Central/State/local statutory bodies at his cost.

1.17.02 The Purchaser may, however, furnish to the Contractor such certificates (on receipt of such written request from the Contractor) as may be required for the necessary permits/priorities for the execution of works, if it considers the demand as justified.

1.17.03 The Purchaser however, shall not be responsible for the delay in execution of contract, if permits/priorities are not granted in time in spite of issuance of such certificate.

1.18 WAY LEAVE:

The purchaser will arrange for necessary way leave and clearance of trees. The Purchaser will pay the way leave compensation. The purchaser will also arrange for the following: -

(i) Railway clearance
(ii) PTCC clearance
(iii) Forest clearance
(iv) Any other necessary clearance if required/requested.

The Contractor shall inform the purchaser about the places where there is a way leave problem, sufficiently in advance (preferably 30 days) so that required way leave can be arranged in time.

Further Contractor shall inform the employer at least 15 days in advance, the sections of the line where he has planned to carry out the foundation/ tower erection/stringing work so that MPPTCL may take advance suitable actions to avoid possibility of any ROW problem.

Please note that while carrying out stringing work, if obstruction is faced due to branches of trees, the same will be cleared by the contractor. Further, the contractor will make all- out efforts to carry out stringing work across Electrified Railway Track within minimum possible duration.

1.19 USE OF PRIVATE ROADS/APPROACH ROAD TO SITE:

1.19.01 The purchaser will help in getting necessary permission for use of private/forest/canal, roads for transportation of materials and construction personnels, wherever possible under the rules. Any charges/tole tax etc. levied by the concerned authorities for use of such roads etc. shall be borne by the Contractor.

1.19.02 During the erection work, if approach roads are required to be constructed for reaching the construction sites for transportation of men/materials, the cost of construction of such approach roads and any other expenses incurred in obtaining clearance/permission shall be borne by the Contractor.

1.20 MATERIALS TO BE ARRANGED BY THE CONTRACTOR FOR ERECTION WORK:

1.20.01 The supply of cement for foundation work would be arranged by the Contractor of the quality as per IS - 269 :1989 (Ordinary Portland Cement 33 Grade) or IS – 8112 : 1987 (Ordinary Portland Cement 43 Grade) or IS – 12269 : 1987 (Ordinary Portland Cement 53 Grade) or IS:1489 (Portland-Pozzolana Cement (PPC)). The cost of cement shall be deemed to be included in the quoted unit rates of concreting.

1.20.02 The cement used shall be procured from reputed manufacturer like JP Cement, L&T, Birla Cement, ACC, Ambuja etc. The Contractor shall submit the manufacturer's certificate, for each consignment of cement procured, to the Purchaser. The cement shall be arranged in conventional Jute/HD bags each weighing 50 Kgs net with necessary IS certification mark on it. In case of any dispute regarding quality of cement, sample for testing may be taken jointly by contractor's representative and Engineer in- charge of work or any authorized representative of the Company. The sample taken shall be tested for standard test as per IS code in Govt. Engineering/Polytechnic College and testing charge shall be borne by the contractor. In case the material is found defective i.e. not as per relevant ISS, the same shall be replaced by the contractor at his cost. The Contractor shall also have no claim towards suspension of work due to time taken in conducting tests in the laboratory. Changing of brand or type of cement within the same structure shall not be permitted without the prior approval of the Purchaser.

1.20.03 The Quantity of cement to be used per unit quantity of consumption for different mix (nominal mix) of concrete should be as follows:

S. No.	Description	Unit	Quantity of minimum Cement to be used per Unit quantity of work(in kgs)
1	1:1.5:3 nominal mix concrete	Cu.m.	400
2	1:2:4 nominal mix concrete	Cu.m.	330
3	1:3:6 nominal mix concrete	Cu.m.	220
4	Random Rubble Masonry with 1:6 cement mortar	Cu.m	83

1.20.04 The Contractor shall arrange metal, sand, stone and water required for foundation/revetment work. The transport, octroi, levy or duty on these materials shall be borne by the Contractor himself and the purchaser will not accept any liability on this account.

1.20.05 The Contractor will also arrange steel rods and binding wires etc. for foundation, reinforcement and the cast incurred will be borne by him. Materials for

proper earthing of towers i.e. earthing rod, connecting clamps and connecting wires etc. would also be arranged by the Contractor as already specified.

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SECTION-2
HTLS CONDUCTOR WITH NON METALLIC CORE, HARDWARE FITTINGS & ACCESSORIES

2.01 Scope:

2.01.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site F.O.R. destination of HTLS Conductor with non- metallic core for restringing of various 220 kV Lines with existing conductor (viz. ACSR Zebra) for capacity enhancement and its associated Hardware Fittings & Accessories.

2.01.2 It is not the intent to specify completely herein all details of the design and construction of conductor. However, the conductor shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The Purchaser, who will interpret the meanings of drawings and specification, shall have the power to reject any work or material which in his judgment is not in accordance therewith. The material offered shall be complete with all components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of Bidder's supply only, irrespective of whether these are specifically mentioned in his specification and/or the commercial order or not.

2.02 The HTLS Conductor with non-metallic core shall meet the following minimum requirements:

(i)	Overall diameter of complete conductor	Overall diameter of the conductor should be less than or equal to 28.62 mm. Approx.
(ii)	Mass of complete conductor (kg/Km)	Less than or equal to 1621 kg/km
(iii)	Direction of lay of outer layer	Right Hand

(iv) Outer diameter of core in mm should not exceed diameter of core of existing ACSR Zebra conductor.

(v) DC resistance at 20ºC and AC resistance at 75ºC should be at least 15% less than ACSR Zebra conductor.

(vi) The conductivity at 20 Deg C (corresponding to % IACS) of aluminum or aluminum alloy used in the offered HTLS conductor should not be less than the % IACS Conductivity of Aluminum used in ACSR type conductor (IACS: International Annealed Copper Standard)

(vii) In case of composite core type conductors, composite Core manufacturer must have successfully performed **design validation tests** prior to bid submission as per ASTM B987 on the class of core being offered and it must be witnessed by the representative (s) of Utility or witnessed by representative of a Laboratory which is accredited to ISO/IEC 17025 (different than that of laboratory where tests were performed).

(viii) Sag of offered HTLS conductor at designed maximum temperature must be less than or equal to the corresponding sag of the existing ACSR Zebra conductor at 75 Deg C considering the same span length (350M).

(ix) Sag of offered HTLS conductor at 0°C Nil wind condition must be more than or equal to the corresponding sag of the existing ACSR Zebra conductor considering the same span length (350M) so as to maintain the sag of earthwire equal to 90% of ACSR Zebra conductor.

(x) Tension of offered HTLS conductor at 32°C Full wind condition (45kg/sqm must be less than or equal to the corresponding sag of the existing ACSR Zebra conductor the same span length(350M).

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 1400 amperes per conductor at specified ambient conditions (maximum continuous operating temperature).

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

2.03 Maximum Conductor sag for prevailing span (of the line in which replacement of conductor is being carried out) at steady state conductor temperature and no wind corresponding to 50 Hz alternating current of 1400 Amperes per conductor under ambient conditions will be such that the statutory ground clearance will be maintained throughout the route keeping (erection) tension at 25% of UTS of conductor. It is to inform that the conductor has to be strung on old existing towers.

2.04 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. The design of conductor shall be suitable for operation at a steady state conductor temperature experienced for AC current flow of 1400 Amperes under the above ambient conditions based on ampacity calculations mentioned above. The bidder shall also indicate the maximum permissible conductor temperature for continuous operation without any deterioration of its electrical, mechanical & metallurgical properties. The bidder shall also furnish the maximum permissible conductor temperature for short-term operations including permissible duration of such short-term operation.

2.05 Current Carrying Capacity / Ampacity Requirements

Each HTLS Conductor with non-metallic core shall be suitable to carry minimum 50 Hz alternating current of 1400 Amperes under the ambient conditions & maximum conductor sag specified below while satisfying other specified technical requirements/ parameters. It is to inform that climatic conditions of MP State (like wind zone -4) may be assumed for ampacity calculations.

2.06 Sag-Tension Requirements

2.06.1 The HTLS Conductor with non-metallic core shall meet the following sag tension requirements for existing span of the line.

Particulars	Limiting value
(i) Tension at every day condition (32°C, no wind)	- 3322 kgs & Not exceeding 25% of UTS of proposed conductor
(ii) Tension at 32°C, full wind (45 kg/m2)	_ 3952.9 kgs & not exceeding 70% of UTS of proposed conductor
(iii) Sag at Maximum continuous operating temp (corresponding to 1400 amperes and no wind) including all of the above conditions.	- Less than or equal to 9.24 meters

2.06.2 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.

2.06.3 The bidder shall also furnish sag & tensions under no wind for various temperatures starting from 0° C to maximum continuous operating temperature in steps of 5° C. After award of the contract, the Supplier shall submit Sag-Tension calculations corresponding to various conditions given above for all the existing spans and spans ranging from 50 m to 360 m in intervals of 10m. It is to inform that the ruling span is the prevailing span as existing conductor on existing towers is being replaced.

2.06.4 Besides above, the Supplier shall also furnish details of creep characteristics in respect of HTLS Conductor with non-metallic core based on laboratory investigations/ experimentation (creep test as per IEE1138) conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year & 10 year creep at everyday tension & at designed maximum operating temperature.

2.06.5 Evaluation of Technical parameters will be based on the following parameters:

i) DC resistance
ii) AC resistance at its operating temperature at 1400 Amps,
iii) Sag
iv) Weight

2.06.6 Penalty for deviation from GTP:

On testing or during operation, if it is found that actual parameters are deviating in excess than that are allowed as per the relevant specifications, actions like forfeiting the Security Deposit, black listing from the supplier/contractor etc. will be initiated.

2.06.7 Hardware & accessories should be compatible with the supplied HTLS Conductor with non- metallic core and existing insulators & structures.

2.06.8 Workmanship

i) 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.

ii) 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.

2.06.9 Joints in wires

a) Aluminum OR Aluminum Alloy Wires

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

b) Core Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no joints or splices in any length of the completed stranded core. Splices of the fibers in composite cores are allowed as long as they conform to the requirements of ASTM B987 for Joints and Splices.

2.06.10 Tolerances

Manufacturing tolerances on the dimensions to the extent of one percent shall be permitted for individual strands and the complete conductor. It is to inform that the manufacturing tolerances shall be as per IEC or relevant standards. For composite cores, the manufacturing tolerance shall be +/- 0.05 mm of the stated nominal value.

2.06.11 Materials

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

2.06.12 Outer Layer

The material of outer layer of HTLS Conductor with non-metallic core shall be of annealed aluminium 1350-O temper, high temperature resistant aluminum/ aluminum alloy added with zirconium or any other suitable elements to electrolytic aluminum having purity not less than 99.5% and a copper content not exceeding 0.04%. Bidder shall guarantee the chemical composition in the schedule GTP and also furnish description of the manufacturing process in the bid. It is to inform that the test shall be carried out as per the relevant standards.

2.06.13 Core

Carbon Fiber Composite Core should be used. The core wire strands may be of any composite materials or special steel and shall have properties conforming to the technical performance requirements of the finished conductor. Bidder shall furnish properties and composition of the core wire strands in the GTP schedule. The composite material for core shall be of such proven quality that its properties are not deteriorated by the normal operating conditions of 220KV transmission line in tropical environment conditions as experienced by the existing lines. The Bidder shall provide adequate details including specifications / test reports / operating experience details / performance certificates etc. in support of the suitability of the offered materials. Care to be taken for internal friction due to different material having different thermal co efficient of expansion.

2.06.14 Conductor Length

The Bidder after his survey of the **existing line shall determine the most appropriate individual conductor lengths to be manufactured & supplied keeping in view of the tower schedules**, section lengths, special crossings etc. The drum drawing as per IS 1778 or any international standard shall be submitted to purchaser for review and approval. The Bidder shall also indicate the maximum single length of conductor that they can manufacture, in the GTP.

2.06.15 Standards

The conductors & accessories shall comply in all respects to the clauses of this specification as indicated above & with the specified standards.

2.06.16 Stranding

For all, constructions, each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the under laying wire or wires. The final layer of wires shall have a right hand lay.

2.06.17 Packing

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

ii. The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5000 Kgf.

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

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

v. 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.

2.06.18 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.

(k) Barrel diameter at three locations & an arrow marking at the location of the measurement.
(l) Number of turns in the outer most layer.
(m) Gross weight of drum after putting lagging.
(n) Tear weight of the drum without lagging.
(o) Net weight of the conductor in the drum.
(p) Dispatch instruction.

The above should be indicated in the packing list also.

2.06.19 Verification of Conductor Length

The MPPTCL 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.

2.06.20 Tests and Standards

2.06.20.1 Type Tests

i. Type Tests on Stranded Conductor/ Stranded wire:

The following tests should have been conducted in last five year for which offer is made and should be submitted along with the bid. The bids without valid type test reports are liable for rejection.

All the specified type tests on HTLS Conductor with non-metallic core offered by the bidder shall not be required to be carried out if valid test certificate is available i.e., tests conducted within last **five years from the date of bid opening** in an accredited laboratory or witnessed by the representative (s) of a 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 noncompliance with the requirement stipulated in the Technical Specification) the **tests shall be conducted by the Contractor at no extra cost to MPPTCL.**

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 as per IEC 1089
d) Stress-strain test on stranded conductor and core at elevated temperature As per Annexure-A
e) High temperature endurance & creep test on stranded conductor: As per Annexure-A
f) Sheaves Test : As per Annexure-A
g) Axial Impact Test : As per Annexure-A
h) Crush Strength Test : As per Annexure-A
i) Torsional Ductility Test : As per Annexure-A

iii. On Conductor Strand/core
a) Bending test on core: As per Annexure-A
b) Compression test on core: As per Annexure-A

c) Coefficient of linear expansion on core/ core strands: As per Annexure-A

2.06.20.2 Acceptance Tests

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/composite core and Aluminum Alloy strands: As per Annexure-A
d) Check for lay-ratios of various layers As per Annexure-A
e) Galvanizing test on core strands (if applicable): As per Annexure-A
f) aluminum thickness on aluminum clad wires (if applicable)
g) Torsion and Elongation tests on core strands/composite core:As per Annexure-A
h) Breaking load test on core strands and Aluminum / Aluminum Alloy strands: As per Annexure-A
i) Wrap test on core strands and conductor. : As per IEC: 888 & IES: 889
j) Minimum conductivity test on conductor strands: As per IEC: 889
k) Ageing test on filler (if applicable): As per Annexure-A
l) Minimum conductivity test on core strands (if applicable): As per Annexure-A
m) Dimensional check on conductor
n) Galvanic layer thickness test for composite core: As per ASTM B987

Note: All the above tests except (j) shall be carried out on Aluminum /Aluminum Alloy and core strands after stranding only. It is to inform that the test shall be carried out as per IEC or relevant standards. For composite core conductors, all acceptance tests shall be carried out before stranding

2.06.20.3 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 each coil

2.06.20.4 Tests during Manufacture

a) Chemical analysis of zinc used for galvanizing (if applicable): As per Annexure-A
b) Chemical analysis of Aluminum alloy used form making Aluminum Alloy strands: As per Annexure-A
c) Chemical analysis of core strands As per Annexure-A

2.06.21 Test Reports

i. Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the MPPTCL's representative.
ii. Test Certificates of tests during manufacture shall be maintained by the Supplier.
These shall be produced for verification as and when desired by the MPPTCL.

2.07 Inspection

i) MPPTCL'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.
ii) The Supplier shall keep MPPTCL 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.

iii) 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 MPPTCL in writing. In the latter case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

iv) 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.

2.08 Test Facilities

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

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

b) Standard resistance for calibration of resistance bridges.

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

2.09 Standards

i. 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.

ii. 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	Title	International
1	IS: 209-1992	Specification for zinc	BS:3436-1986
2	IS: 398-1982	Specification for Aluminum Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3	IS:398-1990 Part-II	Aluminum Conductor Galvanised Steel Reinforced	BS;215-1970 IEC:1089-1991
4	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel- Reinforced For Extra High	IEC:1089-1991 BS:215-1970
5	IS : 1778-1980	Reels and Drums for Bare Conductors	BS:1559-1949
6	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
7	IS : 2629-1990	Recommended Practice for Hot Dip Galvanizing of Iron and	
8	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated	
9	IS : 4826-1992	Galvanised Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969

10	IS : 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973
11	IS : 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
12	IS : 9997-	Aluminium Alloy Redraw Rods	IEC 104 - 1987
13		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
14		Hard drawn Aluminium wire for	IEC : 889-1987
15	IS:398 (Part-IV)	Aluminium Alloy stranded conductor	IEC : 208-1966 BS-3242-1970
16		Aluminium clad steel wires	IEC:1232
17		Method of measurement of resistivity of metallic materials	EC:468
18		Ampacity	IEEE738
19		Creep	
20		Standard Specification for Carbon Fiber Thermoset Polymer Matrix Composite Core(CFC) for use in Overhead Electrical Conductors1	ASTM B987

The standards mentioned above are available from:

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

2.10 Principal Parameters:

The principle parameters of HTLS conductor with non-metallic core are tabulated below

	PARAMETER	HTLS conductor with non-metallic core
a)	Current carrying capacity	≥ 1400 Amps
b)	Sectional area of Aluminium (Sq.mm)	> 428.90
c)	Total Sectional area (Sq.mm)	> 484.50
d)	Overall diameter (mm)	≤ 28.62
e)	Approximate weight (kg/km)	≤ 1621
f)	Calculated maximum D.C resistance at 20 deg. C	≤ 0.06868
g)	Minimum UTS (kN)	≥ 130.32
h)	Modulus of Elasticity (gN/Sq.meter)	≤ 69
i)	Coefficient of linear expansion per	≤ 19.3×10^{-6}

SECTION-3
TECHNICAL SPECIFICATIONS FOR HARDWARE FITTINGS & ACCESSORIES FOR HTLS CONDUCTOR WITH NON- METALLIC CORE.

Technical Description of Hardware Fittings

3.01 General

3.01.1 This section details technical particulars of fittings viz. suspension clamps and compression type dead end clamps for the HTLS Conductor with non-metallic core to be supplied by the bidder. Each fitting shall be supplied complete in all respects.

3.01.2 The fittings shall be suitable for attachment to suspension and tension insulator strings along with hardware fittings and shall include 2.5 % extra fasteners and Aluminum filler plugs. Indicative drawings of complete insulator strings along with hardware fittings as well as indicative drawings for suspension clamps and dead end clamps are enclosed with this specification. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the maximum temperature specified by them for the conductor.

3.02 Corona and RI Performance

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

3.03 Maintenance

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

3.04 5 Split Pins

Split pins shall be used with bolts & nuts.

3.05 Suspension Assembly

i. The suspension assembly, the bidder intend to supply, shall be suitable for the HTLS Conductor with non-metallic core. The technical details of the conductor shall be as proposed by the bidder.
ii. The suspension assembly shall include either free centre type suspension clamp along with standard preformed armour rods or armour grip suspension clamp
iii. 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 ofoscillation of the same.
iv. The suspension clamp suitable for various type of Conductor along with standard preformed armor rods/armor grip suspension clamp set shall have slip strength between 20 to 29 KN.
v. The suspension clamp shall be designed for continuous operation at the temperature specified by the bidder for conductor.
vi. 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.

vii. The suspension assembly/clamp shall be designed so that it shall minimize 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.

viii. The magnetic power loss shall not be more than 4 watts per suspension clamp, at designed rated sub-conductor current of 1400 amperes.

3.06 Free Centre Type Suspension Clamp

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

3.07 Standard Preformed Armour Rod Set

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

ii. 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.

iii. 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.

iv. The length of each rod shall not be less than 1930 ± 25 mm and diameter shall not be less than 6.35 + 0.10 mm. The tolerance in length of the rods in complete set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed.

v. The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy application on the line.

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

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

3.08 Armour Grip Suspension Clamp

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

ii. Elastomeric insert shall be resistant to the effects of temperature up to maximum conductor temperature guaranteed by the bidder corresponding to peak current, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

iii. The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavourable stress on the conductor under all operating conditions. However the length of AGS preformed

rods shall not be less than 1760 + 16 mm for HTLS Conductor with non-metallic core.

3.09 Dead end Assembly

i) The dead end assembly shall be suitable for the proposed HTLS Conductor with non-metallic core.
ii) The dead end assembly shall be of compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.
iii) Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COM PRESS 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. Tapered aluminum filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. 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 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.
iv) 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.

3.10 Fasteners: Bolts, Nuts and Washers

i) All bolts and nuts shall conform to IS 6639. All bolts and nuts shall be galvanised as per IS 1367(Part-13)/IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.
ii) Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should be provided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.
iii) Nuts should be double chamfered as per the requirement of IS 1363 Part-III 1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size upto M16.
iv) 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.
v) All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.
vi) Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS: 2016.

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

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

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

x) 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.

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

3.11 Materials

The materials of the various components shall be as specified hereunder. The Bidder shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards. The details of materials for different component are listed as in Table No-1.

3.12 Workmanship

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

ii) High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings under simulated service condition corresponding to continuous operation of conductor at rated maximum 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.

iii) 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.

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

v) 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.

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

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

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

ix) 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.

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

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

3.13 Bid Drawings

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

ii) Fully dimensioned drawings of the hardware and their component parts shall be furnished in two (2) copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

iii) 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.

iv) The drawings shall include :

a) Dimensions and dimensional tolerance.

b) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.

c) Catalogue No.

d) Marking

e) Weight of assembly

f) Installation instructions

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

h) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.

i) The compressions die number with recommended compression pressure. j) All other relevant terminal details.

v) After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in three (3) copies to MPPTCL for approval. After getting approval from the MPPTCL and successful completion of all the type tests, the Contractor shall submit ten (10) more copies of the same drawings to the MPPTCL for further distribution and field use at MPPTCL end.

TABLE-1 (Details of Materials)

S. No	Name of item	Material Treatment	Process of Standard	Reference	Remarks
1.	Security Clips	Stainless Steel/ Phosphor Bronze	-	AISI 302 or 304-L/ IS-1385	-
2.	Arcing Horn	Mild Steel Rod/ Tube Type	Hot dip galvanised	As per IS-226 or IS-2062	-
3.	Ball Fittings, Socket, all shackles Links Cleves	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
4.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
5.	Sag Adjustment Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
6(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welde d joint shall not be less than 20 KN
6(b).	Supporting Brackets & Mounting Bolts	High Strength Al Alloy 7061/ 6063/ 65032/63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	
7(a).	Dead End Assembly : Outer Sleeve	EC grade Al of purity not less than 99.50%			
7(b).	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-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 *vis a vis* specified in the bid or else the bids are liable to be rejected.

SECTION-4

ACCESSORIES FOR THE HTLS CONDUCTOR WITH NON-METALLIC CORE

4.01 General

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

4.02 2.5% extra fasteners, filler plugs and retaining rods shall be provided.

4.03 The supplier shall be responsible for satisfactory performance of complete conductor system along with accessories offered by him for continuous operation at temperature specified for the HTLS Conductor with non-metallic core.

4.04 Mid Span Compression Joint

i. 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.

ii. The dimensions of mid span compression joint before & after compression along with tolerances shall be shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

4.05 Connector

Connector of compression type shall be used for jumper connection at tension tower. It shall be manufactured out of 99.5% pure aluminum / aluminum alloy and shall be strong enough to withstand normal working loads as well as able to withstand the continuous maximum operating temperature of conductor. The connector shall have a resistivity across jumper less than 75% resistivity of equivalent length of conductor. The connector shall not permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of connector should be kept at an angle of 15 deg. from vertical and horizontal plane of the conductor in order to minimize jumper pull at the welded portion. The dimensions of connector 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.

4.06 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 aluminum / aluminum alloy and shall have a smooth surface. It shall be able to withstand the continuous maximum operating temperature of conductor. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions of Repair sleeve along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

4.07 Vibration Damper

i. Vibration dampers of 4R-stockbridge type are installed in the existing line at suspension and tension points on each conductor in each span along with bundle spacers to damp out Aeolian vibration as well as sub- span oscillations. One damper minimum on each side per sub-conductor for suspension points and two dampers minimum on each side per sub-conductor for tension points has been used for a ruling design span of the line for which replacement of conductor is being carried out.

ii. The bidder shall offer damping system including Stockbridge type dampers and bundle spacers for HTLS Conductor with non-metallic core 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 minimum 4 nos. of 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 with non-metallic core. 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 strains. 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.

iii. The clamp of the vibration damper shall be made of high strength aluminum 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.

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

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

vi. 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.

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

viii. The vibration damper shall be capable of being installed and removed from energized 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.

ix. 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.

x. 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:

S. No.	Description	Technical particulars
1. i) ii) iii)	Span length in meters Ruling Design Span Maximum span Minimum span	 Prevailing span Prevailing
2.	Configuration	Double / Single Circuit conductor per phase in prevailing configuration.
3.	Tensile load in Conductor at temperature of 0 deg. C and still air	≤ 2884 kgF
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible Dynamic strain i.e. endurance limit.	+/- 150 micro strains

xi. The damper placement chart shall be submitted for spans ranging from 50 m to 350 m. Placement charts should be duly supported with relevant technical documents and sample calculations.

xii. The damper placement charts shall include the following

1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.
2) Placement distances clearly identifying the extremities between which the distances are to be measured.
3) Placement recommendation depending upon type of suspension clamps (viz free centre type/Armour grip type etc.)
4) The influence of mid span compression joints, repair sleeves & armour rods (standard& AGS) in the placement of dampers.

4.08 Material and Workmanship

i. All the equipment shall be of the latest proven design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for

220 kV transmission line applications with HTLS Conductor with non-metallic core and will give continued good performance at all service conditions.

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

iii. High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings under simulated service condition corresponding to continuous operation of conductor at rated maximum 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.

iv. All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanised as per grade 4 of IS-1573. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629/ IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall have a minimum average coating of Zinc equivalent to 600gm/sq.m and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Peerce test for galvanising unless otherwise specified.

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

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

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

viii. No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.

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

x. The fasteners shall conform to the requirements of IS: 6639-1972. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

4.09 Compression Markings

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks show 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.

4.10 Bid Drawings

i. The Bidder shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing

number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3mm. All dimensions and dimensional tolerances shall be mentioned in mm.

ii. The drawings shall include

a. Dimensions and dimensional tolerances

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

c. Catalogue No. d. Marking

e. Weight of assembly

f. Installation instructions

g. Design installation torque for the bolt or cap screw

h. Withstand torque that may be applied to the bolt or cap screw without failure of component parts

i. The compression die number with recommended compression pressure.

j. All other relevant technical details

iii. Placement charts for spacer/spacer damper and damper

The above drawings shall be submitted with all the details as stated above along with the bid document. After the placement of award, the contractor shall again submit the drawings in three copies to the MPPTCL for approval. After MPPTCL's approval and successful completion of all type tests, 20 (twenty) more sets of drawings shall be submitted to MPPTCL for further distribution and field use at MPPTCL's end.

4.11 Tests and Standards

Type Tests (Type tests should have been completed during last five years)

All the specified type tests on Hardware Fittings and Accessories for HTLS Conductor with non-metallic core offered by the bidder shall not be required to be carried out if valid test certificate is available i.e., tests conducted within last five years from the date of bid opening in an accredited laboratory or witnessed by the representative (s) of a Utility. In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/ manufacturing process change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the MPPTCL.

4.11.1 On Suspension Clamp

a) Magnetic power loss test: As per Annexure-B

b) Clamp slip strength Vs torque: As per Annexure-B

c) Ozone Test on elastomer: As per Annexure-B

4.11.2 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 IS:2486-(Part-I)
c) Slip strength test for dead end assembly: As per IS:2486-(Part-I)
d) Ageing test on filler (if applicable): As per Annexure-B

4.11.3 Mid Span Compression Joint for Conductor

a) Chemical analysis of materials: As per Annexure-B
b) Electrical resistance test: As per IS: 2121 (Part-II)

c) Heating cycle test: As per IS: 2121 (Part-II)
d) Slip strength test: As per Annexure-B
e) Corona extinction voltage test (dry): As per Annexure-B
f) Radio interference voltage test (dry): As per Annexure-B

4.11.4 Repair Sleeve for Conductor

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

4.11.5 Connector for Conductor

a) Chemical analysis of materials: As per Annexure-B
b) Electrical resistance test: As per IS: 2121 (Part-II) Clause 6.5 & 6.6 c)
Heating cycle test: As per IS: 2121 (Part-II)
d) Axial tensile load test on welded portion: As per Annexure-B
e) Corona extinction voltage test (dry): As per Annexure-B
f) Radio interference voltage test (dry): As per Annexure-B

4.11.6 Vibration Damper for Conductor

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

* Applicable for 4 R stock bridge dampers. For alternate type of vibration dampers (permitted as per clause 4.7), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/ carried out by the supplier.

4.12 Acceptance Tests

4.12.1 On Both Suspension Clamp and Tension Assembly

a) Visual Examination : As per IS:2486-(Part-I)
b) Verification of dimensions : As per IS:2486-(Part-I)
c) Galvanising/Electroplating test : As per IS:2486-(Part-I)
d) Mechanical strength test of each component : As per Annexure-B
e) Mechanical Strength test of welded joint : As per Annexure-B
f) Chemical analysis, hardness tests, grain size,inclusion rating & magnetic particle inspection for forgings/castings : As per Annexure-B

4.12.2 On Suspension Clamp only

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

4.12.3 On Tension Hardware Fittings only

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

4.12.4 On Mid Span Compression Joint for Conductor

a) Visual examination and dimensional verification : As per IS:2121(Part-II), Clause 6.2, 6.3, 7 6.7
b) Galvanising test : As per Annexure-C
c) Hardness test : As per Annexure-C
d) Ageing test on filler (if applicable): As per Annexure-C

4.12.5 Connector for Conductor

a) Visual examination and dimensional verification: As per IS: 2121(Part-II)
b) Axial tensile load test for welded portion: As per Annexure-B

4.12.6 Repair Sleeve for Conductor

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

4.12.7 Vibration Damper for Conductor

a) Visual examination and dimensional verification: As per IS: 2121(Part-II) Clause 6.2, 6.3, 7 6.7
b) Galvanising test: As per Annexure-C
(i) On damper masses: As per Annexure-C
(ii) On messenger cable : As per Annexure-C
c) Verification of resonance frequencies : As per Annexure-C
d) Clamp slip test : As per Annexure-C
e) Clamp bolt torque test : As per Annexure-C
f) Strength of the messenger cable : As per Annexure-C
g) Mass pull off test : As per Annexure-C
h) Dynamic characteristics test* : As per Annexure-C
* Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 4.2.7), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/ carried out by the supplier.

4.13 Routine Tests

4.13.1 For Hardware Fittings

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

4.13.2 For conductor accessories

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

4.13.3 Tests During Manufacture on all components as applicable

a) Chemical analysis of Zinc used for galvanising IS: 2486-(Part-I)

b) Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings : As per Annexure-B
c) Chemical analysis, hardness tests and magnetic particle inspection for forging: As per Annexure-B

If any of the above type tests have not been made, the supplier should furnish an undertaking with the bid that the test reports to be furnished before offering call for acceptance test. Otherwise the EMD will be forfeited; the bidder will not be eligible to participate in future tenders of MPPTCL.

4.13.4 Co-ordination for testing

The Contractors shall have to co-ordinate testing of their hardware fittings with insulators to be supplied by other Supplier to the MPPTCL and shall have to also guarantee overall satisfactory performance of the hardware fittings with the insulators.

4.13.5 Inspection

i. The MPPTCL's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works raw materials. Manufacturer's of all the material and for conducting necessary tests as detailed herein.
ii. The material for final inspection shall be offered by the Contractor only under packed condition as detailed in clause 4.2.16 of this part of the Specification. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.
iii. The Contractor shall keep MPPTCL informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.
iv. 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 MPPTCL in writing. In the latter case also the material shall be dispatched only after all tests specified herein have been satisfactorily completed.
v. 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.

4.13.6 Packing and Marking

i. All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.
ii. The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
iii. Suitable cushioning, protective padding, spacers shall be provided to prevent damage or deformation during transit and handling.
iv. 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.
v. Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture.
vi. All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

4.13.7 Standards

i. 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.

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

Sl. No.	Indian Standard	Title	International Standard
1	IS: 209-1992	Specification for zinc	BS:3436-1986
2	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage	IEC:1089-1991 BS:215-1970
3	IS 1573	Electroplated Coating of Zinc on iron and	
4	IS : 2121 (Part-II)	Specification for Conductor and Earth wire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for	
5	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
6	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
7	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8		Ozone test on Elastomer	ASTM- D1 171
9		Tests on insulators of Ceramic material or glass for overhead lines with a	IEC:383-1993
10	IS:4826	Galvanised Coating on Round Steel Wires	ASTM A472729 BS:443-1969
11	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and	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	
15	IS:10162	Specification for Spacers Dampers for Twin Horizontal Bundle Conductors	

The standards mentioned above are available from:

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

4.14 Guaranteed Technical Particulars

The bidder shall fill in the guaranteed technical particulars in the Schedule and submit the same with his tender, without which bid will not be considered.

4.15 Sag-Tension Chart and Sag Templates

The contractor shall supply six copies of sag tension charts and sag templates each in respect of the conductor. The contractor shall also supply sag template in celluloid, which shall be subject to the approval by the MPPTCL and without involving any extra charges. The sag template will be used for changing the tower positions in future.

4.16 Accessories

The Bidder after his survey of the existing line shall determine the quantity and type of the accessories required for the turnkey job, which are to be supplied by them. These accessories should be suitable for the supplied conductor for its entire operating range without degradation of mechanical, metallurgical and electrical properties. The steady state temperature of hardware and accessories must not exceed 90°C during no wind and 50°C ambient temperature at minimum 1400Amp load. The contractor shall be responsible for satisfactory performance of complete conductor, hardware and accessories, offered by him, for continuous operation at temperatures corresponding to various conditions stipulated at Clause 3 of this technical specification.

ANNEXURE-A

1. **Tests on 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 up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 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 meter 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 200C as per IS:398- (Part-IV)/(Part-V). The resistance corrected at 20deg C shall conform to the requirements of this Specification.

1.3 Coefficient of linear expansion for core/core strands

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15 degree C from laboratory ambient temperature to maximum designed operating temperature corresponding to rated current(1400 A) by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.4 Breaking load test on Aluminum Alloy & Core strands and D.C Resistance test on Aluminum Alloy wire.

The above tests shall be carried out as per IEC: 888/889 and the results shall meet the requirements of the specification. For composite cores, the breaking load shall be performed as described in Section 9 of ASTM B987.

1.5 Wrap test on Core strand

The wrap test on steel strands shall be meet the requirements of IEC: 888. In case of aluminum clad core wire, the same shall be wrapped around a mandrel 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. It is to inform that the test shall be carried out as per IEC or relevant standards.

1.6 Heat Resistance test on Aluminium Alloy wire

Breaking load test as per clause 1.5 above shall be carried out before and after heating the sample in uniform heat furnace at 280 degC (+5/-3 degC) 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.

1.7 Chemical Analysis of Aluminum Alloy :

Samples taken from the Aluminum and 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. It is to inform that the test has to be carried out as per applicability.

1.8 Visual and Dimensional Check on Drums

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

1.9 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the MPPTCL. The MPPTCL 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 MPPTCL's representative.

1.10 Dimensional Check on Core Strands and Aluminium Alloy Strands

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

1.11 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.

1.12 Procedure Qualification test on welded Aluminum Alloy strands.

Two Aluminum 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.

1.13 Chemical Analysis of Zinc

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

1.14 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.

1.15 Torsion and Elongation Tests on Core Strands

The test procedures shall be as per clause No. 10.3 of IEC 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will
be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the

strand shall not be less than 1.5% for a gauge length of 250 mm. It is to inform that the test shall be carried out as per the relevant standards

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

i) 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.

ii) 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. For Standard and High Strength Grade composite cores as per ASTM B987 Table 2, a sample shall be cut long enough as to have a gauge length that is 170 times the diameter of the composite core being tested, between the gripping fixtures. For Extra High Strength Grade composite core as per ASTM B987 Table 2, a sample shall be cut long enough as to have a gauge length that is 340 times the diameter of the composite core being tested, between the gripping fixtures. One grip shall then be fixed so that it does not twist and the other end shall be twisted a full 360 degrees and then fixed in this position for 2 minutes. Once the twist time is completed, the core is untwisted an inspected for any crazing or other damage. If no damage is observed, the composite core is then tensile tested to failure and the final load recorded. For the test to be accepted, the composite core must withstand at least 100% of its rated tensile strength. Two samples need to be completed in order to satisfy the testing requirement.

1.16 Bending test on conductor core strand

A sample of conductor core 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 aluminum at the bending point after this operation. It is inform that the test shall be carried out as per the IEC or relevant standards.

Bending test on polymer composite core (Type test):

Bending test on polymer composite core (CFC) before stranding shall be performed as per ASTM B987/B987M-17. Samples are to be taken from the composite core manufacturer site, from the same reels being supplied to conductor manufacturer subject to proper traceability of the same at the conductor manufacturers works.

Bending test on polymer composite core (CFC) shall also be performed as per ASTM B987/B987M-17 on polymer composite core samples taken at the stranding facility. Core sample selected at the stranding facility, either before or after stranding, the diameter of cylindrical mandrel shall be as following:

1. For high strength grade CFC – 60 times the diameter of CFC
2. For Extra high strength grade CFC – 70 times the diameter of CFC

1.17 Compression test on aluminum clad strand

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

1.18 Aluminum conductivity test on aluminum clad strand

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

1.19 Minimum conductivity test on thermal resistant aluminum alloy strands

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

1.20 Stress-strain test at elevated temperature

Stress-strain test as per IEC-1089 shall be conducted keeping conductor temperature at designed maximum temperature. It is inform that the test shall be carried out as per the IEC or relevant standards.
RTS used for final strength and intermediate holds shall be 70% of the ambient UTS guaranteed in the GTP.

1.21 High Temperature endurance & creep test

A conductor sample of at least 20 m length shall be strung at tension equal to 25 % of conductor UTS. The conductor temperature shall be increased to design maximum temperature in steps of 20°C and thermal elongation of the conductor sample shall be measured & recorded at each step. Further, the temperature of the conductor shall be maintained at maximum continuous operating temperature according to 1400 A (+10 °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 up to
1000 hours time period. After completion of the above, the conductor sample shall be subjected to UTS test as mentioned above at clause 1.1 of Annexure-A.

The supplier shall furnish details of creep characteristic in respect of the conducted based on laboratory test and other laboratory investigations/ experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension & continuous designed temperature. It is inform that the test shall be carried out as per the IEC or relevant standards.

1.22 Axial Impact Test

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

1.23 Crush Strength Test

A section of conductor is to be crushed between two six inch steel plates. Load shall be held at 350 Kgs for 1 minute and then released. All the strands shall be subsequently disassembled and tensile tested. All the strands shall exhibit full strength retention.

1.24 Torsional Ductility Test

After removing the outer layer aluminum/ aluminum alloy strands, the conductor shall be loaded to 25% of UTS and then loaded in increasing steps of +/-180 deg, the core shall withstand at least 16 such rotation. It is inform that the test shall be carried out as per the IEC or relevant standards.

In case of carbon-fibre composite core conductors utilizing High Strength composite cores as per ASTM B987, the sample length shall be at least 10 meters, and not be shorter than 1500 times the diameter of the composite core. The conductor sample should be loaded to between 10 and 20% of UTS and then rotated in increasing steps of +/-180 deg. The twist rate must be a maximum of 1 rotation per minute. After 4 rotations, or after separation of the aluminium strands, the aluminium wires shall be cut and removed from the conductor. The exposed core shall be twisted and shall withstand up to 16 rotations.

1.25 Sheaves Test (if required)

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. It is inform that the test shall be carried out as per the IEC or relevant standards.

The conductor sample of minimum length of 35 meter shall be tested in accordance with IEC 60794-1-2, Section 20, Figure 27 (Procedure 4) with the following details: Tension shall be between 20 and 25% of the conductor UTS; pulley diameter shall be at least 32 times that of the conductor; angle between the pulleys shall be 20 degrees. For composite core conductors, the pulley diameter shall be at least the diameter of the bottom of the grove of the sheave that the manufacturer requires for the first and last structure during installation. The conductor shall be passed over the pulleys 36 times at a speed between 0.5 m/sec and 2 m/sec. After this test, an UTS test on the conductor shall be carried out as mentioned above at clause 1.1 of Annexure-A. In the case of polymer composite core conductors, the core shall be inspected for damage by subjecting the core to a dye penetration test per ASTM B987 section 14. Dye penetrant exposure time shall be 30 +1/-0 minutes.

ANNEXURE-B

1.0 Tests on Hardware Fittings

1.1 Magnetic Power Loss Test for Suspension Assembly

Two hollow aluminum tubes of 32 mm diameter for the conductor shall be placed 450 mm apart respectively. An alternating current over the range of 1500 to 2000 amps shall be passed through each tube. The reading of the wattmeter with and without suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to 2456 amperes per phase shall be read off from the graph and the same shall not be more than the value guaranteed by the supplier.

1.2 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 Preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.3 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.

1.4 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 more than 20 kN but less than 29 kN.

1.5 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.

1.6 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.

1.7 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.

1.8 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 program.

ANNEXEUE-C

2.0 Tests on Accessories for Conductor

2.1 Mid Span Compression Joint for Conductor and Earth wire

(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/earth wire and retained for one minute at this load. There shall be no movement of the conductor/ earth wire relative to the fittings and no failure of the fittings during this one minute period.

2.2 Connector for Conductor

Axial Tensile Load Test for Welded Portion

The sleeve portion of the T-Connector shall be compressed on conductor. The compressed portion shall be held rigidly on some fixtures and axial load shall be applied along with the jumper terminal. The load shall be increased gradually till breaking of welded joint occurs. The breaking load should be above 30 kN.

2.3 Vibration damper for conductor.

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 400 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.

3.0 Tests on All components (As applicable)

3.1 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%.

3.2 Tests for Forgings

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

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and MPPTCL in Quality Assurance Program.

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. Connector for Conductor

(a) Axial Tensile Load Test for Welded Portion

Same as clause 2.2 of Annexure - B.

3. 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 2.3 of Annexure - B.

(c) Clamp Bolt Torque Test
The clamp shall be attached to a section of the conductor/earth wire. 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 2.4 (c) (i), Annexure-B.

(d) Strength of the Messenger Cable

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor.

(e) Mass Pull off Test

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

SECTION- 5

Part A

TECHNICAL SPECIFICATION FOR DISC INSULATORS

5.01 STANDARDS

This section provides for the design, manufacture, stage testing and inspection and testing before dispatch packing and delivery of disc insulators as per technical requirements furnished in this section. Unless otherwise specified elsewhere in this specification, the rating as well as performance & testing of the disc insulators shall conform but not limited to the latest revision & amendments available at the time of placement of order of all the relevant standards as listed hereunder, except as modified in this document.

S. No	Indian Standard	Title
1	IS:209-1992	Specification for Zinc
2	IS:206-1991	Method for Chemical Analysis of Slab Zinc
3	IS:731-1991	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V
4	IS:2071 Part(I)-1993 Part(II)-1991 Part(III)-1991	Method of High Voltage Testing
5	IS:2121 Part(I)	Specification of Conductors and Earth wire Accessories for Overhead Power Lines. Armour Rods, Binding Wires & Tapes for Conductors
6	IS:2486 Part I-1993 Part II-1989 Part III - 1991	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000V General Requirements & Tests Dimensional Requirements Locking Devices
7	IS:2629-1990	Recommended practice for Hot Dip Galvanization for iron & steel
8	IS:2633-1992	Testing for Uniformity of Coating of Zinc coated articles
9	IS:3188-1988	Dimensions for Disc Insulators
10	IS:6745-1990	Determination of Weight of Zinc coating on Zinc coated iron and steel articles
11	IS : 8263-1990	Methods of RIV Test of HV Insulators
12	IS:8269-1990	Methods for Switching impulse test on HV insulators

5.02 PRINCIPAL PARAMETERS

5.02.01 DETAILS OF DISC INSULATORS

i) The insulator strings shall consist of standard discs for a three phase 50 Hz, effectively earthed 220KV/132KV transmission system in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type.

ii) The specified values and disc dimensions, impulse and power frequency voltages, electromechanical strength [EMS] of individual insulator units are as under. The values given are minimum which apply to all cases. Specified withstand and flashover voltages are referred to standard atmospheric condition.

5.02.02 CHARACTERISTICS OF DISC INSULATORS

The disc insulators should have the following particulars and characteristics:

S.No	Particulars	Disc Insulators		
		70KN EMS	90kN EMS	160kN EMS
i	Diameter of the disc (mm)	255	255	280
ii	Spacing of the disc (mm)	145	145	170
iii	Size and designation of pin-ball shank	16 mm	16 mm	20 mm
iv	Creepage distance (mm) (minimum)	320	320	330
v	Power frequency one minute dry withstand voltage kV (rms)	70	75	75
vi	Power frequency one minute wet withstand voltage kV (rms)	40	45	45
vii	Power frequency puncture withstand voltage kV (rms)	120	125	125
viii	Minimum dry impulse withstand voltage 1.2x50 micro second wave, positive and negative Kv Peak)	110	110	120
ix	Maximum Radio interference voltage with 10 kV RMS to ground. (microvolts)	50	50	50
x	Minimum corona extinction voltage kV(rms)	9	9	18

5.03 SPECIFICATION DRAWINGS

The specification drawing in respect of the disc insulators indicated above is attached with this specification. The specification drawing is attached herewith for information and guidance of the Contractor only. The drawings to be furnished by the Contractor shall be as per his own design and manufacture and shall be distinct and separate from these specification drawings.

The drawing shall include but not limited to the following information:-

a) Shell diameter and ball to ball spacing with manufacturing tolerances.
b) Minimum creepage distance with positive tolerance.
c) Protected creepage distance
d) Eccentricity of the disc
i) Axial run out
ii) Radial run out
e) Unit mechanical and electrical characteristics
f) Size and weight of ball & socket parts
g) Weight of unit insulator disc
h) Materials
i) Identification mark
j) Manufacturer's catalogue number.

After placement of order, the Contractor shall submit full dimensioned manufacturing drawing of insulator cap, pin & insulator shell in six copies to the Employer for reference & record.

5.04 GENERAL TECHNICAL REQUIREMENTS

5.04.01 Porcelain

The porcelain used in the manufacture of the shells shall be ivory white, nonporous of high dielectric, mechanical and thermal strength, free from internal stresses, blisters, laminations, voids, foreign matter, imperfections or other defects which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid, alkalizes, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by thorough verification.

5.04.02 Porcelain Glaze

Surfaces to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster, smooth on surface and be subject to satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

5.04.03 METAL PARTS

5.04.03.1 Cap and Ball Pins

Ball pins shall be made with drop forged steel and 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 material. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black hearth malleable cast iron and annealed. Galvanising shall be by the hot dip process with a heavy coating of zinc of very high purity. The Contractor shall specify the grade, composition and mechanical properties of steel used for caps and pins.

5.04.03.2 Security Clips

The security clips shall be made of phosphor bronze or of stainless steel.2.5% extra security clip shall be provided.

5.05 FILLER MATERIAL

Cement to be used as a filler material shall 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.

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and hard metal should be coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

5.06 MATERIAL DESIGN AND WORKMANSHIP

5.06.01 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 220KV/132KV Transmission lines.

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

5.06.02 INSULATOR SHELL

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

5.06.03 METAL PARTS

(i) The pin and cap shall be designed such that it will not transmit the mechanical stresses 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 pin ball 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 pin ball 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, blow holes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

5.06.04 GALVANISING

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of 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 bright, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

5.06.05 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as a 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 be 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 when 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 could be countersunk 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 position shall not be less than 50 N (5 kgs) or more than, 500 N (50 kgs).

5.06.06 BALL AND SOCKET DESIGNATION

The dimensions of the balls and sockets for 70 KN & 90 KN discs shall be of 16 mm and for 160KN discs shall be of 20 mm designation in accordance with the standard dimensions stated in IS:2486 (Part II).

5.07 DIMENSIONAL TOLERANCE OF DISC INSULATOR

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

a. Diameter of Disc (mm)

Rating	Standard	Maximum	Minimum
160 KN Disc	280	293	267
90 KN Disc	255	266	244
70 KN Disc	255	266	244

b. Ball to Ball Spacing between Discs (mm)

Rating	Standard	Maximum	Maximum
160 KN Disc	170	175	165
90 KN Disc	145	149	141
70 KN Disc	145	149	141

5.08 INTERCHANGEABILITY

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

5.09 SUITABILITY FOR LIVE LINE MAINTENANCE

The insulators shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

Contractors shall indicate the methods generally adopted in routine hot and cold line maintenance of EHV lines for similar insulators supplied by them. Contractors shall also indicate the recommended periodicity of such maintenance.

5.10 FREEDOM FROM DEFECTS

Insulators shall have none of the following defects:

i) Ball pin shake
ii) Cementing defects near the pin like small blow holes, small hair cracks, lumps, etc.
iii) Sand fall ferro particle defects on the surface of the insulator.
iv) Shell eccentricity

5.11 INSULATOR STRINGS:

5.11.01 TYPE AND RATING

44
The insulator strings shall be formed with standard discs described in this specification for use on 3 phase, 220kV/132kV, 50Hz effectively earthed systems in a moderately polluted atmosphere. Suspension insulator strings for use with suspension towers are to be fitted with discs of 70 kN EMS rating while tension insulator strings for use with Anchor/Tension towers are to be fitted with discs of 90 kN & 160 kN EMS rating.

The Bidder may also use Long Rod Porcelain Insulators String or Long Rod Polymer Insulators in place of Disc Insulator Strings. The Long Rod Porcelain Insulators or Long Rod Polymer Insulators shall have technical specification equivalent to or better than the technical specification of Disc Insulator Strings. It may please be noted that in a particular work, the bidder will have to use any one type of Insulators and combination of two different types of Insulators in one particular work will not be allowed.

5.11.02 STRING SIZE

The size of the disc insulator, the number to be used in different types of strings and their electro-mechanical strength shall be as follows:

S. No.	Type of String	Size of disc insulator (mm)	No. of standard discs	Electro mechanical strength of insulator string (kN)
a)	Single Suspension for 220/132KV	255x145	13/9	70
b)	Double Suspension for 220KV/132KV	255x145	2x13/2x9	2x70
c)	Single Tension for 220KV	280x170	14	160
d)	Double Tension for 220KV	280x170	2x14	2x160
e)	Single Tension for 132KV	255x145	10	90
f)	Double Tension for 132KV	255x145	2x10	2x90

5.11.03 STRING CHARACTERISTICS :

5.11.03.1 The characteristics of the complete string shall be as follows **:**

S. NO.	Characteristics	Single/Double Suspension		Single/Double Suspension	
		220kV	**132kV**	**220kV**	**132kV**
1	No. of Standard Discs	1x13 2x13	1x9 2x9	1x14 2x14	1x10 2x10
2	Nominal diameter of discs	255	255	280	255
3	Power frequency Withstand voltage (wet) kV (rms)	460	280	490	300
4	Lighting impulse withstand voltage (dry)(kVp)	1200	800	1200	800

45

S. NO.	Characteristics	Single/Double Suspension		Single/Double Suspension	
		220kV	**132kV**	**220kV**	**132kV**
5	Switching surge Withstand voltage (Dry & wet) (kVp)	900	350	900	350
6	Mechanical failing Load (kgf)	7000/ 14000	7000/ 14000	16500/ 33000	9000/ 18000
7	Pollution	Moderately polluted		Moderately polluted	
8	No deformation load (kgf)	4690/ 9380	4690/ 9380	11055/ 22110	6030/ 12060
9	Corona Extinction voltage (KV rms)	176	-	176	-

5.11.03.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian standards**.**

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

5.12 TESTS :

5.12.01 The Disc insulators offered should be fully type tested as per the relevant standards. The following tests shall be carried out on the insulator string and also on unit disc insulators.

5.12.02 Acceptance Tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

5.12.03 Routine Tests shall mean those tests, which are to be carried out on each insulator to check the requirements which are likely to vary during production.

5.12.04 Stage tests during manufacture shall mean those tests which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

5.12.05 The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or other internationally accepted standards.

5.12.06 The standards according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms and procedure for the same shall be as specified in Appendix-I attached hereto or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Programme.

5.12.07 For all type and acceptance tests, the acceptance values shall be the value guaranteed by the Contractor in the "Technical Questionnaire" or the acceptance value specified in this specification or the relevant standard whichever is more stringent for that particular test.

5.13 DETAILS OF TYPE TESTS :

46

5.13.01 The Disc insulators offered shall be fully type tested for the following tests as per relevant International/Indian Standard and the bidder shall furnish type test reports along with the offer.

a)	Visible discharge test	IS:731
b)	Impulse voltage withstand test	IS:731
c)	Wet power frequency voltage withstand test	IS:731
d)	Verification of dimension test	IS:731
e)	Temperature cycle test	IS:731
f)	Electro-Mechanical failing load test	IS:731
g)	Puncture test	IS:731
h)	Porosity test	IS:731
i)	Galvanising test	IS:731
j)	24 hours mechanical failing load test	IS:731
k)	Metallurgical test	IS:2108 & IS:2004

5.14 DETAILS OF ACCEPTANCE AND ROUTINE TESTS :

5.14.01 All Acceptance and Routine tests as stipulated herein shall be carried out by the Contractor in the presence of Employer's representative. Immediately after finalisation of the programme of acceptance/routine testing, the Contractor shall give sufficient advance intimation to the Employer, to enable him to depute his representative for witnessing the test.

5.14.02 For String Insulator Units following Acceptance & Routine tests shall be conducted:

(A) Acceptance tests:

a)	Verification of dimensions	IS:731
b)	Temperature cycle test	IS:731
c)	Galvanising test	IS:731
d)	Mechanical performance test	IEC:575
e)	Test on locking device for ball and socket coupling	IEC:372/IS-2486(part-IV)
f)	Eccentricity test	As per Specification
g)	Electro-mechanical strength test	IS-731
h)	Puncture test	
i)	Porosity test	

(B) Routine tests:

a)	Visual Inspection	IS-731
b)	Mechanical routine test	
c)	Electrical routine test	IEC:383

5.15 Tests during Manufacture (STAGE TESTS)

On all components as applicable

a)	Chemical analysis of Zinc used for galvanizing	As per this Specification
b)	Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings	
c)	Chemical analysis, hardness test and magnetic particle inspection for forgings	
d)	Crack detection test for metal parts	

5.16 ADDITIONAL TESTS :

The Employer reserves the right for carrying out any other tests of a reasonable nature at the works of the Contractor/laboratory or at any other recognized laboratory / research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the Employer to satisfy that the material complies with the intent of this specification.

5.17 COORDINATION FOR TESTING:

For 220KV/132KV insulator strings, the Contractor is required to produce type test reports to the satisfaction of the Employer. However, in case the Employer desires, the Contractor shall conduct all the type tests on the complete string with relevant hardware fittings. Responsibility of arranging required hardwares for the purpose of type testing will remain with the Contractor.

5.18 QUALITY ASSURANCE PROGRAM :

The contractor shall submit the Quality Assurance Programme as specified in clause 1.12 Section-1 of the biding document. A copy of the accepted Quality Assurance Plan must be available at the manufacturer's works of the Plant for reviewing by inspecting officer of the employer.

5.19 INSPECTION :

5.19.01 As specified in clause 1.13 Section-1 of the biding document, Plant to be supplied will be subject to inspection and approval by the Employer's representative before despatch.

5.19.02 The acceptance of any quantity of insulators shall in no way relieve the successful Contractor of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such disc insulators are later found to be defective.

5.19.03 The Contractor shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the insulator.

5.20 IDENTIFICATION MARKING :

i) Each disc insulator shall be legibly and indelibly marked with the trade mark of the manufacturer, the month and year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.

ii) The marking shall be on porcelain shell of insulators. The marking shall be printed and not impressed/embossed and same shall be applied before firing.

iii) One 10mm thick ring of good quality paint shall be marked on the cap of each insulator of particular strength for easy identification of the type of insulator.

The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark:-

For 70kN disc insulator – Green

For 90kN disc insulator – Blue

For 160kN disc insulator – Red

5.21 DOCUMENTATION

The Contractor shall furnish full description and illustrated catalogues of insulators offered, alongwith the bid. The supplier shall also furnish alongwith the bid the outline drawing of each insulator unit including cross-sectional view of the shell. The drawing shall include the following information :

i) Shell diameter and unit spacing with manufacturing tolerance.
ii) Creepage distance.
iii) Unit mechanical and electrical characteristics as also for the complete string-suspension and tension.
iv) Size and weight of ball and socket part.
v) Weight of unit insulator disc.
vi) Materials for the disc, cap and pin.
vii) Identification mark.
viii) Manufacturer's catalogue number.
ix) Brief installation instructions.
x) Relevant technical details of significance.

5.22 PACKING & FORWARDING :

i) All disc insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates alongwith disc insulators shall not normally exceed 100 kg. to avoid handling problem.
ii) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
iii) Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
iv) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and 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.

Appendix-I

TEST DETAILS

1. Voltage Distribution Test:

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied so as to give a total of 100% distribution. The voltage across any disc shall not exceed 9% for suspension insulator strings and for double tension insulator strings. The total of the voltage distribution of all discs so computed shall be within 95% and 105%. If not, the test shall be repeated. The proportions correction shall be made on the values so as to give a total of 100% distribution.

2. Mechanical Strength Test:

The complete insulator string alongwith its hardware fittings 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 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.

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 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string alongwith hardware fittings and two sub-conductors (each tensioned at 4500 kg) shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of 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 insulator string (more than 10 Hz) by means of vibration inducing equipment. The amplitude of vibration at the antinode point nearest to the string shall be measured and the same shall not be less than + 120/f , f being the frequency of vibration. The insulator string shall be vibrated for five million cycles then rotated by 90 deg. and again vibrated for 5 million cycles without any failure. After the test, the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined for fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The disc insulators shall be subjected to the following tests as per relevant standards:

S. No.	Test	Percentage of discs to be tested
a)	Temperature cycle test followed by mechanical performance test	60
b)	Puncture test (for porcelain insulator only)	40

If the results of the second test show a porcelain shell rupture, the production does not comply with this specification.

4. Chemical Analysis of Zinc used for Galvanising:

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

5. 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.

6. Test on Castings:

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

7. Eccentricity Test:

The insulator shall be vertically mounted on a fixture using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contact with the bottom of the outermost petticot of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to move up and down on the scale but always maintaining contact with the bottom of the outer most petticot. After one full rotation of the disc, the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out. Similarly using a horizontal scale with vertical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumference of the disc insulator and disc insulator rotated on its fixture always maintaining the contact. After one full rotation the maximum and minimum position of the slider reached on the scale are found out. The difference between the above readings shall satisfy the guaranteed value for radial run out.

8. Crack Detection Test:

Crack detection test shall be carried out on each ball and pin before assembly of disc unit. The manufacturer shall maintain complete record of having conducted such tests on each and every piece of ball pin. The Contractor shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

SYSTEM PARTICUALRS

S.No.	PARTICULARS	Electrical System Data		
1	System	A.C. 3phase	A.C. 3phase	A.C. 3phase
2	Line voltage (kV rms)	220	132	400
3	Max.voltage (kV rms)	245	145	420
4	Frequency	50Hz.	50Hz.	50 Hz
5	Neutral grounding system	effectively earthed	effectively earthed	effectively earthed
6	Lightning impulse with-stand voltage(dry & wet)(kVp)	1050	550	1425
7	Power frequency withstand voltage (wet) (kVp)	395	230	630
8	Switching surge withstand voltage (wet) (kVp)	650	325	1050

S.No.	PARTICULARS	Electrical System Data		
9	Short circuit level (kA)	40	40	40
10	Minimum corona extinction voltage at 50 Hz AC system dry condition (Kv rms)	-	-	320
11	Radio interference voltage at one MHz for phase to earth voltage of 266KV dry conditions(Microvolt)	-	-	500

Part B

TECHNICAL SPECIFICATION FOR POLYMER INSULATORS

5.23 STANDARDS

5.23.01 Unless otherwise specified elsewhere in this specification, the rating as well as performance & testing of the Polymer Insulators shall conform but not limited to the latest revision & amendments available at the time of placement of order of all the relevant standards as listed hereunder, except as modified in this document.

S. No	Indian Standard	Title	International Standard
1	IS:731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC:61109-1992
2		Verification of Dimensions of Polymer Insulators	IEC:61109
3	IS:13134	Guide for the selection of insulators in respect of polluted conditions	IEC : 60815
4	IS:2071 Part(I), II, III	Method of High Voltage Testing	IEC:60060-1
5		Characteristics of string insulator units of the long rod type	IEC : 60433
6	IS:2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000V-General Requirements , Tests, Dimensional Requirements, Locking Devices	IEC-60575 IEC-60120 IEC:60372
7		Hydrophobicity classification guide	STRI guide 1.92/1
8		Standard for insulators– Composite-Distribution Dead-end type	ANSI C29 13-2000
9	IS : 8263	Methods of RIV Test of HV Insulators	IEC:60487
S. No	**Indian Standard**	**Title**	**International Standard**
10		Standard specification for glass fiber strands	ASTMD 578-05
11		Standard test method for compositional analysis by Thermo gravimetry	ASTME 1131-03
12	IS:8269	Methods for Switching impulse test on HV insulators	IEC:60506
13	IS:2629	Recommended practice for Hot Dip Galvanisation for iron &	ISO:1461(E)

		steel 53	
14	IS:2633	Testing for Uniformity of Coating of Zinc coated articles	
15	IS:6745	Determination of Weight of Zinc coating on Zinc coated iron and steel articles	BS:443-1969 ISO 1460-1973
16	IS : 4759	Hot dip zinc coatings on structural steel & other allied products	ISO : 1459,ISO : 1461
17	IS : 4699	Specification for refined secondary zinc	
18	IS : 3203	Methods of testing of local thickness of electroplated coatings	ISO : 2178
19	IS:209	Specification for Zinc	BS:3436
20	IS:206	Method for Chemical Analysis of Slab Zinc	BS:3436

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND, UK
IEC	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
STRI guide 1.92/1	STRI, Sweden, Website : www.stri.se
NEMA/ANSI C29 13-2000	National Electric Manufacture Association, 155, East 44th Street, New York, NY: 10017 U.S.A
ASTM	American Society for Testing and Materials, 1916 Race St. Phelledelphia, PA19103 U.S.A.

5.23.02 Material meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the material offered by the bidder conforms to other standards, salient points of difference between standards adopted & the standards specified in this specification shall be clearly brought out in the relevant schedules. Three copies of such standards with authentic translation in English shall be furnished along with the bid.

5.24 CLIMATIC CONDITIONS

The insulators shall be suitable for being installed directly in air with Power ACSR conductors of Double Circuit Double Strung transmission lines. The materials offered shall be suitable for operation in tropical climate & shall be subject to the sun & inclement weather and shall be able to withstand wide range of temperature variations. The topography & climatic conditions in general are as under:-

1	Location in the state of	MADHYA PRADESH
2	Maximum ambient air temperature (^{0}C)	50
3	Minimum temperature in shade (^{0}C)	1
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature (^{0}C)	40° Centigrade
6	ISOCERANIC Level (days/year) (Average number of thunder storm days)	50
7	Average rainfall(mm)	1250
8	Maximum wind pressure (kg/ square meter)	50
9	Maximum Altitudes above mean sea level (meters)	1000
10	Seismic level(Horizontal acceleration) (g)	0.3

NOTE:- Moderately hot and humid tropical climate conducive to rust and fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Stroke is also present in the atmosphere. Heavy lightening also occurs during June to October.

5.25 PRINCIPAL PARAMETERS

5.25.01 DETAILS OF POLYMER INSULATORS

A. The Polymer insulator shall be suitable for a three phase 50 Hz, effectively earthed 400 KV, 220 KV and 132 KV transmission system in a moderately polluted atmosphere. They shall be ball and socket type.

B. The specified values and dimensions, impulse and power frequency voltages, electromechanical strength [EMS] of Polymer insulators are as under. The values given are minimum which apply to all cases. Specified withstand and flashover voltages are referred to standard atmospheric condition.

S.No	**Particulars**	**Value**					
		400 KV POLYMER INSULATORS		**220 KV POLYMER INSULATORS**		**132 KV POLYMER INSULATORS**	
		Suspen-sion	**Tension**	**Suspen-sion**	**Tension**	**Suspen-sion**	**Tension**
		120 KN	**160 KN**	**70KN**	**160 KN**	**70 KN**	**90 KN**

i	Size and designation of ball & socket	20 mm	20 mm	16 mm	20 mm	16 mm	16 mm
ii	Creep-age distance (mm) (minimum)	13020	13020	7595	7595	4495	4495
iii	Power frequency one minute dry withstand voltage kV (rms)	720	720	510	510	325	325
iv	Power frequency one minute wet withstand voltage kV (rms)	680	680	460	460	275	275
v	Visible discharge Test voltage kV (rms)	266	266	154	154	105	105
vi	Minimum dry impulse withstand voltage 1.2x50 micro second wave, positive and negative Kv Peak)	1550	1550	1050	1050	650	650
vi	Nominal length (Insulation Spacing) (mm)	3335 mm	4080 mm	1885 mm	2380 mm	1305 mm	1450 mm

C. Polymer Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc., and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS : 13134

D. Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109 :
± (0.04d + 1.5)mm when d≤300mm
± (0.025d+6)mm when d>300mm

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance

5.26 GENERAL TECHNICAL REQUIREMENTS

5.26.01 Core:

The core shall be glass-fiber reinforced epoxy resin rod (FRP) of high strength. Both, glass fiber and resin shall be optimized in the FRP rod. Glass fibers with low content in alkalies shall be boron free E glass or Boron free electrically corrosion resistance (ECR) glass. Use of resin with hydrolysis trend due to water penetration should be prevented i. e.

matrix of the FRP rod shall be Hydrolysis resistant. Suitability of Epoxy matrix as well as interface between matrix and fibers is to be considered as design parameter to prevent brittle fracture. The FRP rod should be void free and shall be manufactured through Pultrusion process.

5.26.02 Housing (Sheath):

The core of the Polymer insulator shall be completely covered by a continuous housing consisting of a sheath-weathershed. For moulding of entire weathershed structure on to the rod in a one shot moulding process to be employed to avoid multiple interfaces. Hardware i. e. metal fittings may be installed on the rod prior to moulding of the shed controlling moulding lines. The base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers. The thickness of compounding material on core should be minimum 3 mm. Manufacturer should furnish a description of its Quality Assurance Programme including fabrication, testing and inspection for any material (i.e. rubber), components(i.e. rod) or hardware (i.e. end fittings). The manufacturer has had fabricated by others should also be included. Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer. Insulator should have hermetically sealed structure in which the housing material is moulded to cover the interface between the end fittings and the FRP rod. This seal should never be broken during testing or otherwise.

5.26.03 End fittings:

The Polymer insulators shall be socket and ball type with the necessary coupling arrangement such that pin shall move freely in the socket but do not get disengaged while in service under various operating and atmospheric conditions.
The socket & ball type metal end fittings shall be designed to transmit the mechanical load to the core & the end fittings shall maintain uniform and consistent mechanical strength Material and methods used in the fabrication of metal parts shall be selected to provide good toughness and ductility. Metal end fittings shall be made from a quality malleable cast iron or forged steel or Spheroidal Graphite Iron(SGI) and shall be hot dipped galvanized in accordance with IS 2629. Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, slivers, slag, blow-holes shrinkage defects and localized porosity. The attachment to the FRP rod shall be performed with a symmetrically controlled crimping method control by acquistic method that compresses the metal radically onto the rod without damage to the rod fibers or resin matrix while providing a strength equal to or greater than the defined and specified ultimate strength to the insulator. The material used in fittings shall be corrosion resistant. Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard . No joints in ball & socket or pin will be allowed. Outer portion of ball or socket should be Zinc sleeved with minimum 99.95% purity of electrolytic high grade Zinc. The finished surface shall be smooth and shall have a good performance The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection. The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either sound or vision transmission.

5.26.04 GRADING RINGS

Grading rings shall be provided when system voltages are equal to or greater than 220 KV. For 220 KV transmission, grading ring is to be provided at the energized end only. For 400 KV transmission , grading ring is to be provided at both ends of the insulators.

All grading rings and brackets shall be designed as an integral part of the insulator assembly with a positive mounting system that allows mounting in one position . The design of the grading ring shall be such that ring can only be mounted with its orientation towards the weather sheds for maximum RIV and

Corona control . Grading rings shall be designed in such a manner that the rings can be readily installed and removed with hot line tools without disassembling any other part of the insulator assembly .

Grading ring height (is the distance from the end of the end fitting to the top of corona ring) should be so selected that maximum field minimizes and uniformly distributed along the insulator. Manufacturer should provide reports of successful electric field modeling testing for the specific insulator design. The EFM should be three dimensional with result containing drawing depicting the electric field in various colours , each of a different voltage level. The result of this study should show that the voltage field surrounding the polymer insulators is optimum along the entire length of the insulator , with the effected hot end of the insulator being a critical location . The threshold at which corona may or may not be present should be defined as a figure in KV/mm for the designed insulator.

5.27 VERIFICATION OF HOUSING MATERIAL

The manufacturer should provide written verification about housing material, for which base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers considered will provide satisfactory performance in the particular environment It shall meet following requirements Be homogenous, impermeable, with no fissures, bubbles and strange materials inclusions. Be designed in order to avoid formation of localized discharges and to prevent interfaces humid penetration. Be resistant to corona, UV radiation, ozone, atmospheric contamination, water penetration and power arcs.

5.28 BALL AND SOCKET DESIGNATION

The dimensions of the Ball and Socket shall be 16mm designation for 70KN and 90KN Polymer insulators and 20 mm designation for 120 KN and 160 KN Polymer insulators in accordance with the standard dimensions stated in IEC:60120/IS:2486(Part-II)

5.29 MARKINGS:

5.29.01 Each insulator shall be legibly and indelibly marked with the following details as per IEC – 61109.

a. Name or trademark of the manufacturer.
b. Voltage and Type.
c. Month and year of manufacturing.
d. Minimum failing load / guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
e. Country of manufacture

5.29.02 One 10 mm thick ring of suitable quality of paint shall be marked on the end fitting of particular strength for easy identification of Polymer insulators. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark :

For 70KN Polymer insulator : Green
For 90KN Polymer insulator : Blue
For 120KN Polymer insulator: Yellow
For 160KN Polymer insulator: Red.

5.30 MATERIAL DESIGN AND WORKMANSHIP

5.30.01 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

58

manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on 400KV/220 KV and 132kV Transmission lines.

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

5.30.02 GALVANISING

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS:2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS:209. The Zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements**.**

5.30.03 INTERCHANGEABILITY

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

5.30.04 CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) PERFORMANCE

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

5.31 SUITABILITY FOR LIVE LINE MAINTENANCE

5.31.01 The Polymer insulators shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

5.31.02 Suppliers shall indicate the methods generally adopted in routine hot and cold line maintenance of EHV lines for similar Polymer insulators supplied by them. Suppliers shall also indicate the recommended periodicity of such maintenance.

5.32 TESTS

The following tests shall be carried out on the Polymer insulator:

5.32.01 TYPE TESTS

This shall mean those tests which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production.

5.32.02 ACCEPTANCE TESTS

This shall mean those tests which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

5.32.03 ROUTINE TESTS

This shall mean those tests, which are to be carried out on each Polymer insulator to check the requirements, which are likely to vary during production.

5.32.04 STAGE TESTS DURING MANUFACTURE

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

5.32.05 TEST VALUES

For all type and acceptance tests, the acceptance values shall be the value guaranteed by the Supplier in the guaranteed technical particulars or the acceptance value specified in this specification or the relevant standard whichever is more stringent for that particular test.

5.32.06 TEST PROCEDURES AND SAMPLING NORMS

5.32.06.1 The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or other Internationally accepted standards. This will be discussed and mutually agreed to between the successful Supplier and Purchaser before placement of order. The standards and norms according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification the norms and procedure for the same shall be as mutually agreed to between the successful supplier and purchaser in the quality assurance programme. The supplier shall offer at least three times the quantity of material required for conducting all the type tests for sample selection. Before sample selection, the supplier shall be required to conduct all the acceptance test successfully in presence of purchaser's representative.

5.32.06.2 TYPE TESTS

(A) The following type tests shall be conducted on all types of the Polymer insulator with hardware fittings :

a)	Power frequency voltage withstand test with corona control rings and arcing horn under (dry/wet) conditions
b)	Power frequency voltage flash over test with corona control rings and arcing horn under (dry/wet) conditions
c)	Power frequency voltage flash over test without corona control rings and arcing horn under (dry/wet) conditions
d)	Switching surge voltage withstand test under wet condition.
e)	Impulse voltage withstand test under dry condition.
f)	Voltage Distribution test
g)	Impulse voltage flash over test under dry condition

h)	Corona and RIV Test under dry condition.
i)	Mechanical strength test
j)	Vibration test.
k)	Power Arc Test
l)	Salt fog pollution withstand Test

(B) On composite Insulator Unit:-

1. Tests on interface and connection of metal fittings

(a) Dry Power frequency Voltage Test
(b) Sudden Load Release Test
(c) Thermal Mechanical Test
(d) Steep Front Impulse Voltage Test
(e) Dry Power frequency Voltage Test

2. Assembled Core Load Time Test

(a) Determination of the Average failing load of the core of the assembled unit
(b) Control of slope of the strength time curve of the insulator

3. Accelerated Ageing Test of 5000 hours
4. Flammability Test
5. Recovery of Hydrophobic Test
6. Mechanical Load Time Test
7. Brittle Fracture resistance test
8. Test of Housing, Tracking and Erosion Test
9. Test for the Core Material
- Dye Penetration Test
- Water diffusion Test

5.32.07 ACCEPTANCE AND ROUTINE TESTS

On Polymer Insulators following Acceptance & Routine tests shall be conducted:

(A) Acceptance tests:

a)	**Verification of dimensions**	**IEC:61109-1992**
b)	**Verification of Locking System**	
c)	**Galvanising test**	**IS-731**
d)	**Verification of specified Mechanical Load**	**IEC:575**
e)	**Recovery of Hydrophobicity**	**As per annex-A**

(B) Routine tests:

a)	**Visual Inspection**	IS-731
b)	**Mechanical routine test**	
c)	**Electrical routine test**	**IEC:383**

5.32.08 Tests during Manufacture (STAGE TESTS)

On all components as applicable

a) Chemical analysis of Zinc used for galvanizing

b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings

c) Chemical analysis, hardness test and magnetic particle inspection for forgings

d) Crack detection test for metal parts

5.32.09 ADDITIONAL TESTS

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the Supplier/laboratory or at any other recognized laboratory / research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the Purchaser to satisfy that the material complies with the intent of this specification.

5.32.10 COORDINATION FOR TESTING:

For polymer insulator strings, the Supplier is required to produce type test reports to the satisfaction of the Purchaser. However, in case the Purchaser desires, the Supplier shall conduct all the type tests on the complete string with relevant hardware fittings. Responsibility of arranging required hardwares for the purpose of type testing will remain with the insulator Supplier.

5.32.11 TEST SCHEDULE

5.32.11.1 TYPE TESTS

The material offered shall be fully type tested as per this specification and the Supplier shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years.

For any change in the design/type ,already type tested and the design/type offered against this bid, the purchaser reserves the right to demand repetition of some or all type tests without any extra cost.

5.32.11.2 ACCEPTANCE AND ROUTINE TESTS

All Acceptance and Routine tests as stipulated herein shall be carried out by the Supplier in the presence of Purchaser's representative.

Immediately after finalization of the programme of acceptance/routine testing, the Supplier shall give sufficient advance intimation to the Purchaser, to enable him to depute his representative for witnessing the test.

5.33 INSPECTION

i) Purchaser and its representatives shall at all times be entitled to have access to the works and to all places of manufactures where insulators are manufactured and the successful Supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of material, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

62

ii) The successful Supplier shall keep the Purchaser informed in advance of the time of starting and progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.

iii) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of insulators shall in no way relieve the successful Supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

5.34 QUALITY ASSURANCE PLAN

5.34.01 The Supplier hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection. Information shall be separately given for individual type of material offered.

i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw material are tested, list of tests, normally carried out on raw material in presence of Supplier's representative, copies of test certificates.

ii) Information and copies of test certificates as in (i) above in respect of bought out items.

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas where manual processing exists.

v) List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such test and inspections.

vi) Special features provided in Polymer insulators to make it maintenance free.

vii) List of testing equipment available with the Supplier for final testing of Polymer insulators specified and test plant limitation, if any, vis-a-vis the type, special, acceptance and routine tests specified in the relevant standards.

5.34.02 The successful Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

i) List of raw material as well as bought out accessories and the name of material as well as bought out accessories and the names of sub-suppliers selected from those furnished alongwith the offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality assurance plan (QAP) with hold points for Purchaser's inspection. The QAP and Purchaser's hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalized.

5.34.03 The successful Supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the insulator.\

5.35 DOCUMENTATION

5.35.01 The Supplier shall furnish full description and illustrated catalogues of insulators offered, alongwith the bid. The supplier shall also furnish alongwith the bid the outline drawing of Polymer insulator unit including cross-sectional view. The drawing shall include the following information:

i) Shed diameter and unit spacing with manufacturing tolerance.
ii) Creepage distance.
iii) Unit mechanical and electrical characteristics for the complete string-suspension and tension. unit
iv) Size and weight of ball and socket part.
v) Weight of Polymer unit.
vi) Materials for the cap and pin.
vii) Identification mark.
viii) Manufacturer's catalogue number.
ix) Brief installation instructions.
x) Relevant technical details of significance.

5.35.02 TEST REPORTS

i) Four copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the Purchaser to the Supplier within three weeks thereafter and on receipt of the same Supplier shall commence with the commercial production of the Polymer insulators.

ii) Four copies of acceptance test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be despatched.

iii) All records of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser.

iv) All test reports of tests conducted during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when requested for by the Purchaser.

5.36 GUARANTEED PARTICULARS AND PERFORMANCE GUARANTEE:

(i) The bidder shall furnish all relevant technical guaranteed particulars of the long rod Polymer Insulators offered. Offers without such details may not be considered.

(ii) The Polymer Insulators shall be guaranteed for satisfactory performance for a period of 24 months from the date of commissioning of line. Any defect due to faulty material or workmanship found during guarantee period shall be rectified free of cost to the MPPTCL. The replacement will have to be organized expeditiously and within one month from the date of intimation.

The manufacturer shall also guarantee that there shall not be any failure/decapping/ breaking of insulators on line under normal operating condition. In the event of any failure/decapping/ breaking of insulators during first ten years of service, the manufacturer shall supply to the owner/purchaser free of cost spare insulators equal to 10 times the failed quantity. Further , in case of decapping/breaking and subsequent line drop , during the first ten years of service , the manufacturer shall also have to pay Rs. 1,00,000/-(Rs. One Lakh

64

only) per dropped string towards expenditure to be incurred by MPPTCL for the line repair.

(iii) In case, the replacement of defective material is not made within one month then apart from operating clause of Penalty, the MPPTCL may also take suitable penal action against the contractor, which may include encashing the Performance Security to the extent required besides debarring the contractor and the manufacturer from all future business with the MPPTCL for a period which will be at the discretion of MPPTCL.

(iv) The defective/ rejected material shall be collected by the contractor from Trans. Stores/Site within one month from the date of intimation at your own cost.

(v) The bidder shall indicate the facilities available at the manufacturer's works to carry out the tests as per relevant ISS. Supplies shall be subject to testing as per IS.

5.37 PACKING & FORWARDING

i) All Polymer insulators shall be packed in suitable PVC/Plastic tubes/any other suitable packing. The packing shall provide protection against rodents. The supplier shall furnish detailed design of the packing. For marine transportation crates shall be palleted.

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

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

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

v) The supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation handling, storage and installation due to improper packing indelible ink.

ANNEXURE-II

1.0 Tests on Complete composite Insulator with Hardware Fittings.

1.1 Salt - fog pollution withstand test

This test shall be carried out in accordance with IEC-60507. The salimity level for composite long rod insulators shall be 80 Kg / m3 NACL.

2.0 Composite Long rod Insulator Units

2.1 Brittle Fracture Resistance Test.

Assembled core load time test with container that contains in-HNO3 concentric acid this is applied at the naked rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96 hour test duration.

2.2 Recovery of Hydrophobicity Test

(1) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface

(2) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester. Holding the electrode approximately 3 mm from the sample surface slowly move the electrode over an area approximately 1″ x 1″. Continue treating this area for 2-3 minutes, operating the tester at maximum output.

(3) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic with an HC value of 6 to 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

(4) Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

3.0 Test on All components (As applicable).

3.1 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%.

3.2 Tests for Forgings.

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

3.3 Tests on Castings.

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized Procedures for these tests. The samplings will be based on heat number and heat treatment batch.

66

The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

4.0 Power Arc Test:

Three insulators having any one design of end fittings shall be tested for power arc endurance while tensioned horizontally at 3000lb. An arc shall be initiated across the insulator by means of a Copper shorting fuse wire. The arc shall burn 15 to 30 cycles and its current magnitude is determined by ampere- time product(IxT) equal to a minimum of 150kA cycles. Each insulator is only acceptable if there is no exposure of the core, no mechanical separation of the insulator, and no cracks in the housing .

SECTION- 6

TECHNICAL SPECIFICATION FOR ERECTION OF TRANSMISSION LINE

6.01 Execution of Work

6.01.1 The erection works consist of

a. Dismantling of existing ACSR Zebra Conductor, hardware, accessories and crediting at nearer store of MPPTCL.
b. Transportation, delivery of conductor, hardware, accessories etc. at erection site and keeping in safe custody.
c. Insurance of materials during storage-cum-erection.
d. Distribution of materials at erection site,
e. Stringing of conductor up to both ends of the lines, with the help of **tensioner** and **puller machine** and if required, manually with the approval of the MPPTCL.
f. Guarantee of all the activities carried out from (a) to (e) and submission of FQP for carrying out of all above activities.
g. Other items not specifically mentioned in this Specification and are required for the successful erection and commissioning of the transmission lines, unless specifically excluded in the Specification.

6.01.2 All works shall be carried out in accordance with the revised and latest provisions under Indian Electricity Act and Rules made there under.

6.01.3 All the erection tools required during erection of lines shall be arranged by the Contractor at his own cost. The Contractor shall also be responsible for any damage to and / or loss of his erection tools.

6.01.4 It will be the Contractor's sole responsibility to take the materials up to the location. Any pathway, temporary road, temporary bridge required for the work, same will be provided by the contractor at his cost. If, for any reasons the above is not feasible, the contractor at his own cost shall have to arrange transportation by head loads.

6.02 Stringing

The stringing work shall be carried with the help of tensioner and puller machines. Wherever it is not possible to install the tensioner, it can be done manually with the approval of site engineer of MPPTCL. Stringing shall mean, the activities of paying, jointing, tensioning, clamping with armor-rod, providing dampers and fixing the conductor at tension hardware and jumpering etc.

6.02.1 Stringing of conductor shall be done up to gantry at both ends of the individual lines.

6.02.2 The stringing work should be planned in such a manner in consultation with the Engineer in charge of the MPPTCL that minimum shut down of power line crossings are required. Revenue loss due to any undue shut down due to contractor's irresponsibility shall be recoverable from the contractor.

6.02.3 Before commencing of stringing work, Contractor shall obtain approval of sag tension charts showing final sag and tension for various temperature and spans.

6.02.4 The Contractor shall be responsible and will take care of proper handling of conductor drums. Sufficient numbers of aluminum snatch blocks shall be used for paying out the Conductors. Necessary precautions shall be taken to avoid conductor rubbing on the ground by providing adequate ground roller, rollers on supports. Additional rollers shall also be provided to cross thorny hedges, tower footing and other obstructions to avoid scratching of conductor. The conductor shall be made to sag correctly as per stringing charts, before they are finally transferred to the hardware and clamps. No mid span joint shall be made at less than 30 meters from the tower end and no mid span joint shall be permitted in road and other important crossings spans. There shall not be more than one joint in the same span of individual conductor. The sag shall be adjusted to suit the sag indicated against actual temperature. The thermometer shall be provided at the conductor point during the stringing work. Dynamo meters shall be used in tensioning the conductors. All conductors shall be stressed to their load at the time of stringing, as per approved stringing charts.

6.02.5 The minimum clearance between the lowest point of conductor and ground shall not be less than as specified in the chart. All compression joints should be carefully made and a record of initial and final lengths of the joints, jointly signed by contractor and MPPTCL representatives shall be maintained. Check for sag should also be made at intervals when conductors are drawn up. Over stressing, causing damage to towers must be avoided. Care should be exercised not to over tension the conductor. To avoid contact with the ground or any object above ground level the conductors shall be pulled by the controlled tension methods using neoprene lined double pulled wheel type tension stringing equipments. The equipment shall be capable of maintaining continuous tension of not less than of 3000 kg. per conductor.

6.02.6 When the conductor is on the stringing rollers before sagging-in, it shall be ensured that the conductor is not damaged due to wind, vibration, vehicles or other causes. Scaffolding should be used to cross the important road crossings for minimum interruption to traffic.

6.02.7 The conductor shall be pulled up to desired sag and left in serial stringing sheaves for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before clipping in and transferring the conductors from the serial stringing sheaves to the suspension clamps.

6.02.8 The stringing rollers, when suspended on the transmission structure for supporting conductors, shall be so adjusted that the conductor will be on the rollers at the same height as the suspension clamp to which it is to be secured.

6.02.9 Armour rods and vibration dampers shall be fitted at each suspension and tension tower before final clamping of conductor with Insulator strings. Vibration dampers are to be fixed with clamping bolt and in correct vertical position in relation to conductor.

6.02.10 Compression type joints are to be used for jointing of conductors. Each part connected with joints shall be perfectly cleaned & precautionary measures taken before final compression. All the joints of conductors shall be made with the best workmanship and shall be perfectly straight and having maximum possible strength.

6.02.11 Proper guys shall be provided to counter balance the paying out tension of conductor at the tension locations, to avoid damage to towers and/or accident.

6.03 FIELD QUALITY PLAN (FQP)

Bidder shall invariably submit the FQP along with Technical Bid for erection of line including all the activities such as dismantling, stringing etc. with detailed checklist to be referred.

6.04 WASTAGE

6.04.1 The maximum permitted ceiling for wastages for conductor permitted is 0.5% (maximum) which takes into account the additional length for sag & jumpers.

6.04.2 No wastage is allowed for any material except the percentage limit mentioned for Conductor here in above in Clause No. 6.20.1.

6.05 LOSSES

In the event of any material used for transmission line found broken or damaged or received short during transit or failed during the erection / testing at site before commissioning of line, the contractor shall replace the same free of cost.

6.06 COMMISSIONING

6.06.1 The contractor shall ensure that at the end of each sub-activity the surplus material is immediately removed from the work-site to avoid loss and injury to the public.

6.06.2 The contractor has to make reconciliation of material account and to settle final bill including signature in all relevant papers required for passing of final bill within three months from the date of charging / commissioning of line.

6.07 TAKING OVER:

When all performance tests called for by the Specification have been successfully carried out, the transmission line shall be accepted and taken over when it has been satisfactorily put into operation on site, or within one month of its being ready to be put into operation, whichever shall be the earlier and the Engineer shall forthwith issue a taking over certificate. The Engineer shall not delay the issue of any taking over certificate contemplated by this clause on account of minor defects in the plant which do not materially effect the commercial use thereof, provided that the Contractor shall undertake to make good the same in due course.