

MADHYA PRADESH POWER TRANSMISSION CO. LTD.

SHAKTI BHAWAN RAMPUR: JABALPUR



VOLUME –V(Part-2)

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**TECHNICAL SPECIFICATION FOR SUPPLY
OF MATERIALS AND CONSTRUCTION OF
400KV TRANSMISSION LINES.**

**O/o CHIEF ENGINEER (PROCUREMENT)
MPPTCL, JABALPUR.**

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SECTION-1

COMMON TECHNICAL REQUIREMENT

1.1 SCOPE:

1.1.1 The provisions under this section are to supplement common requirements for supply of Transmission Line Materials and Installation work. Section-2 to Section-8 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.

1.1.2 The scope of work involves fabrication, galvanizing and delivery of 400kV Double Circuit towers, their body extensions, river crossing Towers, Hangers, U bolts, D Shackles, Bolts and Nuts, Spring washers, pack washers, step bolts, tower accessories (earthing rod with clamps, Danger Boards, Number plates, Phase plates and Anti-climbing Devices (including fixing arrangements and barbed wire), ACSR Conductor, Earth wire, Disc insulators, hardware and accessories for conductor and Earth wire and complete erection of transmission lines including, detailed survey/check survey, casting of foundations, tower erection, stringing etc. and testing & commissioning of the transmission lines. Cement and reinforcement steel for foundation of towers, extensions, river/ line crossing structures and any such materials required for erection work shall also be provided by the successful Bidder. **The Bidder is also required to provide required number of stub setting templates for each installation work at his own cost.**

1.1.3 This section also provides for the Design, manufacturing, stage testing, inspection and testing before despatch, packing and delivery of materials for use on 400kV transmission lines in the State of Madhya Pradesh.

1.1.4 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.

1.1.5 If due to site condition any other type of tower (which is not envisaged at present) is required to be provided, the same will also be supplied by the bidder at the same rates terms and conditions.

1.2 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 ($^{\circ}\text{C}$)	50
3	Minimum temperature in shade ($^{\circ}\text{C}$)	1
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature ($^{\circ}\text{C}$)	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.

1.3 STANDARDS:

- 1.3.1 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.
- 1.3.2 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.
- 1.3.3 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.
- 1.3.4 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.

1.4 ACCEPTANCE OF OTHER AUTHORITATIVE STANDARDS :

- 1.4.1 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.**
- 1.4.2 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- 8 of Volume-V(Part-1) of bid document.
- 1.4.3 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.

1.5 TYPE TESTS:

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

1.5.2 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.

1.6 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.

1.7 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

1.8 SCHEDULE OF QUANTITIES:

1.8.1 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 Volume-V(Part-1) of bid document. The bidder shall refer these detailed descriptions for clarity.

1.8.2 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.

1.9 PERFORMANCE GUARANTEE PERIOD:

All the Material & its accessories and Installation work covered under the Bid shall guaranteed for performance and quality for a period of 24 months from the date of completion of facilities (or any part thereof). In case after commissioning of transmission line, any operational problem is observed in

any Material/ installation work because of which any major rectification or replacement work is done, then the guarantee for such Material / installation work shall be extended by a period equal to the period during which the facilities or such part can not be used by the EMPLOYER.

1.10 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.

1.11 DRAWINGS AND DOCUMENTS:

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

1.11.2 With in 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.

1.11.3 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.

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

1.11.5 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.

1.11.6 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.

1.11.7 The approval of the documents and drawings by the EMPLOYER shall mean that the EMPLOYER is satisfied that:

- a. The Contractor has completed the part of the Works covered by the subject 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.

- 1.11.8 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.

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

- 1.11.10 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 use/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.

- 1.11.11 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.

- 1.11.12 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.

1.12 QUALITY ASSURANCE PROGRAM:

- 1.12.1 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.

- 1.12.2 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.

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

1.12.4 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.

1.12.5 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.

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

1.13 INSPECTION AND TEST CERTIFICATES:

1.13.1 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.

1.13.2 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.

1.13.3 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.

- 1.13.4 The Material shall not be dispatched unless the test certificates approval and despatch instructions have been issued by the EMPLOYER.
- 1.13.5 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.
- 1.13.6 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.
- 1.13.7 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.
- 1.13.8 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.
- 1.13.9 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.

1.14 SPECIAL REQUIREMENTS:

- 1.14.1 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.
- 1.14.2 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.

1.15 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.

1.16 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 tower parts.	Inspection of Proto Assembly of each type of tower. Submission of quality assurance plan.
2.	Manufacturing of Conductors, Ground wire, Insulators, Hardware fittings & Accessories for Conductor and Earth wire.	Submission of Quality Assurance Plan, approval of drawings.
3.	Dispatch of towers, Conductors, Earth wire, Insulators, Hardware fittings & Accessories for Conductor and Earth wire.	Acceptance test and issue of test certificate approval
4.	Foundation work.	Classification of foundation.
5.	Erection of tower	Quality Assurance Plan for erection.
6.	Stringing of Conductor and Earth wire.	Stringing chart and stringing method.

1.17 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.

1.18 PERMITS AND PRIORITIES:

- 1.18.1 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.
- 1.18.2 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.
- 1.18.3 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.

1.19 WAY LEAVE:

The purchaser will arrange for necessary way leave and clearance of trees. The Purchaser only will pay the way leave compensation along the route.

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.

1.20 USE OF PRIVATE ROADS/APPROACH ROAD TO SITE:

- 1.20.1 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.
- 1.20.2 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.

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

- 1.21.1 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.
- 1.21.2 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.
- 1.21.3 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

- 1.21.4 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.
- 1.21.5 The Contractor will also arrange steel rods and binding wires etc. for foundation, reinforcement and the cost 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.

* * *

SECTION-2
TECHNICAL SPECIFICATIONS FOR TOWERS

Clause No.	Name of Clause
2.01	INDIAN STANDARDS/CODE
2.02	TYPE OF TOWERS
2.03	EXTENSIONS
2.04	STUB SETTING TEMPLATES
2.05	DESIGN
2.06	GALVANIZING PASSIVATION AND PAINTING
2.07	MATERIAL
2.08	WEIGHTS
2.09	BOLTS AND NUTS AND WASHERS:
2.10	STEP BOLTS
2.11	DANGER BOARD, NUMBER PLATE AND PHASE PLATES
2.12	ANTICLIMBING DEVICE WITH BARBED WIRE:
2.13	EARTHING
2.14	ATTACHMENT FOR INSULATOR STRING & GROUNDWIRE CLAMPS
2.15	FABRICATION WORKMANSHIP
2.16	BENDING
2.17	DRILLING AND PUNCHING
2.18	TOLERANCES
2.19	MARKING

SECTION-2
TECHNICAL SPECIFICATIONS FOR TOWERS

2.01 INDIAN STANDARDS / CODE :

The material and services under this specification shall be performed as per the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian standards/codes listed here under or equivalent International Standards , except as modified in this document.

S.No.	Indian standards	Title
1.	IS:209-1992	Zinc ingot- Specification.
2.	IS:278-1991	Galvanized Steel Barbed Wire.
3.	IS:800-1991	Code of Practice for General Building Construction in Steel.
4.	IS:802 -1990 (Part-II)	Code of practice for use of structural steel in over-head Transmission Line : Fabrication, Galvanising, Inspection & packing.
5.	IS:802 -1990 (Part-III)	Code of practice for use of structural steel in over-head Transmission Line Towers: Testing
6.	IS:808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.
7.	IS:1363(Part-III)-1992	Specification for Hexagon head bolts, screws and nut for product grade - "C" Hexagon nuts of property class 5.
8.	IS:1367-1979	Technical supply conditions for threaded fasteners (1 st Revision).
9.	IS:1367(Part-III)-1991	Mechanical properties and test method for bolts, screws & studs with full loadability.
10.	IS:1367(Part-VI)-1994	Mechanical properties and test method for nuts with specified proof loads.
11.	IS-1367(Part-XIII)-1983	The hot dip galvanized coating of fasteners.
12.	IS:1573-1991	Specification for electroplated coating of zinc on Iron & steel.
13.	IS:1586-1968	Methods of Rock well hardness test (`B' & `C' scales) for steel (first revision).
14.	IS:1852-1991	Rolling and Cutting Tolerances of Hot Rolled Steel Products.
15.	IS:2016-1992	Plain Washers.
16.	IS:2062-1992	Steel for general Structural purposes - Specification.
17.	IS:2614-1969	Method for sampling of fasteners.
18.	IS:2629-1990	Recommended practice for hot dip galvanizing of iron and steel.
19.	IS:2633-1992	Method of testing uniformity of coating of zinc coated articles.

S.No.	Indian standards	Title
20.	IS:3063-1994	Single Coil Rectangular Section spring washers for bolts, nuts, and screws.
21.	IS:3202-1972	Methods for testing local thickness of electro plated coatings.
22.	IS:3218(Part-V)-1979	Isometric screw threads "Tolerance".
23.	IS:3757-1992	High Strength Structural Bolts.
24.	IS:4072-1975	Specification for steel for spring washers (first revision).
25.	IS:4218(Part-VI)-1978	Isometric screw threads limits of sizes for commercial bolts & nuts.
26.	IS:4759-1990	Specification, for Hot dip Zinc coatings on Structural Steel and other Allied products.
27.	IS:5358-1969	Hot dip galvanized coatings on fasteners.
28.	IS:5369-1991	General Requirements for Plain Washers.
29.	IS:5613-1995 (part-II)	Code of practice for design, installation and maintenance of overhead power lines. Sec.-1 - Designs. Sec.-2 - Installation & Maintenance
30.	IS:6610-1991	Specification for Heavy Washers for Steel Structures.
31.	IS:6623-1992	High Strength Structural Nuts.
32.	IS:6745-1972	Methods for determination of weight of zinc coating of zinc coated iron and steel articles.
33.	IS:6821-1973	Methods for sampling of non threaded fasteners.
34.	IS:8500-1992	Specification for weldable structural steel (Medium & High Strength Qualities).
35.	IS:10238-1989	Step Bolts for Steel Structures.
36.	IS:12427-1992	Specification for Transmission Tower Bolts of property class 5.6
37.	IS:269-1967	Ordinary rapid hardening and low heat Portland cement.
38.	IS:456-2000	Code of practice for plain and reinforced concrete
39.	IS:1786-1966	Cold twisted steel bars for concrete reinforcements
40.	IS:4091-1967	Code of practice for design & construction of foundation for transmission line towers & poles

2.02 TYPE OF TOWERS:

The towers are self supporting lattice type, designed for the specified loading conditions. There will generally be following type of towers:-

- a. Tower type FD-0: Tangent type tower with maximum line deviation up to 2° to be used with Single/Double suspension insulator strings.
- b. Tower type FD-30/FDT: Medium angle tower to be used for line deviation from 0° to 30° with Single/Double tension insulator strings. FD-30 type tower is also used as Transposition tower with modified cross arms.
- c. Tower type FD-60: Heavy angle tower to be used for line deviation from 0° to 60° and also as dead end tower with Single/Double tension insulator strings.
- d. River Crossing Towers:- The Bidder will have to supply River Crossing Towers for crossing major river. Similarly for crossing 400kV line if FD60+ 30/35M extension tower is required, the same will have to be supplied by the contractor after approval of the Purchaser.

2.03 EXTENSIONS:

Suitable extension of 3M, 6M, 10M height shall be supplied for use with the FD-0, FD-30 and FD-60 type towers. 18/25M extension shall be supplied for FD-0 type tower depending upon the requirement intimated by the Purchaser.

2.04 STUB SETTING TEMPLATES:

The stub setting template shall be required for each type of tower and its respective extensions and shall be supplied by the Bidder for each type of tower and its respective extensions. The template shall be of adjustable type i.e. for use with normal towers as well as extensions.

2.05 DESIGN:

2.05.1 400kV Towers/extensions to be supplied are designed as per IS 802(Part-I)-1977.

2.05.2 The towers have square base with twin MOOSE ACSR conductor per phase in vertical formation and two ground-wires of 7/3.66 mm galvanized stranded steel wire of 95kg/sq.mm grade placed on the top of the towers. .

2.06 GALVANIZING PASSIVATION AND PAINTING:

The tower parts, stubs and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

Unless otherwise specified the fabricated tower parts and stubs shall have a minimum overall Zinc coating of 610 gms per sq. m of surface except for plates & sections below 5mm which shall have Zinc coating of 460 gms per sq. m of surface. The average zinc coating for all sections and plates 5mm & above shall be maintained as 87 microns and that for plates and sections below 5mm shall be maintained as 65 microns.

The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/bare spots, ash rust strains, bulky white deposits/wet storage strains and blisters.

The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out as indicated herein below:

- (i) **Degreasing & Cleaning of Surface:** Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629-1985. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.
- (ii) **Pickling:** pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629-1985. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to MPPTCL along with Quality Assurance Program.
- (iii) **Rinsing:** After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residue from the tank.
- (iv) **Fluxing:** The rinsed article shall be dipped in a solution of zinc ammonium chloride, The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to MPPTCL along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.
- (v) **Drying:** When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc shall form part of plant standard to be formulated and submitted to MPPTCL along with Quality Assurance Program.
- (vi) **Quality of Zinc:** Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or other comparable international standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain

minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminium alloy shall be added as per IS 2629.

- (vii) **Dipping Process:** The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at $450 \pm 10^{\circ}\text{C}$. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.
- (viii) **Post Treatment:** The article shall be quenched in water. The quench water is to be changed / drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard while rust attack. The temperature of the chromate solution shall not exceed 65°C . The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.
- (ix) **Storing, Picking and Handling:** In order to prevent while rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.
- (x) The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to Purchaser for approvals as part of Quality Assurance Plan.
- (xi) Minor defects in hot-dip galvanised members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of the Owner before erection.

2.07 MATERIAL :

2.07.1 IS Steel Sections of tested quality in conformity with IS:2062 : 2006 grade E250 (Designated Yield Strength. 250 MPa) and/ or grade E350 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

2.07.2 Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS : 1079 -1994 (Grade -0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates , joint splices etc. the same shall conform to IS : 2062 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to grade E250 or E350 (designated yield strength not more than 355MPa),

depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers. The chequered plates shall conform to IS : 3502. SAILMA 350HI grade plate can also be accepted in place of HT plates (EN 10025 grade S355 JR/JO / IS 2062:2006 – grade 350, as applicable) provide SAILMA 350HI grade plate meet all the mechanical properties of plate as per EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) / IS 2062:2006 – grade 350.

- 2.07.3** For designing of towers, preferably rationalised steel sections has been used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Owner before any substitution and records of such substitutions shall be maintained by the Contractor.

2.08 WEIGHTS :

The unit weight of each type of tower and extension including bolts and nuts, accessories, attachments and step bolts is indicated in the Bill of Materials which shall be supplied by the Employer to the successful Bidder. The weight of structure means the weight calculated using black sectional (i.e. ungalvanised) weights of all steel members of the sizes indicated in the fabrication drawings without taking into consideration the reduction in weight due to drilling of bolts, holes, skew cuts, chamfering etc. or increase in weight due to galvanising. The weight of gusset plates shall mean the weight of its circumscribing rectangle, without taking into considerations the reductions in weight due to holes, notches etc.

2.09 GALVANISED BOLTS AND NUTS AND WASHERS :

- 2.09.1** The design of the towers and extensions are based on use of HRH mild steel hot dip galvanized bolts (5.6 quality) and nuts (5.0 quality). The connections are designed on the basis of use of 16mm dia bolts. The spring washers shall be provided for insertion under all nuts.
- 2.09.2** The nuts shall be forged and tapped after galvanizing and then lubricated. The nuts shall be chamfered on one face only, the other face shall be machined.
- 2.09.3** The Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts 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-I) to ensure proper bearing.
- 2.09.4** Nuts for hexagonal bolts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.
- 2.09.5** Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members
- 2.09.6** All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm

and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

- 2.09.7** Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electrogalvanised, positive lock type and 3.5mm in thickness for 16mm dia bolt and 4.5mm for 24mm bolt.
- 2.09.8** To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.
- 2.09.9** The bolt positions in assembled towers shall be as per structural drawing.
- 2.09.10** Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.
- 2.09.11** To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS:14000 series Quality System Standard
- 2.09.12** The bolts and nuts shall be free from forging and threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.
- 2.09.13** The bolts shall be threaded up to standard length only as per relevant Indian Standard and not to full length.
- 2.09.14** The bolts and nuts shall confirm to IS 1967-1971 Part-III and Part-IV, IS 12427, IS 1363-92, IS 1367 Part-XIII with latest amendment.
- 2.09.15** The spring washers designated as M 16-B suitable for 16mm dia galvanized bolt shall be manufactured out of rectangular section with tolerances as per IS 3063-1994 with latest amendments. The spring steel shall conform to IS- 4072-1975 with latest amendments "Specification for steel for spring washers".
- 2.09.16** The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS 1586- 1968.
- 2.09.17** The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall not abut when the washers are compressed. The ends shall be so served as to prevent tangling.
- 2.09.18** The approximate weight of 1000 pieces of spring washers suitable for 16mm dia bolt shall be 8.91 kg. in natural black finish as shown in IS 3063-1972 with latest amendments.
- 2.09.19** The spring washer shall be electro galvanized with chromate passivation. The electro galvanizing of washers should conform to 'severe' grading service conditions incorporated in IS 1573-1986 as "Service Grade No.4", classification Fe Zn 25. The local thickness of zinc coating should

be minimum 25 microns and average thickness 38 microns. It should be further suitably heat treated to avoid any danger of hydrogen embrittlement.

2.10 STEP BOLTS :

Each tower will be provided, on one of the legs, with step-bolts of 16mm dia and 175mm long, spaced not more than 450mm and extending from 3 meters approx. above ground level up to the top portion of the tower. The step bolts shall be confirm to IS 1363-1992, IS 10238:1989 and IS 1367(Part-XIII): 1983.

2.11 DANGER BOARD, NUMBER PLATE AND PHASE PLATES :

Each tower will be fitted with danger board, number plate and phase plates. The tower to be supplied shall have provision to fix these plates at a height of about 3 meters above ground level. Necessary provision in tower & extensions for fixing of these items shall be made. The Danger board, number plate and phase plates shall be supplied conforming to following technical details:-

- 2.11.1** The danger boards shall conform to IS-2551-1982 and their revision, if any except where modified in this specification.
- 2.11.2** The danger boards, number plates and phase plates shall conform to the drawings enclosed in this specification.
- 2.11.3** The colour scheme of the enamel and size of figures and dimensions of lettering shall be as shown in the drawing as also the overall size. The holes as indicated in the drawing shall be provided before enamellings.
- 2.11.4** The thickness of the plate out of which the danger board, number plate and phase plate will be manufactured, shall not be less than 1.6mm.
- 2.11.5** The enamellings shall be done by vitreous enameling process only.
- 2.11.6** All letterings shall be centrally spaced. The dimensions of the letters, figures and their respective positions shall be as given in drawings. The size of each letter in the word in each language and the spacing between them for the purpose of scribing shall be so chosen that they are uniformly written in the space earmarked for them.
- 2.11.7** The corners of the plate shall be rounded off. The location of the fixing holes shall be according to drawing annexed with this specification.
- 2.11.8** The plate shall be made from mild steel at least 1.6mm thick and vitreous enameled white, with letters, figures and the conventional skull and cross-bones in signal red colour on the front side. The rear side of the plate shall also be enameled.
- 2.11.9** The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.
- 2.11.10** The letters of number and phase plates shall be red enameled with white enameled background.

2.12 ANTICLIMBING DEVICE WITH BARBED WIRE :

The barbed wire type anticlimbing device shall be used at a height of approximately 3 meters as an anticlimbing deterrent measure, as per the details given in IS:5613(Part- 2/Sec-I)1985. The towers to be supplied by the Bidder shall have provision to fix the barbed wire as indicated above.

Thus the angle pieces with notches for accommodating barbed wire shall be supplied with the towers alongwith with provision for suitable bolt holes on leg members for fitting the angles. It should have the facility of the locking arrangement. The Barbed wire shall confirm to IS:278/1978 with latest amendment and shall be type 'A-3'.

The Barbed wire shall be made of Hot dip Galvanised MS solid wire of size 2.5mm dia (for line wire) and 2.0 mm dia (for point wire). The barbs shall have four points and shall be formed by twisting 2 point wires, each two turns, tightly around both line wires making altogether four complete turns. The wire shall be galvanised by Hot dip process as per IS:2629/1966 (with latest amendment). The galvanised wire shall confirm to the requirement as per IS:4826/1971 with latest amendment in all respect. IS:2633/1972 and IS 6745/1972 for testing of uniformity & mass of zinc coating. The zinc coating shall be medium type on line wire and light type on point wire i.e. having zinc coating minimum 110 gm/m² on line wire and 70 gm/m² on point wire.

2.13 EARTHING :

2.13.1 A provision shall be made in the stub for fixing earthing material. The stub will be provided with a hole at a distance of 250 mm from bottom end and at a distance of 500 mm below ground level for connection with earthing materials. The hole will be of 17.5 mm dia.

2.13.2 The Bidder shall also supply the following materials per earthing set for earthing of towers (four sets per tower): -

- (i) One no. Hot dip galvanized earthing Mild Steel Rod (2 Meter long, 25 mm diameter);
- (ii) Hot dip galvanized connecting clamps (‘F’ type and ‘U’ type- 2 Nos. per set);
- (iii) Hot dip galvanized stranded steel wire of size 7/4.00mm, Grade 5 to be used as connecting wire conforming to Indian Standard:2141:1992 and Indian Standard 4826: (5 Meter per earthing set).

2.13.3 The details of earthing rod and clamps and earthing arrangement for towers are shown in the drawing enclosed.

2.13.4 The earthing rod shall be of mild steel solid rod of 2 meters in length and 25mm in diameter with one end pointed. The rods shall be galvanized as per relevant Indian Standard . The zinc coating on the rod shall not be less than 610 gm/m² of surface area.

2.13.5 The tower end-connecting clamp shall be of flat type and rod end connecting clamp shall be of ‘U’ type. The clamps shall be of forged steel cast iron / malleable iron. The clamps should be hot dip galvanized as per Indian

Standard:2629:1990 . The zinc coating on the clamps shall not be less than 610 gm/m² of surface area.

- 2.13.6** The hot dip galvanized stranded steel wire of size 7/4.00mm shall be supplied for connection between the earthing rod and the stub. The steel wire shall conform to Indian Standard 2141: 1992 and Indian Standard:4826: 1979 and latest revision thereof and shall consist of seven strands, each strand having a diameter of 4 mm and Grade-5. The galvanizing shall be done as per Indian Standard specification 2141: 1992 and 4826: 1979 and latest revision thereof for heavy zinc coating. The coating of zinc shall not be less than 260 gm/m².

2.14 ATTACHMENT FOR INSULATOR STRING & GROUNDWIRE CLAMPS:

- 2.14.1** The towers shall be provided with suitable attachment for supporting insulator strings and ground-wire suspension and tension assembly.

- 2.14.2** The towers shall be provided with the cleats to support the hanger. The details of hanger are shown in the drawing enclosed.

- 2.14.3** The ground-wire suspension assembly has got a 'D' shackle. There shall be a suitable arrangement to support the same.

- 2.14.4** On angle towers, strain plates shall be provided for purpose of attaching the tension insulator string. For fixing ground-wire tension assembly a hole 17.5mm dia shall be provided in the strain plate.

2.15 FABRICATION WORKMANSHIP :

- 2.15.1** Except where hereinafter modified, details of fabrication shall conform to IS-802(Part-II)-1990.

- 2.15.2** The fabrication of towers shall be done strictly in accordance with the drawing supplied by the Employer.

- 2.15.3** The towers shall be of bolted construction.

- 2.15.4** Normally lap splice shall be used for connecting members of un-equal size and the inside angles of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. Butt-joint as well as lap joint splices shall be made as above and as close to the main panel as possible.

- 2.15.5** Joints are designed and detailed to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the eliminations of the gusset plates would result in eccentric joints, gusset plates and spacer plates may be used in conformity with modern practice.

- 2.15.6** The tower structures shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.

- 2.15.7** No angle member shall have two leg flanges brought together by closing the angle.

- 2.15.8** The diameter of the hole shall be equal to the diameter of the bolt plus 1.5 mm.

2.15.9 All similar parts shall be made strictly interchangeable. All steel section before any work is done on them shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structures. Hammering is not permitted for straightening.

2.15.10 Cutting may be done by shearing, cropping, flame cutting or sawing. The surface so cut shall be cleaned smooth, reasonably square and free from deformation and distortion.

2.16 BENDING :

2.16.1 Mild steel angle sections up to 75x75 mm (up to 6mm thick) shall be bent cold up to and including bend angle of 10° Angles. Above 75x75mm (thickness up to 6mm) and up to and including 100x100 mm (thickness up to 8 mm) may also be bent cold up to the bend angle of 5 Deg. All other angle sections and bend angles not covered above shall be bent hot.

2.16.2 All plates up to 12mm thickness shall be bent cold up to a maximum bend angle of 15 Deg. Plates of thickness more than 12mm with bends greater than 15 Degree shall be bent hot.

2.16.3 All hot bend material shall be air-cooled. The bends shall be of even profile and free from any surface damages.

2.17 DRILLING AND PUNCHING :

2.17.1 The holes in the member shall either be drilled or punched with a jig, the former process will be preferred.

2.17.2 Punching may be adopted for sections up to 12 mm thickness. For thicker sections drilling shall be done.

2.17.3 The holes shall be punched/drilled after bending and related position of these holes shall be maintained with the use of proper templates/jigs and fixtures.

2.17.4 The holes shall be perfectly circular and no tolerance in this respect is permissible. The holes shall be perpendicular to the plate and angle flanges.

2.17.5 Holes must be square with the plates or angles and have their walls parallel.

2.17.6 All burrs left by drills or punch shall be removed completely. When the tower members are in positions, the holes shall be truly opposite to each other. Drilling or ramming to enlarge defective holes shall not be permitted.

2.17.7 The minimum spacings of bolt and edge distance shall be as under :-

- a. For 16 mm dia bolt edge distance of 20 mm from hole center to rolled or swaged edge and 23mm from hole center to sheared or flame cut edge, hole center to hole center distance minimum 40mm (the hole size being 17.5mm).
- b. The gap between the edges of the connected members in butt joint shall not be more than 6mm and less than 4mm.

- c. The bolt gauge distance in flanges of angle sections shall generally be in accordance with Table XXXI of SF6(1)-1961-ISI "Hand Book for structural Engineers-Structural Steel Sections (Revised)."
- d. The bolt gauge distance in flanges of angle sections shall generally be in accordance with Table XXXI of SF6(1)-1961-ISI "Hand Book for structural Engineers-Structural Steel Sections (Revised)."

2.18 TOLERANCES :

- 2.18.1 The maximum allowable difference in the diameter of the hole on the two sides of the plate or angle shall not exceed 0.8 mm on diameter. The allowable taper in drilled/punched hole shall not exceed 0.8 mm on diameter.
- 2.18.2 The tolerance cumulative or between consecutive holes shall be within +/- 0.5mm.
- 2.18.3 The tolerance on the overall length of member shall be within +/- 1.6 mm.
- 2.18.4 The tolerance on gauge distance shall be within +/- 0.5mm.
- 2.18.5 Rolling and weight tolerance of steel sections shall be as per Indian Standard: 1852 and Indian Standard: 808.

2.19 MARKING :

All members shall be distinctly given punch mark similar to those given in structural drawings. The mark shall be given with marking dies of minimum 18 mm size and this mark shall be legible. Letter XMPTFD0, XMPTFD30 and XMPTFD60 shall precede erection mark where 'X' stands for manufacturer's name, 'MPT' stands for Madhya Pradesh Power Transmission Company and FD0, FD30 & FD60 stands for type towers.

2.20 QUALITY ASSURANCE PROGRAM :

The contractor shall submit the Quality Assurance Programme as specified in clause 1.12 Section-1 of the bidding 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.

2.21 INSPECTION OF PROTOTYPES :

- 2.21.1 Proto type of each type of structure/extensions shall be offered by the successful bidder for inspection within three month's time from the date of contract.
- 2.21.2 Notwithstanding any thing covered in the drawings and other details furnished by the Employer, the successful bidder shall make minor modifications, if any, in length, size, notching etc. according to the proto assembly which are necessary for easy assembly of the structure.

2.22 INSPECTION :

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

- 2.22.2** Each consignment ready for transportation shall be offered to the Employer for inspection before dispatch giving a minimum time of not less than fifteen days. Only complete sets of towers/extensions shall be offered for inspection. All materials constituting towers (Steel parts, Bolts & nuts, spring and pack washers, earthing sets) shall be offered simultaneously. Samples of fabricated tower materials and accessories shall be subjected to tests as per relevant Indian Standard or equivalent International Standard. The Employer shall be kept informed about the source of procurement of raw-steel, particularly through re-rollers. The Employer reserves right to inspect and get the samples of raw-steel tested as per Indian Standard-2062 and relevant standards or equivalent International Standard. The cost of testing shall be borne by the bidder.
- 2.22.3** The Contractor shall keep the Employer informed in advance of the time of starting and of the progress of manufacture and fabrication of structures at various stages.
- 2.22.4** In case, any member of the structure is not found to comply with the relevant drawing, it shall be liable for rejection even after receipt.
- 2.22.5** Defects, which may appear during fabrication, shall be made good. Any member once rejected shall be cut into pieces in front of the Employer's representative so that it is not offered again by mistake.

2.23 GENERAL GUIDE-LINE FOR INSPECTION :

2.23.1 Fabricated Structure Members :

- (i) Visual examination and quantity verification of offered lot.
- (ii) Sample selection from the offered lot at a ratio of 40 MT (or part thereof) 1 no. each for all tests.
- (iii) Dimension, fabrication and trueness verification of structure member from fabrication sketch.
- (iv) Galvanising test of each sample i.e. dip test, hammer test and mass of zinc test.
- (v) Random verification of Zinc coating of galvanized surface by Alko-meter.
- (vi) Tensile test and bend test of each sample.
- (vii) Chemical composition test of at least two samples per offered lot of 50 MT for inspection.
- (viii) Verification of manufacturer's test certificate for mild steel used in structure members.

2.23.2 Bolts-Nuts, Washer, Accessories, Attachments etc.: (To be carried out at manufacturers works of these items)

- (i) Visual examination and quantity verification of offered lot.
- (ii) Sample selection from the offered lot as per relevant Indian Standard for each item.
- (iii) Dimension, fabrication and trueness verification from fabrication sketch.

- (iv) Galvanising test of each sample.
- (v) Other acceptance tests for respective items as per relevant Indian standard.

2.23.3 The supplier shall submit the factory test certificates of bought out accessories at the time of acceptance tests of towers.

2.23.4 Since at the time of inspection only fabricated tower members and accessories will be verified, acceptance of any lot shall in no way relieve the bidder of his responsibility to meet all technical requirements of this specification for fabricated towers. In case any shortcoming is noticed at the time of actual assembly and erection, the Employer may reject any part or item or accessory and the contractor will have to assume the responsibility for free replacement/rectification of such defects.

2.24 PACKING AND MARKING ON PACKING :

2.24.1 The material shall be boxed or bundled for transport in the following manner:

- (i) Angle shall be packed in bundles securely wrapped four times around at each end and over 900 mm with No.9 SWG steel wire with ends twisted tightly. Gross weight of any bundle shall not be less than 450 Kg and more than 2000 Kg. The bundle shall be in complete Tower form only.
- (ii) Cleat angles, brackets, filler plates and similar small loose pieces shall be nested and bolted together through holes and wrapped around at least four times with No.9 SWG wire with ends twisted tightly or packed in wooden crates. Gross weight of each bundle shall not exceed 200 Kg.
- (iii) Correct number of bolts, nuts and washers required for structures shall be packed in heavy gunny bags accurately tagged in accordance with the contents and a number of bags packed in a solid box of 22mm thick lumber with paneled ends to be accurately nailed and further reinforced with 22 mm x 75 mm Batons round the sides and at the ends with 25 mm x No.18 SWG iron band stretched entirely around the batons with ends overlapping at least 150mm. Gross weight of each box shall not exceed 200 Kg.
- (iv) Packing list incorporating all relevant details e.g. quantity of structures (complete sets), number and size of steel sections, quantity of nuts, bolts, washers etc. shall be forwarded along with each consignment.
- (v) In the nutshell the packing arrangement should be such that all lots of one particular type of structure are identifiable at site for the purpose of allocation for a particular work. In case more than one structure of a particular type is delivered in area store/work site, combined packing arrangement by way of clubbing members of similar type (for more than one structure) in a combined package should not be done. Uniform packing procedure for each structure should be adopted.

2.24.2 All above packing are subject to the approval of the Employer or his appointed representatives.

2.24.3 Each bundle or packing shall have the following marks:

- (i) The name of the consignee (as per dispatch instructions given by the Employer).
- (ii) Ultimate destination as required by the Employer.

- (iii) The relevant marks and number of structure members or reference or bolts, nuts and small components like gusset plats, various attachment, etc. for easy identification.

2.24.4 The marking shall be stenciled and indelibly inked on the top members in the bundles, on wooden boxes and also on gunny bas containing smaller components.

SECTION-3**TECHNICAL SPECIFICATIONS FOR CONDUCTOR****3.1 SCOPE :**

- 3.1.1** This specification provides for standard design, manufacture, stage testing, inspection and testing before despatch, packing and delivery of Steel Cored Aluminium Conductor specified hereunder for their satisfactory operation in various lines and sub-stations of the State. The Conductor is to be used as power conductor on double circuit transmission lines.
- 3.1.2** Bidders are required to quote for supply of all materials as detailed in the specification. The bidder shall furnish full particulars as called for in various clauses, in addition to filling and completing the schedules annexed to this specification.
- 3.1.3** The unit rate quoted shall be inclusive of deployment of all plant, equipment, men, material, skilled & unskilled labors etc. essential for satisfactory supply of ACSR Moose.
- 3.1.4** All the raw materials for supply of ACSR Moose shall be included in the Bidder's scope of supply. Bidder shall inform the sources from where he proposes to procure the raw materials.

3.2 STANDARDS:

- 3.2.1** The power conductor shall conform to the following Indian Standards, which shall mean latest revisions, amendments/changes adopted and published, unless otherwise specified hereinbefore.

Sl. No.	Indian Standards or any Equivalent International Standard	Title
1	IS:209	Specification for Zinc
2	IS:398 Part I to Part V (as relevant)	Specification for Aluminium Conductors for overhead Transmission purpose.
3	IS:1778	Reels and drums for Bare wires
4	IS:1521	Method of Tensile Testing of Steel wire
5	IS:2629	Recommended practice for Hot Dip Galvanising Iron and Steel
6	IS:2633	Method of Testing Uniformity of Zinc coating of Zinc coated Articles.
7	IS:4826	Galvanised coating on Round Steel wire
8	IS:6745	Method of Determination of weight of Zinc coating of zinc coated Iron and Steel Articles
9	IS:8263	Method of Radio Interference Tests
10	IS:1841	EC Grade Aluminium Rod produced by

		rolling
11	IS:5484	EC grade Aluminium Rod produced by continuous casting and rolling
12	IS: 2141	Method of Elongation test of steel wire

3.2.2 Acceptance of Other Authoritative Standards :

In the paragraph above, relevant Indian standards have been mentioned. However, the ACSR Moose meeting any other authoritative international standard, which ensures equal or better quality than the standards, mentioned above shall also be acceptable. Please attach photocopy of all such standards according to which the, ACSR Moose have been offered.

In this bid, 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, ACSR Moose as per details given in this specification.

3.3 CLIMATIC CONDITIONS :

- 3.3.1** The ACSR conductor shall be suitable for being installed directly in air supported with suspension insulator strings or anchored through tension insulator strings supported with hanger/suspension clamp or tension clamp at the cross arms of single circuit and double circuit transmission line towers. The conductor shall be therefore suitable for satisfactory continuous operation under the following climatic conditions:

1	Location in the state of	MADHYA PRADESH
2	Maximum ambient air temperature (0C)	50.
3	Minimum temperature in shade (0C)	1.
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature (0C)	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 metre)	150
9	Max. Altitudes above mean sea level (metres)	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.

3.4 PARAMETERS :

3.4.1 Principal Parameters of Stranded Conductor:

Sr. No.	Details of Stranded Conductor	ACSR Moose
a)	No. of Strands	Aluminium-54 Steel -7
i.	Steel Centre	1
ii.	1st Steel Layer	6
iii.	1st Aluminium Layer	12
iv.	2nd Aluminium Layer	18
v.	3rd Aluminium Layer	24
b)	Sectional Area of Aluminium (Sq.mm)	528.5
c)	Total Sectional Area (Sq.mm)	597.0
d)	Overall diameter(mm)	31.77 mm
e)	Approximate weight (Kg/Km)	2004
f)	Calculated D.C. Resistance at 20 Deg.C (Ohm/Km)	0.05552
g)	Minimum UTS (kN)	161.2
h)	Modulus of Elasticity kg/cm ²	0.703x10 ⁶

3.4.1.1 The details of aluminium strand are as follows :

Sr. No.	Details of Aluminium Strands	ACSR Moose
a)	Minimum breaking load of strand Before stranding (kN)	1.57
b)	Minimum breaking load of strand after stranding (kN)	1.49
c)	Maximum D.C. resistance of strand at 20 deg.C (Ohm/Km)	2.921
d)	Nominal Strand Dia	3.53
e)	Max. Strand Dia	3.55
f)	Min. Strand Dia	3.53
g)	Mass (Kg/Km) of Strand at Nominal dia	21.47

3.4.1.2 The details of steel strand are as follows:

Sr. No	Details of Steel Strands	ACSR Moose
p)	Minimum breaking load of strand Before stranding (kN)	12.86

q)	Minimum breaking load of strand after stranding (kN)	12.22
r)	Nominal Strand Dia	3.53
s)	Maximum Strand Dia	3.60
t)	Minimum Strand Dia	3.53
u)	Mass (Kg/Km) of Strand at Nom. dia	76.34
v)	Zinc coating testing	3 dips of 1 min. each
w)	Wt. of Zinc Coating (gms/sq. metre)	260

3.5 GENERAL TECHNICAL REQUIREMENTS : MATERIAL AND WORKMANSHIP (FOR ACSR MOOSE):

3.5.1 Materials:

3.5.1.1 The conductors shall be manufactured from EC grade aluminium rods suitably hard-drawn on wire drawing machines. The aluminium rods used shall comply with IS: 1841 and IS: 5484 or any equivalent International Standard. The mechanical and electrical properties of aluminium wire shall comply with the requirements given in relevant standard.

3.5.1.2 Physical constants for Hard-drawn Aluminium:

i. Resistivity:

The resistivity of aluminium depends upon its purity and its physical condition. For the purpose of this specification the maximum value permitted is 0.28264 Ohm sq.mm/mt. at 20° C and this value has been used for calculation of the maximum permissible value of resistance.

NOTE : It is not intended to check the resistivity from the measured values of resistance.

ii. Density:

At a temperature of 20° C the density of hard drawn aluminium has been taken as 2.703 g/cm.³

iii. Constant-Mass Temperature Co-efficient of Resistance:

At a temperature of 20°C, the constant-mass temperature co-efficient of resistance of hard drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.004 per degree Celsius.

iv. Co-efficient of Linear Expansion:

The co-efficient of linear expansion of hard-drawn aluminium at 0° C has been taken as 23.0×10^{-6} per ° C. This value holds good for all practical purposes over the range of temperature from 0 ° C to highest safe operating temperature.

Galvanised steel wire shall be drawn from high carbon steel rods produced by either acidic or basic open hearth process, electric furnace process or basic oxygen process. The mechanical and electrical properties of wire shall comply with the

requirements given in relevant standard. The chemical composition of high carbon steel wires is given below for guidance only.

Element	Percentage Composition
Carbon	0.5 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

3.5.1.3 Physical constants for Galvanised steel wires:

i. Density :

At a temperature of 20° C, the density of galvanized steel wire is to be taken as 7.80 g/Cm³.

ii. Coefficient of Linear Expansion :

In order to obtain uniformity in calculation a value of $11.5 \times 10^{-6} \text{ }^{\circ}\text{C}$ may be taken as the value for the co-efficient of Linear Expansion of galvanized steel wires used for the cores of steel-reinforced aluminium conductors.

- iii. The zinc used for galvanizing shall be electrolytic high-grade Zinc not less than 99.95 percent purity. It shall conform to and satisfy all the requirements of IS: 209. Galvanising may be done either by hot process or electrolytic process. Minimum weight of Zinc coating shall be 260 g/sq. metre. Neutral grease may be applied between the layers of wire.

iv. Freedom From Defects:

The wires shall be smooth and free from all imperfections such as spills, slag inclusion, die marks, scratches, fittings, blow-holes, projections, looseness, overlapping of strands, chipping of aluminium layers etc. and all such other defects which may hamper the mechanical and electrical properties of the conductor. Special care should be taken to keep away dirt, grit etc. during stranding.

3.5.2 Wire Sizes

3.5.2.1 Nominal Size:

The aluminium and galvanized steel wires for the stranded conductor covered by this standard shall have diameters specified in clause 3.4.1.1 & 3.4.1.2. The diameter of the steel wires shall be measured over the zinc coating.

3.5.2.2 Tolerances on Nominal Size :

Tolerance of + 1% is permitted on the nominal diameter of Aluminium Wires of Moose Conductor and a tolerance of + 2 % is permitted on the nominal diameter of Galvanised Steel Core Wire.

3.5.3 Joints in Wires:

3.5.3.1 Aluminium Wires:

No joints shall be permitted in the aluminium wires in the outermost layer of the ACSR Conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15

mtr. apart in the complete stranded conductor such joints shall be made only by cold pressure butt-welding. It may please be noted that Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses on extra high voltage lines.

3.5.3.2 Galvanised Steel Wires:

There shall be no joints except those the base rods or wires before final drawing, in steel wires forming the core of the steel-reinforced aluminium conductor. Joints are not permitted in the steel wires after final drawing also in order to avoid reduction in the breaking strength of the conductor that may occur as a result of failure of the joints.

3.5.4 Stranding:

3.5.4.1 The wires used in the construction of galvanized steel reinforced aluminium conductor, before stranding, shall satisfy all the relevant requirements of this specification.

3.5.4.2 The lay ratio of the different layers shall be within the limits given in the Table below:-

LAY RATIO OF ALUMINIUM CONDUCTORS GALVANISED STEEL-REINFORCED (Moose Aluminium-54 Wire Steel - 7 Wire)

Ratio of Alu. wire diameter to steel wire diameter	Lay Ratios of Steel core 6 wire layer		Lay Ratios for Aluminium wires (3 Alu. Wire Layer Conductors)					
			Outermost layer		Layer immediately beneath outer most layer		Innermost Layer	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	16	18	10	12	11	13	12	14

NOTE : For the purpose of calculation, the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table.

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

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

3.5.4.5 The finished Conductor shall have a smooth surface without any surface cut, abrasion, scuff marks and shall be free from dirt, grit, etc. even if the damage to conductor is acceptable from mechanical considerations. It will not be acceptable from electrical considerations, and full care should be taken not to supply damaged conductor. Projections of more than 2 mils shall not be acceptable. Any such damage shall be properly rectified or new conductor supplied.

3.5.4.6 Failure of any sample to meet the above requirements shall be sufficient cause for rejection of the lengths of conductor represented by the sample. Particular care shall, therefore, be taken during manufacture, handling, packing and transportation of the conductor, to see that the surface is not dented, cut or damaged in any way.

3.5.5 Standard Length :

3.5.5.1 The standard length of conductor shall be 1500 metres. A tolerance of +/-5% on the standard length offered by the supplier shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.

3.5.5.2 Random lengths will be accepted provided no length is less than 70% of the standard length specified and the total quantity of such random lengths shall not be more than 5% of the total quantity ordered.

3.5.5.3 Supplier shall also indicate the maximum single length, above the standard length, they can manufacture in the guaranteed technical particulars. This is required for special stretches like river crossing etc. The purchaser reserves the right to place orders for the above length to the 5% of the total ordered quantity on the same terms and conditions applicable for the standard lengths during the pendency of the contract.

3.5.6 Galvanising:

3.5.6.1 All the wires of Iron & steel strand shall be galvanized in accordance with IS-2629-1966. 'Recommended practice for hot dip galvanizing of Iron and Steel' or some other authoritative equivalent standard.

3.5.6.2 Specific technical requirements for galvanizing and relevant tests quoted in clause-6 of this specification for guidance shall be complied.

3.6 TESTS :

3.6.1 The conductor offered shall be type tested as per the relevant standards. Further the acceptance, routine tests and tests during manufacture shall be carried out on the conductor.

3.6.2 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification.

3.6.3 All the materials offered shall be fully type tested as per the relevant standards and the supplier shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five

years, prior to the date of opening of bid. For any change in the design/type already type tested and the design/type offered against this specification, the purchaser reserves the right to demand repetition of tests without any extra cost.

- 3.6.4** 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 that lot.
- 3.6.5** Routine tests shall mean those tests which are to be carried out on each strand/spool/length of the conductor to check requirements which are likely to vary during production.
- 3.6.6** Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the supplier to ensure the desired quality of the end product to be supplied by him.
- 3.6.7** The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Supplier and the Purchaser as per relevant clause of General Conditions of Contract.
- 3.6.8** The standards and norms to which these tests will be carried out are listed in para 2.0. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be as mutually agreed to between the Supplier and the Purchaser in the Quality Assurance Programme.
- 3.6.9** For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Supplier in the 'Guaranteed Technical Particulars' of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

3.6.10 Type Tests :

The Conductor offered shall be fully type tested as per the relevant International/Indian Standard and the bidder shall furnish the report along with the offer. These tests must not have been conducted earlier than 5 years prior to the date of opening of bid. 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.

The above said test reports submitted with the offer shall not be older than five years, prior to the date of opening of bid.

- a) UTS test on stranded conductor
- b) DC resistance test on stranded conductor
- c) Stress-strain test on composite conductor

3.6.11 Acceptance Tests :

- a) Visual and dimensional check
- b) Visual check for joints, scratches etc. and lengths of conductor

- d) Dimensional check on steel and aluminium strands
- d) Check for lay ratios of various layers
- e) Galvanising test on steel strands
- f) Torsion and Elongation test on steel wire
- g) Breaking load test on steel and aluminium strands
- h) Wrap test on steel and aluminium strands
- i) DC resistance test on aluminium strands
- j) UTS test on welded joint of aluminium strand

NOTE: All the above tests except test mentioned at (j) shall be carried out on aluminium and steel strands after stranding only.

3.6.12 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 specifications.
- d) All acceptance tests as mentioned in Clause 6.1.10 above shall be carried out on each coil.

3.6.13 Tests During Manufacture :

- a) Chemical analysis of zinc used for galvanizing
- b) Chemical analysis of aluminium for making aluminium strands
- c) Chemical analysis of steel used for making steel strands

3.6.14 Testing Expenses:

The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspection/Purchaser's representative.

3.6.15 Additional Tests:

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

3.6.16 Sample Batch for Type Testing

- (a) The bidder shall offer at least three (3) drums for selection of samples required for conducting all the type tests, in case of change in design/type already tested and the design type offered against this specification, for which the purchaser reserves the right to demand carrying out type test without any extra cost.
- (b) The bidder is required to carry out all the acceptance tests successfully in the presence of Purchaser's representative before despatch of conductor.

3.6.17 Test Reports

- (a) Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser's representative.
- (b) Test Certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Purchaser.

3.6.18 Test Facilities

The following additional test facilities shall be available at Bidder'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 metres per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with transverse layering facilities.

3.7 INSPECTION :

- 3.7.1** The purchaser'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 the 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.
- 3.7.2** The Supplier shall keep the Purchaser 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.
- 3.7.3** No material shall be despatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the purchaser in writing. In the later case also, the conductor shall be despatched only after satisfactory testing for all tests specified herein has been completed.

3.7.4 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.

3.7.5 At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by following method:

"At the works of the manufacturer the conductor shall be transferred from one drum to another at the same time measuring its length with the help of graduated pulley and Cyclometer. The difference in the average length thus obtained and as declared by the supplier in the packing list shall be applied to all the drums if the conductor is found short during checking"

3.8 QUALITY ASSURANCE PLAN :

3.8.1 The Supplier shall invariably furnish following information along with his offer, failing which his offer may be liable for rejection. Information shall be separately given for individual type of equipment offered.

- (i) Statement giving list of important raw materials names of sub supplies for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials 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 accessories.
- (iii) List of manufacturing facilities available.
- (iv) Level of automation achieved and list of areas where manual process exists.
- (v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- (vi) Special features provided in the equipment to make it maintenance free.
- (vii) List of testing equipments available with the Supplier for final testing of material specified and test plant limitation. If any, vis-a-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviation from specified test requirements.

3.8.2 The successful Supplier shall within 30 days of placement of order, submit following information to the purchaser.

- (i) List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with 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 quality assurance of plan and Purchaser's hold points shall be discussed between the Purchaser and Supplier, before QAP is finalized.

3.8.3 The successful Supplier shall submit the routine test certificates of bought out accessories and central excise passes for raw material viz. oil, copper,

aluminium, conductor's insulating materials, core material at the time of routine testing of the Conductor.

3.9 DOCUMENTATION :

- 3.9.1** Six sets of type test reports, duly approved by the Purchaser shall be submitted by the supplier for distribution, before commencement of supply. Adequate copies of acceptance and routine test certificates, duly approved by the Purchaser shall accompany with despatched consignments.
- 3.9.2** 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 Purchaser. All manufacturing and fabrication work in connection with the material prior to the approval of the drawing shall be at Supplier's risk.
- 3.9.3** Approval of drawing/work by Purchaser shall not relieve the Supplier of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The material shall conform in all respect to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering. Purchaser shall have the power to reject any work or material, which in his judgment is not in full accordance therewith.

3.10 PACKING AND FORWARDING :

- 3.10.1** The conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength, to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778 except otherwise specified hereinafter.
- 3.10.2** The drums shall be suitable for wheel mounting and for jetting off the conductor under a minimum controlled tension of the order of 5kN.
- 3.10.3** The standard drum drawings are enclosed however, supplier should submit the proposed drum drawings along with the bid. The same shall be in line with the requirements of standard drawings and as stated herein. After placement of the letter of Award, the supplier shall submit four copies of fully dimensioned drawing of the drum he wishes to supply, for Purchaser's approval, before taking up manufacturing of conductor. After getting approval from the Purchaser, Supplier shall submit 30 more copies of the approved drawing to Purchaser for further distribution and field use at Purchaser's end.
- 3.10.4** All wooden components shall be manufactured out of seasoned soft wood free from such defects that may materially weaken the component part of the drums. Preservative treatment for anti-termite /anti-fungus (Aldrine/Aldruse) shall be applied to the entire drum with preservatives of a quality which is not chemically harmful to the conductor.
- 3.10.5** The flanges shall be of two/three ply construction with each ply at right angles to the other and nailed together. Further the outer face of the flange shall be reinforced with the circumferential battens, fixing in octagonal shape.

The nails shall be driven from the inside face of flange, punched and then clenched on the outer face. The tolerance in thickness of each ply shall be ± 3 mm only. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in line with the periphery of the barrel. Spindle hole shall be provided at the centers of the planks of the plies and spindle plates with 102 mm dia. Holes shall be fitted on either side of both the flanges.

- 3.10.6** The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 3.10.7** Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing. Barrel studs should be tack welded with the nuts after tightening.
- 3.10.8** Normally, the nuts on the studs shall stand protrude of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 3.10.9** The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.
- 3.10.10** Before reeling, cardboard or double corrugated or thick bituminised waterproof bamboo paper shall be secured to the drum barrel and inside of flanges or the drum by means of a suitable commercial adhesive material. The paper should be dried before use. Medium grade craft paper shall be used in between the layer of the conductor/earth wire. After reeling the conductor the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.
- 3.10.11** Minimum space of 125 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor.
- 3.10.12** Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nail shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.
- 3.10.13** Outside the protective layer, there shall be minimum of two binder consisting of hoop iron/galvanized steel wire. Each protective layer shall have two recess to accommodate the binders.
- 3.10.14** The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm of steel core on either ends by U-nails. The composite conductor shall be binded by use of galvanized steel wire/aluminum wire at three locations at least 75 mm apart or more covered with PVC adhesive tape so as to avoid loosening of conductor layers in transit and handling.

3.10.15 Only one length of conductor shall be wound on each drum.

3.11 MARKING :

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

- i. Contract/Award letter number
- ii. Name and address of consignee
- iii. Manufacturer's name and address
- iv. Drum number
- v. Size of conductor
- vi. Length of conductor in metres
- vii. Gross weight of drum with conductor
- viii. Weight of empty drum with protective lagging
- ix. Arrow marking for unwinding

3.12 END SEALING :

Both the ends of each length of conductor should be provided with non-destructive type metal crimped or epoxy capped seals with punching embossing/ engraving of manufacturer's monogram and drum number.

3.13 CHECK MEASUREMENT

3.13.1 At least 5% of the total number of drums in any lot put up for inspection shall be selected at random to ascertain the length of conductor by rewinding method. The % shortage if any in the length thus obtained and as declared by the supplier in the packing list, shall be applied to all the drums if the conductor is found short during checking.

3.13.2 The length of conductor shall also be verified at the consignees end. Where length measurement machines are not available the length will be verified by the weight basis. The determining factor will be length weight ratio of the sample drums verified at the firm's premises of the Lot of which the drum under measurement at the consignees end forms a part.

SECTION-4**TECHNICAL SPECIFICATIONS FOR EARTH WIRE****4.01 STANDARDS:**

The high Tensile Steel Galvanised Earth Wire shall conform to the following Indian Standards, which shall mean latest revisions, amendments/changes adopted and published, unless otherwise specified hereinbefore.

Sl. No.	Indian Standards or any Equivalent International Standard	Title
1	IS:209	Specification for Zinc
2	IS:2141	Specification for Earth wire for overhead Transmission purpose
3	IS:1778	Reels and drums for Bare wires
4	IS:1521	Method of Tensile Testing of Steel wire
5	IS:2629	Recommended practice for Hot Dip Galvanising Iron and Steel
6	IS:2633	Method of Testing Uniformity of Zinc coating of Zinc coated Articles.
7	IS:4826	Galvanised coating on Round Steel wire
8	IS:6745	Method of Determination of weight of Zinc coating of zinc coated Iron and Steel Articles
9	IS: 12776	Method of Testing of Ground wire

4.02 CLIMATIC CONDITIONS :

The Earth wire shall be suitable for being installed directly in air supported with suspension clamp or tension clamp at the cross arms of single circuit and double circuit transmission line towers. The earth wire shall be therefore suitable for satisfactory continuous operation under the following climatic conditions:

1	Location in the State of	MADHYA PRADESH
2	Maximum ambient air temperature ($^{\circ}\text{C}$)	50.
3	Minimum temperature in shade ($^{\circ}\text{C}$)	1.
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature ($^{\circ}\text{C}$)	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 meters)	150
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. Stroke is also present in the atmosphere. Heavy lightening also occurs during June to October.

4.03 PARAMETERS :

4.03.1 PRINCIPAL PARAMETERS OF EARTH WIRE:

The standard technical particulars of 7/3.66mm galvanized steel earth wire shall be as follows :-

(A) The details of Steel strand:

Sr. No.	Details of steel strands	Earth Wire
a)	Material	Steel
b)	Stranding	7
c)	Weight per Km	583 Kgs
d)	Dia. of wire	3.66 mm
e)	Tolerance	2%
f)	Minimum elongation in 100 mm length	5 mm
g)	Minimum breaking strength per strand	1000 Kg
h)	Minimum tensile strength	95 Kg./mm ²
i)	D.C. resistance at 20 Deg. C	17.15 Ohms/Km

(B) The details of Stranded Earth Wire :

Sr. No.	Details of Stranded Earth Wire	Earth Wire
i.	Maximum Length of Lay	198
ii.	Minimum Length of Lay	165
iii.	Minimum breaking load	6972 Kgs
iv.	Overall diameter	10.98mm
v	Modulus of elasticity	1.933×10^6 Kg./cm ²
vi	Co-efficient of linear expansion	11.50×10^{-6} per Deg.C
vii	Weight of zinc coating on wire	260 gms./ m ² (Min.)
viii	No. of one minute dip and half minute dip respectively	3 one minute and 1 half minute
ix	Calculated d.c. Resistance at 20 Deg.C	2.5 Ohms per Km

4.04 GENERAL TECHNICAL PARTICULARS : MATERIAL AND WORKMANSHIP FOR EARTH WIRE:

4.04.1 The steel wire (strands) used in manufacture of galvanized steel earth wire shall be drawn from steel wire rod produced by either acid or basic open hearth process or by the electric furnace process or basic oxygen process. The steel wire shall not have sulphur and phosphorous contents exceeding 0.045% each. The carbon content shall not exceed 0.55%. The steel produced by bassemmer process shall not be used for drawing of steel wire

strands. The finished earth wire shall have minimum brittleness as it will be subjected to continuous vibration while in use on line.

- 4.04.2 The steel wire shall be hot dip galvanized and shall have clause 'A' (heavy) zinc coating of minimum 260 gram per sq. meter of the uncoated wire surface. The zinc coating shall be smooth and continuous of uniform thickness, free from imperfections not consistent with good commercial practice and shall meet the test requirement. The zinc used in galvanizing of earth wire shall be as per IS: 209-1966.
- 4.04.3 All the steel wires shall be circular, smooth, uniform and free from imperfections, such as spills and splits, die marks scratches, abrasions, cuts and kinks etc. drawing and after stranding.
- 4.04.4 The steel wires, after galvanizing shall be bright in appearance, smooth and free from all defects like flux, ash, cross inclusions, bare and black spots, pimples, lumpiness in runs, rust, stains, bulky white deposits and blisters.
- 4.04.5 To avoid susceptibility towards wet storage stains (white rust) the stranded earth wire shall be provided with a protective coating of boiled linseed oil.
- 4.04.6 The finished earth wire shall have a smooth surface without any surface cuts, abrasions, scuff marks and shall be free from dirt, grit etc.
- 4.04.7 Failure of any sample to meet the above requirements shall be sufficient cause for rejection of the lot of earth wire represented by the sample, particular care shall therefore be taken during manufacture, handling, packing and transportation of the earth wire so that it is not dented, cut or damaged in any way.

4.05 Size and Properties:

- 4.05.1 The earth wire size, physical properties, tolerance in diameter of individual strands and length of lay of the strand shall be as given above.
- 4.05.2 The wires shall be so stranded together that when an evenly distributed pulls is applied at the end of completed strands, each wire will take an equal share of the pull.
- 4.05.3 The earth wire shall be supplied in the standard lengths which shall not be less than 3 Km. and such lengths will be specifically indicated in the tender. Not less than 95% of the total quantity of the earth wire shall be supplied in standard lengths. The quantity of earth wire in length shorter than standard one shall not exceeds 5% of the total quantity to be supplied. Further, no single earth wire length in respect of such 5% (maximum) supply in random lengths shall be shorter than 50% of the standard length.
- 4.05.4 The length of the stranded wire shall be supplied without joints in the individual wires comprising it, excluding welds made in base rod before it is drawn.
- 4.05.5 Each coil be warranted to contain no welds, joints or splice other than in the base rod before it is drawn.

4.06 GALVANISING AND OILING:

- 4.06.1 All the wires of the strand shall be galvanized in accordance with IS-2629-1966. Recommended practice for Hot dip galvanizing of Iron and Steel of some other authoritative equivalent standard.

- 4.06.2 The galvanized earthwire after stranding operation shall have dipped in boiled linseed oil before winding it on drums.

4.07 TEST FOR EARTH WIRE :

- 4.07.1 Earth wire shall be subjected, before despatch from the works to tests as specified in the IS-2141, IS 1521, IS 1755 & IS 4826 or any other authoritative equivalent standard.
- 4.07.2 All the drums of galvanized steel stranded earth wire of the same grade, diameter and construction, manufactured under similar condition shall be grouped to constitute one lot.
- 4.07.3 Samples from each lot shall be tested for ascertaining the conformity to the requirements of the earth wire specified herein. The drums selected shall be tested for length of the lay and diameter of individual strands etc. The lot shall be declared conforming to the requirement of these characteristics if all the samples are found satisfactory. One test specimen from each wire of the strand shall now be drawn from every selected drum and subjected to chemical analysis, tensile tests, ductility test, elongation test and coating test. One test specimen, of the completed strand from each drum shall be subjected to tensile strength. The lot shall be declared conforming to the requirements of these characteristics, if the entire test specimen satisfies the relevant requirement.

4.08 INSPECTION :

- 4.08.1 The purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture where earth wire shall be manufactured and the 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.
- 4.08.2 The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of earth wire in its various stages so that arrangements can be made for inspection.
- 4.08.3 No material shall be despatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the purchaser in writing waives off the inspection. In the later case also, the earth wire shall be despatched only after satisfactory testing for all tests specified herein has been completed.
- 4.08.4 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.
- 4.08.5 At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of earth wire by following method:

"At the works of the manufacturer of the earth wire, the earth wire shall be transferred from one drum to another at the same time measuring its length with the help of graduated pulley and Cyclometer. The difference in the average length thus obtained and as declared by the supplier in the packing list shall be applied to all the drums if the conductor/earth wire is found short during checking"

4.09 DOCUMENTATION:

- 4.09.1 Six sets of type test reports, duly approved by the Purchaser shall be submitted by the supplier for distribution, before commencement of supply.

Adequate copies of acceptance and routine test certificates, duly approved by the Purchaser shall accompany with despatched consignments.

- 4.09.2 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 Purchaser. All manufacturing and fabrication work in connection with the material prior to the approval of the drawing shall be at Supplier's risk.
- 4.09.3 Approval of drawing/work by Purchaser shall not relieve the Supplier of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The equipment shall conform in all respect to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering. Purchaser shall have the power to reject any work or material, which in his judgment is not in full accordance therewith.

4.10 PACKING AND FORWARDING:

- 4.10.1 The earth wire shall be supplied in strong wooden drums provided with lagging of adequate strength, to protect the conductor/earth wire against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778 except otherwise specified hereinafter.
- 4.10.2 The drums shall be suitable for wheel mounting and for jetting off the conductor/earth wire under a minimum controlled tension of the order of 5kN.
- 4.10.3 After placement of the letter of Award, the supplier shall submit four copies of fully dimensioned drawing of the drum he wishes to supply, for Purchaser's approval, before taking up manufacturing of earth wire. After getting approval from the Purchaser, Supplier shall submit 30 more copies of the approved drawing to Purchaser for further distribution and field use at Purchaser's end.
- 4.10.4 All wooden components shall be manufactured out of seasoned soft wood free from such defects that may materially weaken the component part of the drums. Preservative treatment for anti-termite /anti-fungus (Aldrine/Aldruse) shall be applied to the entire drum with preservatives of a quality which is not harmful to the earth wire.
- 4.10.5 The flanges shall be of two/three ply construction with each ply at right angles to the other and nailed together. Further the outer face of the flange shall be reinforced with the circumferential battens, fixing in octagonal shape. The nails shall be driven from the inside face of flange, punched and then clenched on the outer face. The tolerance in thickness of each ply shall be +/- 3 mm only. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor/earth wire, the entrance shall be in line with the periphery of the barrel. Spindle hole shall be provided at the centers of the planks of the plies and spindle plates with 102 mm dia. Holes shall be fitted on either side of both the flanges.
- 4.10.6 The wooden battens used for making the barrel of the earth wire shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the earth wire.
- 4.10.7 Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate

washers, spindle plates and nuts for fixing flanges at the required spacing. Barrel studs should be tack welded with the nuts after tightening.

- 4.10.8 Normally, the nuts on the studs shall stand protrude of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 4.10.9 The inner cheek of the flanges and drum barrel surface shall be painted with bitumen-based paint.
- 4.10.10 Before reeling, cardboard or double corrugated or thick bituminised waterproof bamboo paper shall be secured to the drum barrel and inside of flanges or the drum by means of a suitable commercial adhesive material. The paper should be dried before use. Medium grade craft paper shall be used in between the layer of the conductor/earth wire. After reeling the conductor/earth wire the exposed surface of the outer layer of conductor/earth wire shall be wrapped with thin polythene sheet across the flanges to preserve the conductor/earth wire from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.
- 4.10.11 Minimum space of 125 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor/earth wire.
- 4.10.12 Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nail shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.
- 4.10.13 Outside the protective layer, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective layer shall have two recesses to accommodate the binders.
- 4.10.14 The earth wire ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm of steel wire on either end by U-nails. The earth wire shall be binded by use of galvanized steel wire/aluminum wire at three locations at least 75 mm apart or more covered with PVC adhesive tape so as to avoid loosening of earth wire layers in transit and handling.
- 4.10.15 Only one length of earth wire shall be wound on each drum.

4.11 MARKING :

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

- x. Order Number and date.
- xi. Name and address of consignee
- xii. Manufacturer's name and address
- xiii. Drum number
- xiv. Size of earth wire (7/3.66mm)
- xv. Length of earth wire in meters

- xvi. Gross weight of drum with earth wire
- xvii. Weight of empty drum with protective lagging
- xviii. Arrow marking for unwinding

4.12 END SEALING :

Both the ends of each length of earth wire should be provided with non-destructive type metal crimped or epoxy capped seals with punching embossing/ engraving of manufacturer's monogram and drum number.

* * *

SECTION-5**TECHNICAL SPECIFICATIONS FOR DISC INSULATORS****5.01 SCOPE**

5.01.1 This specification provides for the design, manufacture, stage testing and inspection and testing before despatch, packing and delivery F.O.R. destination of disc insulators as per technical requirements furnished in this specification for various 400 KV Transmission lines to be constructed anywhere in the state of Madhya Pradesh.

5.01.2 These insulators are to be used for suspension and Tension strings for the suspension and Tension of the power conductors on 400 KV Double Circuit transmission lines.

5.02 STANDARDS

5.02.1 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

5.02.2 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.

5.03 CLIMATIC CONDITIONS

5.03.1 The insulators shall be suitable for being installed directly in air with power conductors of Double Circuit Double Strung transmission lines. They shall be therefore suitable for satisfactory continuous operation under the following climatic conditions: -

1	Location in the state of	MADHYA PRADESH
2	Maximum ambient air temperature (0C)	50
3	Minimum temperature in shade (0C)	1
4	Maximum relative humidity (%)	95(sometimes approaches saturation)
5	Average daily ambient air temperature (0C)	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)	150
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.

5.04 PRINCIPAL PARAMETERS

5.04.1 DETAILS OF DISC INSULATORS

5.04.1.1 The insulator strings shall consist of standard discs for a three phase 50 Hz, effectively earthed 400KV transmission system in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type.

5.04.1.2 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.

CHARACTERISTICS OF DISC INSULATORS

The disc insulators should have the following particulars and characteristics:

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

5.04.2 SPECIFICATION DRAWINGS

5.04.2.1 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 Supplier only. The drawings to be furnished by the Supplier 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 award, the supplier shall submit full dimensioned manufacturing drawing of insulator cap, pin & insulator shell in six copies to the purchaser for reference & record.

5.05 GENERAL TECHNICAL REQUIREMENTS

5.05.1 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.

5.05.1.1 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.

5.05.2 METAL PARTS

5.05.2.1 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 Supplier shall specify the grade, composition and mechanical properties of steel used for caps and pins.

5.05.2.2 Security Clips

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

5.05.3 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.

5.05.4 MATERIAL DESIGN AND WORKMANSHIP

5.05.4.1 GENERAL

(i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on 400KV 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.

5.05.4.2 INSULATOR SHELL

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

5.05.4.3 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.

5.05.4.4 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.

5.05.4.5 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).

5.05.5 BALL AND SOCKET DESIGNATION

The dimensions of the balls and sockets for 120KN discs shall be of 20 mm designation in accordance with the standard dimensions stated in IS:2486 (Part II).

5.05.6 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
120 KN Disc	255	266	244
160 KN Disc	280	293	267

b. Ball to Ball Spacing between Discs (mm)

Rating	Standard	Maximum	Minimum
120 KN Disc	145	149	141
160 KN Disc	170	175	165

5.05.7 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.

5.05.8 CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) PERFORMANCE

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

5.05.9 SUITABILITY FOR LIVE LINE MAINTENANCE

5.05.9.1 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.

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

5.05.10 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

5.05.11 INSULATOR STRINGS

5.05.11.1 TYPE AND RATING

The insulator strings shall be formed with standard discs described in this specification for use on 3 phase, 400kV, 50Hz effectively earthed systems in a moderately polluted atmosphere. Suspension insulator strings for use with suspension towers are to be fitted with discs of 120kN EMS rating. Tension insulator strings for use with Anchor/Tension towers are to be fitted with discs of 160 kN EMS rating.

5.05.11.2 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 400KV	255 X145	23	120
b)	Double Suspension for 400KV	255 x145	2x23	2x120
c)	Single Tension for 400KV	280x170	24	160
d)	Double Tension for 400KV	280x170	2x24	2x160

5.05.12 STRING CHARACTERISTICS

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

S.No	Particulars	Single / Double Suspension	Single /Double Tension
		400KV	400KV
i.	Switching surge withstand voltage(dry & wet) KV peak	1050	1050
ii	Lightening Impulse withstand voltage (dry) KV peak	1600	1700
iii	Power frequency withstand voltage (wet) KV r.m.s	680	690
iv	Mechanical failing Load-kgf	11500/23000	16500/ 33000
v	No deformation load-kgf	7705/ 15410	11055/ 22110
vi.	Corona Extinction Voltage KV rms	320	320
vii.	Max.RIV for complete string at 266KV(rms) line to ground voltage (micro volt)	500	500
viii.	Max.voltage across any disc	9%	9%

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

5.05.12.3 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.

5.06 TESTS

The following tests shall be carried out on the insulator string and also on unit disc insulators.

5.06.1 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. The successful supplier shall indicate his schedule for carrying out these tests. For any change in the design/type already type tests and the design/type offered against this specification, the purchaser reserves the right to demand repetition of test without extra cost

5.06.2 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.

5.06.3 ROUTINE TESTS

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

5.06.4 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.

5.06.5 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.

5.06.6 TEST PROCEDURES AND SAMPLING NORMS

5.06.6.1 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 specified in Appendix-I attached hereto or as

mutually agreed to between the successful Supplier and the Purchaser in the Quality Assurance Programme. The supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. Before sample selection, the supplier shall be required to conduct all the acceptance tests successfully in presence of Purchaser's representative.

5.06.7 DETAILS OF TYPE TESTS

5.06.7.1 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.

5.06.7.2 TYPE TESTS

(A) The following type tests shall be conducted on all types of the complete insulator string 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.

(B) Following type tests shall be conducted on string insulators/unit disc insulators

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

5.06.8 DETAILS OF ACCEPTANCE AND ROUTINE TESTS

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

6.8.2 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

5.06.9 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	

5.06.10 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.

5.06.11 COORDINATION FOR TESTING:

For 400KV 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.

5.07 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.
- 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 dispatched 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 disc insulators are later found to be defective.

5.08 IDENTIFICATION MARKING

5.08.1 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.

5.08.2 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.

5.08.3 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 120KN disc insulator- Yellow

For 160kN disc insulator – Red

5.09 QUALITY ASSURANCE PLAN

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

5.09.2 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.

5.09.3 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.

5.10 DOCUMENTATION

5.10.1 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 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.

5.10.2 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 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.

5.11 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:

Test	Percentage of discs to be tested
Temperature cycle test followed by mechanical performance test	60
Puncture test (for porcelain	40

insulator only)	
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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 Supplier and Purchaser 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 Supplier and Purchaser 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 petticoat 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 petticoat. 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 supplier shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

SYSTEM PARTICULARS

S.No	PARTICULARS	Electrical System Data
1	System	A.C. 3phase
2	Line voltage (kV rms)	400
3	Max.voltage (kV rms)	420
4	Frequency	50 Hz
5	Neutral grounding system	effectively earthed
6	Lightning impulse with-stand voltage(dry & wet)(kVp)	1425
7	Power frequency withstand voltage (wet) (kVp)	630
8	Switching surge withstand voltage (wet) (kVp)	1050
9	Short circuit level (kA)	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

SECTION - 6**TECHNICAL SPECIFICATIONS FOR HARDWARE FITTINGS & ACCESSORIES
FOR 400 kV LINES****4.01 SCOPE:**

4.01.1 This section provides for manufacturing, stage testing, inspection and testing before despatch, packing and delivery of Hardware fittings for Insulator string and accessories suitable for Conductor and Ground wire for use on 400KV transmission line.

4.01.2 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.

4.02 STANDARDS:

4.02.1 The material and services under this specification shall be performed as per the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian Standards/Codes listed here under except as modified in this document:

S.No	Indian Standard	Title
1	IS:209-1992	Specification for Zinc Ingot
2	IS:206 –1992	Tee and Strap Hinges
3	IS:7814-1985	Phosphor Bronze Sheet and Strip
4	IS:2071 Part-I, II & III	Method of high voltage testing
5	IS:731	Porcelain Insulator for Overhead Power Lines with a Nominal Voltage Greater than 1000 V.
6	IS:961	Structural Steel
7	IS:1385	Phosphor Bronze Rods & Bar Sheet and Strips and Wire
8	IS:2004	Carbon Steel Forgings for General Engineering Purpose
9	IS:2107	White Hearth Malleable Iron Castings
10	IS:2108	Black Hearth Malleable Iron Castings
11	IS:2121(Part-I & II)	Specification for Conductors and Ground wire Accessories for Overhead Power Line, Armour Rods Binding Wires and Tapes for Conductor
12	IS:2486	Specification for Insulator Fittings for Overhead Power Lines with a Nominal Voltage Greater than 1000 V.
	Part-I	General Requirements and Tests

S.No	Indian Standard	Title
	Part-II	Dimensional Requirements
	Part-III	Locking Devices
	Part-IV	Tests for Locking Devices
13	IS:2629	Recommended Practice for Hot Dip Galvanization of Iron and Steel.
14	IS:2633	Testing of Uniformity of Coating of Zinc coated Articles
15	IS:3138	Hexagon Bolts and Nuts
16	IS:6639	Hexagon Bolts for Steel Structures
17	IS:6745	Determination of Weight of Zinc Coating on Zinc Coated Iron and Steel Articles
18	IS:3188	Characteristic of String Insulators Units
19	IS:4218 Part-I to VI	ISO Metric screw Threads
20	IS:4172	Dimensions for Radii under the Heads of Bolts & Screws
21	IS:4206	Dimensions for nominal lengths and Thread length for Screws and Studs (with amendment)
22	IS:4759	Hot Dip Zinc Coatings on Structural Steel and other Allied Products
23	IS:1573-1986	Electroplated Coatings of Zinc on Iron and Steel
24	IS: 398 (Part-II & III)	Specification for Aluminium Conductor Steel Reinforced for overhead transmission purpose.
25	IS: 1327-1966	Methods for determination of weight of tin Coating on Tin Plates
26	IS: 4826-1979	Hot Dip Galvanised Coating on Round Steel Wires
27	IS: 1363 Part-I to III	Hexagon Head Bolts, Screws & Nuts.
28	IS: 1367 IS: 1367 (Part-I) IS: 1367 (Part-II) IS: 1367 (Part-III)	Technical supply conditions for threaded Steel Fasteners. Introduction and General Information. Product Grades and Tolerances. Mechanical Properties and Test Methods for Bolts, Screws and Studs with full Load ability.
29	IS: 9708	Stockbridge Vibration Dampers for Overhead Power lines.
30	IS: 8263	Method of Radio Interference Tests on High Voltage Insulators.
31	IS:10162	Spacers and Spacer Dampers for twin

S.No	Indian Standard	Title
		horizontal bundle Conductors.
32	IS: 2004	Carbon Steel Forgings for general engineering purposes.
33	BS:970 (Part-I)	General Instructions and Testing Procedures Specific Requirements for Carbon and Carbon Manganese Alloy and Stainless Steels.

4.02.2 In the paragraph 2.1 above, relevant Indian Standards have been mentioned. However, the Hardware fittings meeting any other authoritative international standard, which ensures equal or better quality than the Standards, mentioned above shall also be acceptable. Please attach photocopy of all such Standards according to which the Hardware fittings have been offered.

4.03 TOPOGRAPHY AND CLIMATIC CONDITIONS:

The material to be supplied against this specification shall be suitable for satisfactory operation under the tropical climatic conditions as under:

1	Location in the state of	MADHYA PRADESH
2	Maximum ambient air temp.	50 °C
3	Minimum temperature in shade	1 °C.
4	Maximum relative humidity	95%(sometimes approaches Saturation)
5	Average daily ambient air temp.	40 °C
6	Isoceraunic Level (Average number of thunder storm days)	50 days per year
7	Average rainfall	1250 mm
8	Max. Altitudes above mean sea level	1000 meter
9	Seismic level (Horizontal acceleration)	0.3 g

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.

4.04 PRINCIPAL PARAMETERS:

4.04.1 DETAILS OF HARDWARE FITTINGS:

(a) The Hardware fittings shall meet the technical requirement as per specification and also general arrangement drawings of Hardware fittings attached herewith. Hardware fittings shall be suitable for single/double suspension Insulator strings, single/double tension Insulator strings and single suspension-pilot insulator strings. Each Hardware fitting shall be supplied complete in all respect and shall include all components, which are required for making complete set.

(b) The hardware fittings for lines shall be suitable for ACSR Moose Conductor and Groundwire as per technical parameters indicated below:-

S.No	Particulars	Moose ACSR	Ground Wire
1.	Material	ACSR	Steel
2.	Size	325 mm ² Cu. eq.	--

3.	Nominal Aluminium area	515.70 mm ²	--
4.	Stranding and wire diameter (no./mm)	54/3.53 Alu.+ 7/3.53 steel.	7/3.66mm.
5.	Number of strands in each layer. Central core 1 st layer 2 nd layer 3 rd layer 4 th layer	1 of steel 6 of steel 12 of Alu. 18 of Alu. 24 of Alu.	1 of steel 6 of steel
6.	Sectional area of Alu.	515.70	--
7.	Total sectional area	597 mm ²	--
8.	Approximate overall diameter	31.77 mm	10.98 mm
9.	Overall diameter when wrapped with preformed Armour Rod	-	18.30 mm
10.	Approximate weight	2004 Kg per Km	583Kg per Km
11.	Calculated D.C. resistance at 20° C	0.0551 Ohm/km	2.5 Ohm/km
12.	Approximate Breaking Load	16250 Kgs.	6972 kgs
13.	Co-efficient of Linear Expansion	19.53 x 10 ⁻⁶ per °C	11.5 x 10 ⁻⁶ per °C
14.	Final Modulus of Elasticity	0.686 X 10 ⁶ kg/cm ²	1.931X10 ⁶ kg/cm ²

4.05 INSULATOR STRING CHARACTERISTICS:

- (a) The complete insulator string including Hardware fittings shall have the following characteristics:

S. No	Characteristics	Single / Double Suspension	Single / Double Tension
1	No. of Standard Discs	1x23 2x23	1x24 2x24
2	Nominal diameter of discs	280	280
3	Power frequency Withstand voltage (wet) kV (rms)	680	690
4	Lighting impulse withstand voltage (dry)(kVp)	1600	1700
5	Switching surge Withstand voltage (Dry & wet) (kVp)	1050	1050
6	Mechanical failing Load (kgf)	11500/23000	16500/33000
7	Pollution	Moderately polluted	Moderately polluted
8	Corona Extinction voltage (KV rms)	320	320

- (b) The Insulator string Hardware fittings shall comply and conform to the above requirement.

4.06 BALL AND SOCKET DIMENSIONS:

The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimension of Hardware to be used with 11500 Kg & 16,500 kg Electro Mechanical strength disc insulator shall conform to designation 20mm in accordance with IS-2486:(Part-II).

The Bidder shall submit full detail of locking device in accordance with IS 2486:(Part-III) or equivalent International Standard along with test reports, gauges and adherence to Standards for Tests on Locking Devices in line with IS:2486 (Part-IV) or equivalent International Standard.

4.07 REQUIRED GUARANTEED STRENGTH OF HARDWARE OF INSULATOR STRINGS:

- 4.07.1 The slipping strength of the suspension clamp shall not be less than 15% and more than 20% of the Conductor strength with which it is to be used.
- 4.07.2 The Hardware and Compression Clamp of single & double tension strings suitable for Moose ACSR for 400KV transmission line shall have ultimate breaking strength of not less than 16500 kgs. The Compression Clamp shall have slipping strength not less than 95% of breaking strength of Moose ACSR.
- 4.07.3 Each individual Hardware component of double suspension and double tension strings such as ball-clevis, socket clevis etc. shall have minimum breaking strength as specified for respective single suspension and tension string respectively.

4.08 PARTICULARS OF HARDWARE FITTINGS:

Each Hardware fitting shall be complete in all respect and Bidder should furnish complete drawings and technical particulars of the items quoted. The Hardware fittings should normally comprise items conforming to enclosed drawing as under: -

4.08.1 Single Suspension Hardware Fitting with AGS Type Clamp:

Single suspension Hardware string shall comprise of one Anchor Shackle, Horn holder Ball eye, line side arcing horn, yoke plate, corona control ring and two Suspension Clamps of AGS type with armour rod as per enclosed drawing.

4.08.2 Double Suspension String Hardware Fittings with AGS Type Clamp:

The double suspension string Hardware fittings shall comprise of one Anchor Shackle, one Top Yoke Plate, two Ball Clevis, two Socket Clevis, corona control ring, one bottom Yoke Plate, two line side Arcing Horns, two Clevis Eye and two AGS type Suspension Clamps with armour rod as per enclosed drawing.

4.08.3 Single suspension Pilot string for Moose ACSR:

The single suspension pilot string for Moose ACSR shall comprise of one Anchor Shackle, one Horn holder Ball eye, one line side arcing horn, one yoke plate, corona control ring and two envelope type suspension clamps as per enclosed drawing.

4.08.4 Single Tension String Hardware Fittings:

Single tension string Hardware shall comprise of one 'D' Shackle, one Ball Link, one Forged Steel Socket, Socket Clevis Horn holder, one line side Arcing Horn and one Tension Clamp of compression type having before and after compression dimensions strictly as shown in Clause 7.10 below.

4.08.5 Double Tension String Hardware Fittings:

The double tension string Hardware shall comprise of two Anchor shackle, one chain link one top yoke plate, two ball clevis, two socket clevis, one bottom yoke plate, one arcing horn, two socket clevis, two clevis eye and two compression type dead-end Clamps having 'before and after compression' dimensions strictly as shown in Clause 7.10 below.

4.09 GROUNDWIRE ASSEMBLIES:

4.09.1 Ground Wire Suspension Assembly With Preformed Armour Rods:

This shall comprise of envelope type Suspension Clamp of heat-treated malleable iron, one Chain Link and one 'D' Shackle. The entire assembly shall be hot

dip galvanized complete with minor accessories. The breaking strength of all the Hardware items of the assembly shall not be less than 7000 kgs. The complete assembly of suspension clamp shall be guaranteed for slip strength of not less than 15 KN & not more than 19 KN. The strength of the Ground wire has been specified in Clause 7.04.01. The suspension assembly shall be supplied with armour rod for groundwire.

4.09.2 Ground Wire Tension Assembly:

The Ground wire tension assembly shall have minimum breaking strength equal to that of the Ground Wire. The slipping strength of the Compression Clamp shall not be less than 95% of the breaking strength of Ground Wire. The Ground wire tension assemblies shall be of two types as under: -

The strain assembly of the Ground wire shall comprise of compression type dead end Clamp and two 'D' Shackles complete with minor accessories such as pins, bolts & nuts etc. Strain assembly shall be hot dip galvanized and made inherently resistant to the atmosphere corrosion. The dead end Clamp of the assembly shall be of compression type. The tension clamp shall be attached to the horizontal strain plate of the tower body by means of a "D" shackle. "D" shackle shall be suitable for attaching the tension clamp to strain plate of towers with a hole of 21.5 mm diameter. The tension clamp body shall be made out of steel of 304 L grade or equivalent with Brinell Hardness not exceeding 200. The complete assembly shall also include one 12.5mm dia, 45 mm long HRH MS Bolt hot dip galvanized with nuts and lock washers for attaching copper earth bond. A detailed drawing giving dimensional details of the complete assembly shall accompany the tender. After compression, dimensions of the joint shall be as indicated in Clause 4.10 below.

4.10 BEFORE AND AFTER COMPRESSION DIMENSIONS OF COMPRESSION TYPE DEAD-END CLAMPS FOR CONDUCTOR AND GROUND WIRE

Sr. No.	Particular	Dimension before compression (Rod cross section)		Dimension after compression (Flat to flat distance of hexagon)		Length of sleeve before compression		Length of sleeve after compression	
		G / W	Moose	G / W	Moose	G / W	Moose	G / W	Moose
A	Aluminium clamp								
a	Inner dimension (mm)	-	34	-					
b	Outer dimension (mm)	-	54	-	46	-	735	-	785
B	Steel clamp								
a	Inner dimension (mm)	11.5	11.1	-					
b	Outer dimension (mm)	21	21	17.5	17.5	230	250	262	285

4.11 DETAILS OF COMPONENTS OF HARDWARE FITTINGS:

4.11.1 Suspension Assembly for twin Moose:

- The suspension assembly suitable for twin ACSR "Moose Conductor for 400KV Lines shall include two armour-grip suspension clamps except for pilot insulator string for which two suitable Envelope type suspension clamps shall be used.
- The suspension clamp alongwith standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of

inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

- c) The suspension clamp alongwith standard preformed armour rods shall have slip strength between 20 to 29KN.
- d) The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence, which might damage the conductor.

4.11.2 Armour Grip Suspension Clamp (AGS):

- (a) AGS fitting shall consist of 2 Neoprene Halves, a set of Helical rods made of Aluminium alloy, two Aluminium halves casting having inner profile matching with the profile of the Armour rod cage and jointed by supporting strap made of Aluminium alloy.
- (b) The Bidder should give complete data on the reduction of the dynamic stresses of the Conductor at the point of AGS support compared to that of bare clamp used with preformed types of Armour rods.
- (c) The Bidder will be required to prove the comparative performance in regard to the dynamic flexural stress pattern on the vibrating Conductor on the tensioned span with actual tests on the AGS unit compared to the normal bare clamp with Armour rods. Suitable curves should be furnished along with the bid for the same and also actual reports on the stress/ strain determinations. The Bidder should give the guaranteed value of the power loss of the AGS units offered by them supported by a test certificate of any reputed laboratory of the country. Suitable curves should be furnished along with the bid for the power loss due to AGS unit as well as with the conventional envelope type of Suspension Clamps.
- (d) The housing supports and housing straps should provide positive stop closure. AGS unit should have low rotational inertia, strut action of the Armour Cage, resilient cushioning of the neoprene insert, immunity from high compressive and flexural stress and wide area support. Manufacturer is required to guarantee minimum fatigue life of the AGS units and this would be established under actual tests on tensioned Conductor span. The manufacturer is required to guarantee minimum 40 years life of the complete AGS units including Neoprene cushioning and this should be established under actual test on a tensioned Conductor span.
- (e) The rubber used with AGS unit must be capable of withstanding desired long outdoor performance including the variation of temperature from 0°C to 75°C. The Bidder will have to provide certificate from reputed manufacturers that the rubber being supplied by them is suitable for AGS fitting and must have tensile strength of 2000 PSI and minimum ultimate elongation 300%.
- (f) The helical retaining rods required for AGS assembly shall be made of Aluminium alloy of HE 20 grade as per IS-6051/1970 or equivalent International Standard duly heat treated and shall be suitable to wrap a desired size of Conductor. The tensile strength of the retaining rod material should not be less than 50,000 PSI and the electrical conductivity should not be less than 40% (IACS). The minimum slipping strength of the complete fitting shall not be less than 15% and more than 20% of the UTS of the cable on which it is to be used. The Clamp shall be in 2 parts made of Aluminium and will have inner profile matching with the profile of Armour rod. This Clamp should be made by drop forging process. AGS assembly should be provided with the forged steel socket eye to match with the suspension string and should have UTS not less than 7,000 kgs.

IT IS ESSENTIAL FOR THE MANUFACTURER TO HAVE SUITABLE HEAT TREATMENT FACILITIES FOR ALUMINIUM ALLOY WIRES IN THE ARMOUR GRIP SUSPENSION UNITS. FORMED ROD BASED ITEMS WILL NOT BE ACCEPTABLE FROM MANUFACTURERS WHO DO NOT HAVE NECESSARY TECHNOLOGY FOR DEVELOPMENT

OF ADEQUATE RESILIENCE, ELONGATION UTS AND TWIST TEST FACILITIES BACKED WITH PROPER HEAT TREATMENT SYSTEMS.

4.11.3 AGS Preformed Armour Rods:

- (a) The AGS Preformed Armour rods set suitable for ACSR Moose conductor shall be used to minimize the stress developed in a conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from suspension clamp as a result of unbalance conductor tension in adjacent span and broken wire condition. It shall be made of Aluminium alloy of HE 20 grade as per IS-6051/1970 duly heat-treated. The aluminium alloy wires (pre heat treated) for manufacturing of Armour rods can also be used, however Bidder should submit the test certificates in support of their claim for using pre heat-treated wires. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effects due to resistance losses of the conductor.
- (b) The pitch length of the rods shall be determined by the supplier but shall be less than that of the outer layer of ACSR conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristics wholly independent of the skill of lineman.
- (c) The preformed armour rod sets shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to grip the same tightly. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.
- (d) The length of each rod shall be as per drawing enclosed. The tolerance in length of each rod shall be +/-25mm. The tolerance in length of the rods in completed sets should be within 13 mm between the longest and shortest rod. The ends of the armour rod shall be parrot billed.
- (e) The number of armour rods in each set shall be 11/12. The each rod shall be marked in the middle with paint for easy applications on the line.
- (f) The armour rod shall not loose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of International Annealed Copper Standard (IACS). The minimum tensile strength of armour rod should be 35 kg per sq.mm.

4.11.4 Strain Clamp:

- (a) The Strain Clamp shall be of the compression type for the specified size of Conductor for 400KV lines. The outer sleeve of the Compression Clamp and Jumper Terminal shall be of EC grade Aluminium 99.5% pure tube formed by extrusion process and the inner sleeves shall be of galvanized steel. The angle of jumper terminal to be mounted should be 30 deg. with respect to the vertical line. The Compression Clamp shall have slipping strength not less than 95% of the ultimate breaking strength of Conductor with which it is to be used. The compression dead end clamp for transmission line shall be manufactured out of extruded Aluminium.
- (b) The resistance of the clamp when compressed on the conductor shall not be more than 75% of the resistance of equivalent length of conductor. The compression line shall be clearly marked on each dead-end assembly designed for continuous die compression and shall bear the words "COMPRESS FIRST" suitably inscribed near the point on each assembly where the compression begins. 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 ends of the Zones. Tapered aluminium filler plugs shall also be provided at the line of demarcation between Compression and Non-compression zone. The letters, numbers and other marking on the finished clamp shall be distinct and legible.

4.11.5 Socket Eye & Ball Clevis:

The Socket Eye and Ball Clevis be made of forged steel as per the drawing enclosed.

4.11.6 U Clevis:

These shall be made of forged steel complete with galvanised steel rivets washer and Phosphorus Bronze/Stainless Steel pins.

4.11.7 Ball Fittings:

These shall be made of forged steel in one piece. They shall be normalized to achieve the minimum breaking strength specified in the respective drawings. Before galvanising of ball fittings, all die fleshing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimension below the requirements. The dimension of the ball & socket shall be 20mm designation in accordance with standard dimensions stated in IS:2486 (Part-II).

4.11.8 Dimensions & Tolerances:

- (a) The dimensions and tolerances of pin balls and socket ends shall conform to IS 2486 Part-II/IEC-120 and shall be checked by the gauge therein after galvanizing.
- (b) The pin balls shall be checked with the applicable "GO" gauges in at least two directions, one of which shall be across the line of die flashing and the other 90 deg. to this line. "NO GO" gauges shall not pass in any direction.
- (c) The bearing surfaces of balls and machined sockets, before galvanizing shall not have surface roughness more than 250 micro inches.
- (d) The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contour of the socket ends shall be concentric with the axis of fittings. The axis of the bearing surface of socket ends shall be coaxial with the axis of fittings with no appreciable tilting.

4.11.9 Socket Fittings:

Socket fittings shall be made of clause IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings.

4.11.10 Security clip for Socket fittings:

- (a) Socket fittings shall be provided with R-shaped security clip in accordance with IS:2486 (Part-III) to provide positive locking against unintentional disengagement of socket from the ball of the insulator. The security clip shall be humped to maintain the clip in the locked position and shall have both prongs spread to prevent complete withdrawal from the socket. The clip end shall not project outside the recess of socket when the clip is in locked position.
- (b) The hole for the security clip shall be on the side of the socket opposite to the socket opening. The hole for the clip shall be counter sunk. The clip eye shall be of such design that the same may be engaged by a hotline clip puller to provide for disengagement under energized conditions.
- (c) The force required to pull the clip to its unlocked position shall not be less than 50 N or more than 500N.
- (d) The security clip shall be made of stainless steel of type AISI 302 or 304 or phosphor bronze as per IS:7814.

4.11.11 Clevis-Eye:

These shall be forged steel of malleable cast iron and shall be complete with galvanised pin with flat washer and split pin of Phosphorus Bronze/Stainless Steel.

4.11.12 Yoke Plate:

- (a) The yoke plates/link plate shall be made of mild steel plate as per IS:2062 or equivalent standards. Shearing/cutting of the plates shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used. It shall be ensured that the grain flow of the yoke plate shall be in the direction of the tensile load.
- (b) Holes shall be cylindrical clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.
- (c) All the corners and edges should be rounded off with a radius of at least 3mm.
- (d) Design calculation is for bearing and tensile strength for deciding the dimensions of yoke plate shall be furnished by the Bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per IS:800.

4.11.13 Corona Control Ring :

- (a) The corona control ring shall be provided with hardware fittings and shall be of such design that it should cover at-least one disc insulator in disc insulator strings so that they will reduce the voltage across the insulator units. It shall also improve corona and radio interference performance of the complete insulator string alongwith hardware fittings.
- (b) The corona control rings shall conform to the specification drawings. The same shall be made of aluminium alloy tube of minimum 2.5mm wall thickness of type 6063 or equivalent. The same shall be heat treated to maintain consistency in material properties during service.
- (c) Welding of corona control ring shall be done with Argon welding. The welded locations shall be suitably grinded and shall not allow penetration of water inside the tube during service. The mechanical strength of welded joint shall not be less than 20kN.
- (d) The corona control ring shall be buffed and have a brushed satin finish. No blemish shall be seen or felt while rubbing a hand over the surface.

4.11.14 Sag Adjustment Device:

- (a) The sag adjustment devices to be provided with double tension hardware fittings shall be of three plate type. The sag adjustment device shall be provided with a safety locking arrangement.
- (b) Sag adjuster plates shall be made from high quality mild steel plate as per IS:2062. The grain flow shall not be in a direction transverse to the tensile load. Cutting/shearing and drilling of holes shall be similar to those for yoke plate mentioned under clause 10.13.2 & 10.13.4.
- (c) The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150mm maximum at the interval of 6mm shall be possible with the sag adjustment plate.

4.12 IMPORTANT CONDITIONS:

- 4.12.1 All Hardware items shall be complete with minor items such as security clip, bolts, nuts, washer, split pins and inners etc.
- 4.12.2 Enclosed drawings show the attachment proposed to be fitted on the towers. The Bidder shall be responsible for satisfying him that the Insulator fittings offered are entirely suitable for the proposed attachments and for the sizes of the Conductor specified.
- 4.12.3 All ferrous fittings (except those specified otherwise) shall be hot dip galvanized, after all machining and fitting has been completed, in accordance with relevant

Indian Standard. All Hardware items (other than clamps) and those specified otherwise should be made of Drop Forged Steel. Socket items in forged steel must be forged. All forgings supplied should be stress relieved and this treatment should be done at the Bidder works. Forgings, which are not stress relieved, will not be acceptable. The items like Yoke Plate, Arcing Horn, Bolts and Nuts shall be of mild steel and rest of the items shall be of forged steel.

- 4.12.4 All Bolts, Nuts and Screw heads shall have only wide worth standard thread and of sizes indicated in the enclosed drawing. Bolts head and Nuts shall be hexagonal. Where required, nuts shall be locked in approved manner. The thread in Nuts shall be over tapped after galvanizing and shall be cut before galvanizing. The threads shall not be under cut. The Nuts should be tapped such that they are fit on the bolt threads i.e. these should not have loose fitting.

4.13 LENGTH OF STRINGS:

- 4.13.1 The clearance to the tower steel parts under service conditions of Insulator have been decided on the basis of length of string that the overall length of the 23 Disc for 400KV line will not exceed the length as indicated in the attached drawings. The dimension of the Disc for Ball and Socket type will be 280mm x145mm for 11500 kgs EMS to be used with suspension strings.

- 4.13.2 In case of 400kV tension strings, 24 Disc insulators of 16500 kg EMS of size 280mm (dia) x 170mm (height) will be used.

4.14 GENERAL TECHNICAL REQUIREMENT FOR ACCESSORIES

Details of Accessories:

- i. The Conductor Accessories shall be suitable for ACSR Moose Conductor as per technical parameters furnished in Clause 7.04.
- ii. The Ground wire accessories shall be suitable for Ground wire as per technical parameters furnished in Clause 7.04.

The technical requirements of the individual Accessories are as under:

4.14.1 MID SPAN JOINTS AND REPAIR SLEEVES:

- (a) The Mid Span Joints for Conductor & Ground wire shall be compression type.
- (b) The Conductor Mid Span Joints shall comprise of Aluminium and Steel Sleeves. The Ground wire Mid Span Joints and Steel Sleeves of Conductor Mid Span Joints shall be Hot dip Galvanized. Sleeves shall be of circular shape suitable for compression into hexagonal shape. The detailed drawing showing the length of Sleeves, inner and outer cross sectional dimension, before compression for Aluminium corresponding dimensions of hexagon after compression for Aluminium and Steel Sleeve shall be indicated. The Aluminium Sleeve shall be of extruded Aluminium. The material of the Steel Sleeve shall be specified.
- (c) The Repair Sleeve of Conductor shall be in two halves preferably of same shape, and this should be of extruded Aluminium. . The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface The Repair Sleeve for Ground wire shall be single piece and Hot dip Galvanized. Its material shall be specified. The Repair Sleeves shall be of circular shape suitable for compression into hexagonal shape.
- (d) The steel and Aluminium Sleeves for Mid Span Joints as well as Aluminium Repair Sleeves and Steel Repair Sleeves shall have their outer dia tapered towards the two ends. Also the inside of the Sleeves shall be well rounded off, so that there is no sharp edge, which can cut the strands. A dimensional drawing must be enclosed with the bid.

- (e) The compression type of Joints and Repair Sleeves shall be circular shape suitable for compression into hexagonal shape. The length of Sleeves before compression & cross-sectional dimensions after compression and the cross sectional dimensions between the flats of the opposite sides of the hexagon shall be as under:-

Sr. No.	Particular	Dimension before compression (Rod cross section)		Dimension after compression (Flat to flat distance of hexagon)		Length of sleeve before compression		Length of sleeve after compression	
		G / W	Moose	G / W	Moose	G / W	Moose	G / W	Moose
A	Aluminium Sleeves								
a	Inner dimension (mm)	-	34	-					
b	Outer dimension (mm)	-	54	-	46	-	735	-	785
B	Steel Sleeves								
a	Inner dimension (mm)	11.5	11.1	-					
b	Outer dimension (mm)	21	21	17.5	17.5	230	250	262	285
2	REPAIR SLEEVES								
	Outer dimension (mm)	20.8	54	17.5	46	254	305	280	330

- (f) Other dimensions are indicated in the enclosed drawing. The Bidder shall indicate the elongation of the above sleeves after compression.
- (g) The Joints and Repair Sleeves shall conform to IS:2121/1981 or equivalent International Standard.
- (h) The conductor compressed with mid span joint or with repair sleeve shall not permit slipping of, damage to or failure of complete conductor or any part thereof at a load of not less than 95% of the ultimate tensile strength of the conductor.
- (i) The electrical resistance of the joint/repared portion of the conductor shall not exceed 75% of the measured resistance of equivalent length of conductor.

4.14.24R-VIBRATION DAMPERS FOR MOOSE ACSR:

- (a) Only Vibration Dampers having 4-resonance frequency characteristic commonly called 4R Dampers shall be offered. The Damper shall eliminate fatigue on the Conductor due to vibration and damp-out the vibrations effectively, so that no damage due to vibration is caused to Conductor and string.
- (b) The Dampers are to be used at all tension locations and suspension locations. One or more Dampers are proposed to be used on tension/suspension locations depending upon the span. The Damper shall be such as to effectively damp out the vibration on the conductor, so that the dynamic strain at the suspension point with conventional type of Suspension Clamp 'U' bolt and keeper pieces, shall not exceed 150 micro strains. The manufacturer shall recommend the number of Dampers required to effectively damp out the vibration of the Conductor, so that the dynamic strain at the suspension point with conventional Suspension type Clamp shall not exceed 150 micro strains.
- (c) The requirement indicated in Price Schedule is based on use of two Vibration Dampers per Conductor per span. However, final requirement will depend upon Manufacturer's recommendations duly supported by literature. Manufacturer shall

also recommend the number of Dampers required to effectively damp out Conductor vibration for different values of span lengths and the distance for fixation. While working out Damper Characteristics, it may be kept in view that on suspension locations, preformed Armour rods are also to be fitted on the conductor. Manufacturer shall give full details of the damper characteristics and energy dissipation curves of the Damper and shall also guarantee their effectiveness for damping design.

- (d) The messenger cable shall be made of high strength steel strands of spring steel with a minimum strength of 136 Kg/sq. mm and preformed in order to prevent subsequent dropping of weights in service. The Manufacturer shall indicate full technical particulars of the messenger cable. The keeper pieces shall have proper curvature and edges be rounded off so that it shall have proper grip over the conductor without any damage to conductor strands. Clamping bolts shall be provided with self-locking nuts designed to prevent corroding of the threads or loosening during service ensuring that no slippage occurs up to specified longitudinal force on clamp along the conductor. All ferrous parts including the messenger cable shall be effectively sealed to prevent corrosion.
- (e) The collar for fixing the bolt shall be designed in such a way that sufficient space is available for tightening the bolt through spanner. Further bolt length be maintained in such a way that it should not come out completely while affixing the clamp on Conductor.
- (f) The Bidder shall specify the material used for the Damper weight and shall confirm and explain, how constant design characteristics will be maintained during production. Fixing of the masses to the messenger cable shall be done by pressing Aluminium Sleeves at each end of the messenger cable under pressure. Each end should be sealed properly so as to achieve perfect joint. The molten metal filling method for attachment of messenger cable to counter weight is not acceptable. The Bidder should specifically bring out the procedure for attachment in the bid.
- (g) The Dampers shall meet the test requirements specified hereunder:
 The effectiveness of the Vibration Dampers shall be to reduce the amplitude of vibration, when tested for span of 400 meters for Moose ACSR, tension taken as 25% of ultimate tensile strength in such a order that it limits the dynamic strain in the Conductor below 150 micro strains for 0 to 15 miles per hour wind condition in general and 2 to 10 miles per hour wind condition in particular condition, conforming to as close as possible to the optimum damping force requirement which the Bidder can predict and furnish for the ranges of wind velocity and the conductor tension.
- (h) The Bidder shall furnish the recommended spacing and the basis including wind velocity range for selecting the spacing. The results of the analysis shall account for the following:
 - i. Prediction of (a) Amplitude (b) Frequency and (c) Vibration energy levels of Aeolian vibration on Moose ACSR for spans of 100m to 1100m.
 - ii. Test results for various frequency response characteristics of Vibration Dampers such as vibration amplitude and phase angle including power dissipation measured from its hysteretic loops.
- (i) Maximum residual vibration must be of such an order that the strain level does not exceed 150 micro strains.
- (j) The Vibration Dampers and their attachments shall have smooth surface so that corona and radio interference voltage levels are within specified limits.
- (k) All Ferrous parts shall be fully galvanized.
- (l) The Vibration Damper shall be capable of being installed and removed from energized line by means of hot line tools without completely separating

components. The Damper Assembly shall be electrically conductive. The transmission line details are as under:-

S.N	Description	Technical Particulars
1	Configuration	Twin ACSR Moose
2	Span length in meters:	
	i. Ruling design span	400m
	ii. Maximum span	1100m
	iii. Minimum span	100m
3	Tensile load in Kg:	
	i. At minimum temp. of 0° C and still air	4145 Kg.
	ii. At every day temp. of 32° C	3614 Kg.
	iii. At 0° C and 2/3 rd full wind	4477 Kg.
4	Nature of terrain	Partly hilly, partly flat with cultivated fields
5	Armour rods/AGS clamp	AGS clamps
6	Maximum wind load	45 Kg/m ² .
7	Max permissible dynamic strains	150 micro strains

The Bidder shall recommend the number of vibration dampers of the type offered and their points of fixation for spans ranging from 100M to 1100M in steps of 50M .

- (m) The other important features of vibration dampers as regards to materials test, etc., are as under: -

Material:

- i. Dampers - As per IS-9708/1993 or equivalent International Standard.
- ii. Clamp - Aluminium alloy
- iii. Messenger cable - High strength steel wire with a strength (kg/sq. mm) not less than the strength of steel core of power Conductor/Ground Wire.
- iv. Weight - Cast Iron (Hot dip Galvanized)

Galvanising:

- i. Spring washers - Electro Galvanized.
- ii. Other Ferrous parts- Hot Dip Galvanized.
- iii. Casting - As per IS:729-1961 or equivalent International Standard.
- iv. Wires - As per IS:326-1968 or equivalent International Standard.
- v. Bolts & Nuts - As per IS:5358-1969 or equivalent International Standard.

Slip strength of Clamp:

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

Maximum permissible dynamic strain on the Conductor with the Damper - 150 micro strains.

Minimum number of cycles for fatigue - 10 millions Performances.

Amplitude for fatigue test - ± 1 mm at the highest Resonant frequency.

Radio interference voltage at 266 KV (rms) - Less than 500 microvolts. phase to ground.

4.14.34R VIBRATION DAMPERS FOR 7 / 3.66MM 95 Kg PER MM2 QUALITY GROUND WIRE:

- a) The design and general particulars of Vibration Damper for Ground wire shall be the same as described for Dampers for Conductor, Preformed Armour Rods will be used at Ground wire suspension locations. The dynamic strain at suspension point shall not exceed 150 micro strains.
- b) All the test as described for Vibration Dampers for Conductor shall be carried out except for Magnetic Power Loss Test.

4.14.4LINE SPACERS AND JUMPER SPACERS :

- a) Line spacers shall be used for maintaining the intra phase spacing of 450mm between conductors of each bundle under all normal working conditions. The supplier shall indicate the number of spacers required per phase per span, for spans ranging from 100M to 1100M with the longitudinal spacing recommended for the spacers offered by them for giving the best possible performance. The supplier shall also furnish all the relevant technical documents in support of their placement chart alongwith the bid.
- b) Jumpers at tension points shall also be fitted with line spacers so as to limit the length of free conductor to 3.65M and to maintain the intra phase spacing of 450mm. The supplier may quote for rigid line spacer for the jumper. Spacers for jumpers shall meet all the requirements of spacers used along the line except on its performance for vibration and movement. Spacers requiring retaining rods shall not be quoted for jumpers.
- c) The spacer offered by the supplier shall satisfy the following requirements:-

Spacers shall restore normal spacing of the sub-conductor after displacement due to wind, electromagnetic and electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation/damage either to the conductor or the assemblies themselves. They shall maintain as uniform firm grip on the conductors. They shall also have long life without fatigue or wear. The clamp shall grip the conductor efficiently to prevent the tortional movement of conductor. The clamping shall be designed to compensate for any reduction due to conductor creep.

- d) They shall preferably be of one piece construction and shall not have separate small components. All fasteners shall be captive and need not be removed in order to fit the spacer to the sub-conductor.
- e) For spacers requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The rods shall be made of high strength special aluminium alloy of type 6061 or equivalent material having minimum tensile strength of 35 Kg/sq.mm. The ends of retaining rods shall be properly terminated (parrot billed/ball end). The retaining rods (Armour rods) shall be of preformed type. The rods shall be heat-treated to give proper resilience and retain the same during service. The dimensions shall be generally as follows:-

- i. Length of each rod: About $1086 \pm 15\text{mm}$
- ii. Diameter of each rod: $7.87 \pm 0.1\text{mm}$

The conductivity of the rods shall not be less than 40% IACS (International Annealed Copper Standards). Direction of lay shall preferably be of right hand. Number of rods in the set shall be about 8. The center line of the rod shall be suitably marked for ease of installation.

- f) Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp.
- g) Any nut used, shall be locked in an approved manner against loosening caused by vibrations. The ends of bolts and nuts shall be properly rounded off for specified corona performance.
- h) Nut cracker, hinged open and or boltless type clamps are acceptable provided adequate grip can be maintained on the conductor. Designs requiring clamping bolt cap screw on lock pin shall utilize a single captive fastener.
- i) Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.
- j) The clamp grooves shall be in uniform contact with the conductor over the entire clamping surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free from projections, dirt or other material, which may cause damage to the conductor when the clamp is installed.
- k) Universal type bolted clamps, covering a range of conductor sizes will not be permitted.
- l) No rubbing, other than that of the conductor clamp hinges or clamp swing bolts shall take place between any part of the spacer. All joints shall have a flexible medium such that there is no relative slip between them.
- m) The spacers shall be flexible enough so as to avoid distortion or damage to the conductor or to themselves. Rigid spacers are acceptable only for jumpers.
- n) The spacer shall not damage or chafe the conductor in any way which might affect its mechanical strength or corona performance. The spacer clamp shall not damage the conductor under any condition.
- o) The spacer assembly shall not have any projection, cut abrasion etc., or chattering part which might cause corona.
- p) The material used in the spacer shall be corrosion resistant. As far as possible, the spacer shall be made of aluminium alloy of the type 6061. If iron or steel parts are used, they shall be galvanized conforming to relevant Indian Standard and shall have magnetic power loss of not more than one watt for, 600 amps 50Hz alternating current.
- q) Elastomer, if used, shall be resistant to the effects of ozone, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service, at temperatures upto 75°C . It shall have good fatigue resistant characteristics. The physical properties of the elastomer shall be indicated in the offer. These shall be discussed and finalized with the successful supplier at the time of quality plan approval.
- r) The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly. In case of spacer having elastomer clamp grooves, shall lie between 0.1 and 0.01 mega ohm in order to ensure satisfactory electrical performance under service conditions.
- s) The spacer assembly shall be easy in installation/removal and reinstallation without any damage.

- t) The spacer assembly shall be capable of being installed and removed from the energized line by means of hot line techniques.
 - i. The offer shall include placement charts recommending number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the twin bundle conductors.
 - ii. The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 60Km/hr. The placement shall ensure bundle stability under all operating conditions.
 - iii. The placement chart shall be provided for spans ranging from 100m to 1100m.
 - iv. The supplier shall also furnish all the relevant technical documents in support of their placement charts alongwith the bid.

4.14.5 FLEXIBLE COPPER EARTH BONDS:

The flexible copper earthing bond shall be made of flexible copper cable of size 37/7/0.417 with 9.81mm dia and copper area equivalent to 34 sq.mm. The length of copper cable shall not be less than 500mm. Two steel connecting lugs shall be press jointed to the either ends of the flexible copper cable. One end of the lug shall have hole of 17.5mm size and another of 14.5mm. The complete assembly shall also include one 16mm dia 40mm long HRH M.S.Bolt hot dip galvanized with nut and lock washer.

4.14.6 T-CONNECTOR

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

4.14.7 HANGER SHACKLE:

This shall comprise of one anchor shackle, one long bolt with washer and split pin. The breaking strength of the hanger shackle assembly shall not be less than 11500 kg.

4.14.8 TECHNICAL PARTICULARS FOR “CLAMPS” & “SPACERS”

- a) All the current carrying parts shall be designed and manufactured to have minimum contact resistance. The maximum tension per conductor is expected to be 2000 Kgs. There shall not be any sharp edges which may lead to accumulation of charge & electrical breakdown. All corners/ edges shall be rounded.
- b) The clamps shall be liberally designed and certain minimum contact surface shall be provided.
- c) The clamps and fittings shall be designed so that insulators shall not be subject to any abnormal stresses due to thermal changes in conductor.

- d) All the clamps & fittings shall enable the connection to be as short as possible. Wherever possible the clamps shall be two separate halves. No "U" bolts shall be used. All components of like design shall be inter-changeable
- e) Spacer shall prevent clashing of the "T" clamps and minimize effects of short circuit forces between bundle conductors on structures. They shall be capable of withstanding electro-magnetic and electrostatic forces during short circuit without deformation or damage to the conductor or spacer.
- f) Spacers shall permit the relative axial and torsional movement of sub-conductors and maintain their correct separation without lubrication or maintenance.
- g) All nuts, bolts & washers shall be made of Hot dip galvanized Mild Steel conforming to relevant ISS only.
- h) The clamp in all respect shall incorporate highest quality of modern engineering design and workmanship. The specification is merely for the guidance of the Bidder as has been clearly stated earlier and it is not the intention to specify the details of design and workmanship. The clamps shall be designed and manufactured in accordance with the Bidder's standard practices, when such practices do not conflict with this specification.
- i) The materials offered shall be complete with all components and accessories which are necessary or useful for their satisfactory performance and efficient maintenance. Such parts shall be deemed to be within the scope of this specification whether specifically included or not.
- j) The design should be such that adequate clamping pressure is obtained with the tightening of the nuts and the pressure should be maintained throughout the service of the connector. In order to provide for creep of Aluminium under pressure, it is essential that only Belleville washers are used. This should be specifically confirmed and should also indicate tightening torque required.
- k) All clamps shall be suitable to carry safely the maximum allowable current in the associated conductor and to withstand the maximum loads occurring under adverse circumstances and operating conditions. The maximum fault current is 40 KA rms for a period of 3 seconds. The temperature of the clamps and fittings shall never exceed that of the associated conductor.
- l) Fittings intended to connect two dissimilar metals shall be designed to avoid harmful bimetallic corrosion under service condition, by way of provision of best quality bimetallic strips.
- m) The short circuit current shall be of the order of 40 KA for 3 seconds. The clamps should be suitable to withstand the short circuit forces corresponding to this current.
- n) The design of clamps should be such that proper space for movement of normal quality single head spanner during tightening is available. This is an important requirement and should be confirmed by the Bidder.

4.14.9 Materials:

The Clamps & Connectors/Spacers shall be made of materials listed below: -

- a) For connecting ACSR conductor Aluminium alloy casting conforming to designation A6 of IS:617.(Redesignation 4600)
- b) Bolts, Nuts, plain washers and spring washers for above items shall be made of hot dip galvanized Mild Steel conforming to relevant IS only.
- c) The Bidder shall ensure that the Alloy used assures good stability and sound casting by proper fluidity. Proper mechanical and physical strength characteristics should be obtained corresponding to the standard requirements of the Alloy specified.

- d) The Bidders shall ensure that the Alloy used assures good stability and sound casting by proper fluidity. Proper mechanical and physical strength characteristics should be obtained corresponding to the standard requirements of the Alloy specified.
- e) The clamps bodies shall be made by gravity die-casting only and thereafter given the appropriate heat treatment and precipitation treatment. Clamps bodies made by sand casting shall not be accepted in any case.

4.15 CASTINGS:

All casting shall be free from blow holes, surface, Blisters and shall be rounded off.

4.16 CONSTRUCTIONAL DETAILS:

- a) All sharp edges and corners shall be blurred and rounded off.
- b) Thickness of the clamps shall not be less than 12mm.
- c) Bolts and nuts shall have hexagonal heads and threads as per Indian Standard.
- d) Flexible connectors, braids or laminated straps shall be made from tinned copper strips or aluminium laminates depending upon the clamp.
- e) Size of terminal / conductor for which the clamps is suitable shall be embossed on each component of the clamp.
- f) Casting should be such that adequate free space for placement and movement of spanners for tightening of nuts is available.

4.17 BOLTS, NUTS & WASHERS:

These shall be as per Indian Standard and shall have tensile strength and elongation as per grade 5.6. Further details are indicated in Section-5.

4.18 GALVANISING:

- a) Hot dip galvanizing shall conform to Indian Standard specification IS-2633 or equivalent International Standard. Galvanising shall be uniform, free from blisters, and shall not peel off due to abrasion, Zinc coating shall be thick enough to withstand 6 one minute dips in Copper Sulphate solution (prece test) for all ferrous parts except for threaded portions which shall withstand at least 4 one minute dips.
- b) 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 Zinc of any grade in IS: 209:1992 ingot (fourth revision) or IS:13229:1991.

4.18.1 The Bidder must emboss/engrave their name in each forged steel item and Aluminium castings such as Ball Hook, Yoke Plate, Socket Clevis, Clevis Eye, Clevis-Clevis, Anchor Shackle/D-Shackle, Chain Link, Suspension Clamps of AGS type, Tension Clamps and Arcing Horns. This is very essential. If the Bidder will not agree with this condition, their offer will be treated as non-responsive.

4.19 TESTS :

The following Type Tests, Stage Tests, Routine Tests and Acceptance Test shall be carried out on power Conductor & Ground wire Hardware fittings & Accessories.

a) Type Tests

The material supplied shall be fully Type Tested as per this specification and the Bidder shall furnish two sets of Type Test reports before taking up the supplies.. 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 specification, the purchaser reserves the Rights to demand repetition of test without any extra cost.

b) Stage Tests:

Stage Tests during manufacturing shall mean those test required to be carried out during the process of manufacturing to ensure quality control such that last product is of the designed quality conforming to the intent of this specification.

c) Routine Tests:

Routine Tests are those tests, which required to be carried out on each and every finished product so as to check with requirements that are likely to vary during production.

d) Acceptance Tests:

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

e) Test Values:

For all type and acceptance tests, the acceptance values shall be the value guaranteed by the Bidder in the guaranteed technical particulars or the acceptance value specified in this specification, the relevant Indian Standard or equivalent International Standard.

f) Test Procedures And Sampling Norms:

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 Bidder and Purchaser before placement of order.

4.20 TYPE TESTS FOR HARDWARE FITTINGS

4.20.1	On the complete insulator string with hardware fittings	
a.	Power frequency voltage withstand and flashover test with corona control grading ring under dry/wet condition.	BS:137 (Part-I)
b.	Switching surge voltage withstand test under wet condition.	IEC:383
c.	Impulse voltage withstand test under dry condition	IEC:383
d.	Impulse voltage flashover test under dry condition	IEC:383
e.	Voltage distribution test	
f.	Corona and RIV test under dry condition.	As per specification
g.	Mechanical strength test for complete string	As per specification
h.	Vibration test	
	NOTE: For electrical tests, the insulator string shall be mounted on a stimulated tower.	
4.20.2	On Suspension Hardware fittings only.	

a.	Magnetic power loss test for suspension	As per specification
b.	Clamp slip strength for AGS clamp	
c.	Clamp slip strength Vs torque test for suspension clamp	As per specification
d.	Test on neoprene	
e.	Ozone test.	
f.	Heat resistance test.	
4.20.3	On Tension Hardware Fittings only	
a.	Electrical resistance test for dead end assembly.	IS:2486(Part-I)
b.	Heating cycle test for dead end assembly	
c.	Slip strength test for dead end assembly.	
d.	Mechanical strength test.	As per specification

4.20.4 All the type tests given under clause no 7.20.1 above shall be conducted separately on single/double suspension and tension insulator string alongwith hardware fittings.

4.20.5 The tests specified under clause no. 7.20.1 (e) & (f) (i.e. the voltage distribution test and corona/RIV Dry test) shall also be conducted on single suspension pilot double suspension and single tension insulator string alongwith hardware fittings.

4.20.6 The mechanical strength test given under clause no. 7.20.1 (g) above shall also be conducted on single suspension pilot, double suspension and single tension insulator string alongwith hardware fittings.

4.20.7 The magnetic power loss test specified under 7.20.2 (a) shall be conducted on single suspension, single suspension pilot and double suspension assembly.

4.21 ACCEPTANCE TEST / SAMPLE TESTS:

4.21.1 On both suspension and tension hardware fittings:

a.	Visual Examination	IS:2486 (Part-I)
b.	Verification of dimensions	IS:2486 (Part-I)
c.	Galvanising test/Electroplating	As per this specification.
d.	Mechanical strength test of welded joint	As per this specification.
e.	Mechanical strength test for corona control rings.	BS:3288(Part-I)
f.	Test on locking devices for ball & socket coupling.	IEC:372(2)
g.	Mechanical strength test of each components excluding corona control ring and arcing horn.	As per this specification.
4.21.2 On suspension Hardware fittings only:		
a.	Clamp slip strength vs torque test for suspension clamp.	As per this specification.
b.	Shore hardness test of elastomer cushion for AG suspension clamp.	
c.	Bend test for armour rod set.	IS:2121 (Part-I)

d.	Re silence test for armour rods set.	
e.	Conductivity test for armour rods set	
4.21.3 On tension hardware fittings only:		
a.	Slip strength test for dead end assembly	IS:2486 (Part-I)
4.21.4 On Suspension hardware for groundwire		
a.	Visual examination	
b.	Dimensional verification.	
c.	Slip strength test.	
d.	Mechanical strength test on each component	
e.	Galvanising test	
f.	Mechanical strength test of welded joint	
4.21.5 On Tension hardware for groundwire:		
a.	Visual examination	
b.	Dimensional verification.	
c.	Slip strength test.	
d.	Electrical resistance test.	
4.21.6 Test during manufacture:		
a.	On all components as applicable.	
b.	Chemical analysis of zinc used for galvanizing	
c.	Chemical analysis, hardness test grain size inclusion rating and magnetic particle inspection for forgoing/castings.	
d.	Chemical analysis and proof load test fabricated hardware.	
e.	Tests on malleable castings forgings and fabricated hardware's.	

4.22 TYPE TESTS FOR ACCESSORIES

4.22.1 Flexible Copper Bond for Ground wire:

Slip strength test:

4.22.2 Spacer / Rigid Spacer for power conductor.

i.	Visual examination		As per IS:2121 this
ii.	Dimensional verification.		
iii.	Galvanising test		

iv.	Movement test (except for spacer for jumpers)		specification, IS:2633 & IS:6745
v.	Compressive and Tensile test		
vi.	Clamp slip Test		
vii.	Clamp bolt torque test		
viii.	Assembly torque test		
ix.	Hardness test for neoprene		

4.22.3 Mid span compression joint for conductor & groundwire.

i.	Slip strength test	As per IS 2121,2633 6745
ii.	Electrical Resistance test	
iii.	Healing cycle test	
iv.	Corona Extinction voltage test dry.	
v.	Radio interference voltage test Dry.	
vi.	Galvanising test	

4.22.4 Repair Sleeve for conductor:

- i. Electrical Resistance test.
- ii Corona Extinction Voltage test. As per IS 2121
- iii Radio Interference voltage test dry.

4.22.5 Vibration Damper for conductor & groundwire

- a. Chemical analysis of material
- b. Dynamic Characteristic Test.
- c. Vibration Analysis.
- d. Clamp Slip test.
- e. Fatigue Test.
- f. Magnetic power loss test.
- g. Corona extinction voltage test (Dry).
- h. Radio interference voltage test (Dry).
- i. Damper efficiency test.

NOTE: Tests mentioned at (f), (g) & (h) are not applicable to dampers for groundwire.

4.22.6 Clamps

- i. Tensile Test
- ii. Resistance Test
- iii. Temperature rise Test (As per IS:5561)
- iv. Short time current Test
- v. Dimensional Check
- vi. Galvanising Test

4.23 ACCEPTANCE TEST

(A) FLEXIBLE COPPER BOND:		
a.	Visual examination	IS:2121
b.	Dimensional verification	
c.	Slip strength test.	
(B) SPACERS/ RIGID SPACER FOR POWER CONDUCTOR:		
a.	Visual examination.	
b.	Dimensional verification.	
c.	Galvanising Test.	
d.	Clamp slip test	
e.	Movement test (except for spacers for	
f.	Compressive & Tensile test.	
g.	Clamp bolt torque test	
h.	Assembly torque test	
i.	Hardness test for neoprene	
(C) Midspan Compression Joint for Power Conductor & Groundwire		
i.	Visual examination	
ii.	Dimensional verification.	
iii.	Galvanising Test	
iv.	Hardness test.	
v.	Failing load test (test to be conducted after 24 hours of compression).	
(D) Repair Sleeves for Conductor.		
i.	Visual examination	
ii.	Dimensional verification.	
(E) Vibration Damper for power conductor / groundwire.		
i.	Visual examination	
ii.	Dimensional verification.	
iii.	Galvanising Test	
iv.	Verification of resonance frequencies	
v.	Clamp slip test	
vi.	Clamp bolt torque test	
vii.	Strength of messenger cable.	
viii.	Mass pull off test.	
(F) Clamps		
i.	Tensile Test	
ii.	Resistance Test	
iii.	Dimensional Check	
iv.	Galvanising Test	

(G)	Test during manufacture.	
i.	On all components as applicable.	
ii.	Chemical analysis of zinc used for galvanizing	
iii.	Chemical analysis, hardness test grain size inclusion rating and magnetic particle inspection for forging/castings.	
iv.	Chemical analysis and proof load test.	
v.	Tests on malleable castings forgings and fabricated hardware's.	

4.24 DRAWING AND LITERATURE:

The detailed drawings of each component assembly of the Hardware assembly & Accessories and descriptive literature shall be submitted before taking up supplies. The detailed dimension drawings for each and all individual Hardware items such as clamps, U Clevis, Socket Eye, Yoke Plate and Socket Clevis etc. shall also be submitted separately. The dimensional drawings for compression type Mid Span Joint (Aluminium & Steel Sleeve), compression type Repair Sleeve Preformed Armour rods for Conductor & Ground wire and 4R Vibration Dampers etc. must be submitted. Test certificates for different tests conducted as per relevant ISS, for all the offered items must also be submitted essentially.

4.25 MATERIALS AND WORKMANSHIP:

- 4.25.1 All the materials shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall supply only such equipment as guaranteed by him to be satisfactory and suitable for 400 KV Transmission line.
- 4.25.2 The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.
- 4.25.3 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. The bolts threads shall be under cut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629 or equivalent International Standard and satisfy the tests mentioned in IS:2633 or equivalent International Standard. Fasteners shall withstand four dips while spring washers shall be guaranteed to withstand at least six dips each lasting one minute under the standard precece test for galvanising.
- 4.25.4 The Zinc coating shall be perfectly adhere, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky while deposits and blisters. The Zinc used for galvanising shall be grade Zn. 99.95% as per IS: 209:1992 ingot (fourth revision) or IS:13229:1991.
- 4.25.5 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blowholes, cracks etc.
- 4.25.6 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.
- 4.25.7 No item which would produce high electrical and mechanical stresses in normal working 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. The design of adjacent metal parts and mating surfaces shall be such as

to prevent corrosion of the contact surface and no maintain good electrical contact under service conditions.

4.25.8 Particular care shall be taken during manufacturing and subsequent handling to ensure smooth surface free from abrasion or dents.

4.25.9 The fasteners shall conform to the requirement of IS: 6639-1972 or equivalent International Standard. All fasteners and clamps shall have locking arrangements to guard against vibration loosening.

4.26 INSPECTION:

4.26.1 Purchaser and its representatives shall at all times be entitled to have access to the works and to all places of manufacturing and the Supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of material, inspection of manufacturing process and for conducting necessary tests as specified herein.

4.26.2 The successful Bidder shall keep the Purchaser informed in advance of the time of starting and progress of manufacturing of material in its various stages so that arrangements could be made for inspection.

4.26.3 No material shall be despatched from its point of manufacturing unless the material has been satisfactorily inspected and tested.

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

4.27 IDENTIFICATION MARKING:

The main component of the material covered in the specification shall be legibly and indelibly marked with the trademark of the manufacturer, the month and year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-Newton abbreviated by 'kN' to facilitate easy identification and proper use. Words "MPPTCL" shall also be embossed/engraved on the main components. Marks shall be forged or stamped with a steel die before Galvanizing. The marks shall be distinct, durable and conspicuous. Embossing/Engraving should be done at the time of manufacturing process itself, but before Galvanizing. Smaller component like bolts & nuts, split pin and washers etc. may be excluded from this requirement.

4.28 PACKING:

4.28.1 The material shall be packed in strong wooden boxes with steel straps. The gross weight of packing shall be in range of 50 kgs to 200 kgs to avoid handling problem. The packing shall be strong enough to withstand rough handling during transit or storage in the field. All the packing cases shall be legibly marked to avoid possibility of loss in transit. The Bidder shall be responsible for any damage during transit due to improper and inadequate packing and handling.

4.28.2 Each consignment shall be accompanied by a detailed packing list showing following details:-

- i. The name of the consignees
- ii. Details of consignment.
- iii. Destination.
- iv. Total weight of consignment.
- v. Handling and unpacking instrumentation.
- vi. Bill of material indicating content of each package.

4.29 STANDARD AND TESTS:

4.29.1 The original or attested photocopy of test certificates for material for the test conducted at Govt. Laboratory are required to be submitted giving results of sample

test as per technical values given above respectively in support of compliance of materials to the specification in the quality, performance and composition.

- 4.29.2 The materials offered shall conform to relevant Indian Standard. The material shall be tested before dispatch. The MPPTCL may at its option, depute its representative for inspection and witnessing of test. The test as specified shall be carried out and the test report shall be submitted for an approval before dispatch.
- 4.29.3 Further, the MPPTCL reserves the right to carry out test as mentioned above from bulk quantity received at the cost of supplier to ascertain the quality of the material supplied. The supply should strictly as per our specification. The MPPTCL at its discretion for ensuring that material supplied are conforming to specified quality and composition may get it tested from National Laboratory by drawing samples from the lot after the same is received by consignees. If the test result do not conform to specified quality, the lot will be rejected and replacement shall be made free of cost and testing charges will be to the account of supplier. If some material is already used by time the results are received, the MPPTCL may accept such material which has been used at the reduced cost as may be fixed at its discretion. The test as specified shall be carried out and the test report shall be submitted for an approval before dispatch.

SECTION-7**TECHNICAL SPECIFICATIONS FOR ERECTION OF TRANSMISSION LINES****7.01 INDIAN STANDARDS/CODE :**

The material and services under this section shall conform to the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian standards/codes listed here under or equivalent International Standards, except as modified in this document.

S.No.	Indian standards	Title
1	IS:5613-1995 (part-II)	Code of practice for design, installation and maintenance of overhead power lines. Sec.-1 - Designs. Sec.-2 - Installation & Maintenance
2	IS:269-1967	Ordinary rapid hardening and low heat Portland cement.
3	IS:456-2000	Code of practice for plain and reinforced concrete
4	IS:1786-1966	Cold twisted steel bars for concrete reinforcements
	IS:4091-1967	Code of practice for design & construction of foundation for transmission line towers & poles

7.02 LINE MATERIALS:**7.02.1 Conductor:**

The Conductor used in the line will be single ACSR Moose Conductor. The Conductor size is 54/3.53mm A1. + 7/3.53 mm Steel.

7.02.2 Ground-wire :

The Ground-wire to be used on the line shall be 7/3.66 mm; 95 kg/mm² quality galvanized steel stranded wire.

7.02.3 Insulator Strings with Hardware Fittings:

(i) Single suspension and double tension strings will be used on the line as under:

(a) At Suspension Locations:

23 Disc single suspension strings having 120KN E&MS of 255x145 mm size Disc Insulators with AGS type clamps will be used.

(b) At Tension Locations :

24 Disc double tension strings with 160 KN E&MS Disc insulators of 280x170 mm size Disc Insulators will be used with compression type dead end clamp.

(ii) Pilot strings will be used at deep angle tower locations for restraining the swing of jumpers.

(iii) In cases of Railway/Road/River/Other transmission line crossings, double suspension insulator strings will be used.

7.02.4 Conductor Accessories:

- (i) AGS type suspension clamps shall be used with suspension strings.
- (ii) Vibration Dampers (4-R type) and Spacers or Spacer-Dampers shall be used for Conductors.

7.02.5 Miscellaneous Items:

Enameled Number Plates, Phase Plates and Danger Board, Bolts and Nuts, Spring washers, Pack washers and other tower accessories like 'D' Shackle, Hanger, U-Bolts and fasteners etc., shall be provided with the tower by the Contractor. The Contractor shall supply anticlimbing device (including Barbed wire) separately. Copper earth bond will be used for connecting Ground wire suspension and tension clamp with tower body, which shall also be provided by the Contractor.

7.03 DETAILED SURVEY/CHECK SURVEY:

The contractor will have to carry out detailed survey of the line for which route map indicating the proposed alignment of the transmission line will be handed over by the Employer. If the detailed survey is already conducted by the Employer for some portion of the line, the profiles for such portion will be handed over to the Contractor for carrying out check survey. It may please be noted that no check survey is required to be conducted for the portion of line for which detail survey is conducted by the contractor himself.

7.03.1 Detailed Survey:-

- (a) At the starting point of the commencement of route survey, an angle iron spike 65 x 65 x 1000mm shall be driven firmly into the ground to show only 150mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the surveying instrument. Teak wood pegs 50 x 50 x 650 mm shall be driven at prominent positions at intervals of not more than 750 meter along the transmission line to be surveyed up to the next angle point. 125 mm wire nails should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to show only 100 mm above ground level. At angle positions, stones shall be put up for easy identification. Paint mark in white lead paint shall be put in, about 300 mm squares with a direction indication, on nearby boulders, rocks, or trees, along the complete line alignment. At peg position, identification marks giving the peg position, with reference to painting marks, shall be given. The white lead paint mark shall indicate to the individual the direction of alignment from either direction.
- (b) Routing/Re-routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.
- (c) The route should have minimum crossings of Major river, Railway lines, National/State highways, overhead EHV power line and communication lines.
- (d) The number of angle points shall be kept to minimum.
- (e) The distances between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.
- (f) Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.
- (g) It would be preferable to utilize level ground for the alignment.

- (h) Crossing of power lines shall be minimum. Alignment will be kept at a minimum distance of 300 m from power lines to avoid induction problems on the lower voltage lines.
- (i) Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them
- (j) Areas subjected to flooding such as nalah shall be avoided.
- (k) Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.
- (l) All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
- (m) Certain areas such as quarry sites, tea, tobacco and saffron fields and rich plantations, gardens and nurseries which will present the Employer problems in acquisition of right of way and way leave clearance during construction and maintenance should be avoided.
- (n) Angle points should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.
- (o) The line routing should avoid large habitations, densely populated areas, Forests, Animal/Bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc to the extent possible.
- (p) The areas requiring special foundations and those prone to flooding should be avoided.
- (q) From the field book entries, the route plan and level profile shall be plotted and prepared to the scales of 1=2000 horizontal and 1=200 vertical on 1 mm/5 mm/1 cm square paper.
- (r) If the difference in levels be too high, the chart may be broken up according to requirement. A 400 meter overlap shall be shown on each following sheet. The chart shall progress from left to right. For convenience in handling, the sheet size may be limited to 594x841 mm (A1) size.
- (s) After completing the detail survey, profiles shall be submitted to the Employer duly spotted with tower for approval. While submitting the profiles after conducting the detail survey, the contractor will also submit a copy of route alignment on the route map indicating the surveyed route.

7.03.2 Check Survey:

- (a) The Contractor shall conduct the check survey after the profiles are handed over to the Contractor. The check survey shall include checking of deviation angles, checking of levels at critical points. After completing the check survey the tower spotting shall be carried out by the Contractor and profiles shall be submitted to the purchaser for final approval. The Contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of purchaser and final approval shall be taken before execution of work.
- (b) The requirement of tower site leveling and revetment work, if required, shall also be marked by the Contractor on the profiles while carrying out the detail or check survey work.
- (c) If due to site conditions any change in the tower location/provision of extension is considered necessary compared to approve profiles, the contractor shall bring the same to the knowledge of the purchaser well in time and get revised approval of the profile before setting the stubs. The revised approval shall be conveyed to the Contractor by the Purchaser.

7.03.3 Soil Resistivity:-

While carrying out detailed/ check survey work, the Soil Resistivity values will have to be measured at convenient points along the route, not exceeding 2.50 Km between adjacent points. The Soil Resistivity will be measured using 4 electrode method with an inter electrode spacing of 50 M . The following formula shall be used :

$$P = 2 \pi a R$$

Where a = Interelectrode spacing = 50M
 R = Earth resistance measured in Ohms
 P = Soil Resistivity in Ohm- m

The soil resistivity values shall be submitted duly marked on the route map and also in the form of statement. The quoted rates for detailed survey/ check survey work shall be inclusive of cost of measuring soil resistivity values along the proposed route and the contractor will not be paid separately for this work.

7.04 APPROVED PROFILE:

(Applicable for check survey only)

7.04.1 The detailed survey has been conducted by the Purchaser or any other agency appointed by the Purchaser and the profiles shall be handed over to Contractor progressively for carrying out check survey and submission of profiles for approval of the purchaser. The profiles shall be prepared on cm. graph paper on scale 1:2000 horizontal and 1:200 vertical.

7.04.2 The route alignment surveyed by the Purchaser shall be marked at angle points. At angle points concrete blocks shall be provided and in the straight alignment marking will be done by pegs.

7.04.3 The Contractor will be responsible for the correct setting of towers as shown in approved profiles. If towers after erection are found to be out of the approved alignment/position in the profile, the Contractor will dismantle and re-erect them correctly fully at his own cost and without extension of time.

7.05 EXCAVATION:

7.05.1 Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation walls shall be vertical and the pit dimensions shall be such as to allow a clearance of 150mm on all sides from the foundation pit, where form boxes are used. In undercut/stepped (slab type) foundations where form box is not required to be used at the base, the pit dimensions should be as per the standard drawings. All excavation shall be protected so as to maintain a clean sub-grade, until the footing is placed, by using timbering, shoring or casing, if necessary. Any sand, mud, silt or other undesirable materials which may have accumulated in the excavation shall be removed by the Contractor before placing concrete.

7.05.2 The Soil to be excavated for tower foundations shall be classified as under for the purpose of payment of excavation for tower site leveling and building stone revetment:

- (a) Dry Soil : Soil removable by means of ordinary pick axes and shovels (Normal Soil, intermediate Soil and black cotton Soil fall under this category).

- (b) Wet Soil : Soil as per (a) above, where the sub Soil water table is encountered within the range of foundation depth, the Soil below the water table and that at locations where pumping or bailing out of water is required due to presence of surface water, will be treated as wet Soil.
- (c) Soft Rock: This will mean fissured rock i.e. decomposed rock, hard gravel, kankar, limestone, laterite or any other Soil of similar nature which can be excavated with pick axe, crowbar etc. However, if required, light blasting may be resorted to for loosening the material but this will not in any way entitle the excavation to be classified as hard rock
- (d) Hard Rock : Hard rock will be that which requires chiseling or drilling and blasting.

7.05.3 No extra charges shall be admissible for the removal the fallen earth in the pits when once excavated.

7.05.4 If water is encountered in the foundation pit, de-watering will have to be done. The cost of dewatering shall be deemed to be included in the unit rates of excavation for foundation indicated by the Bidder in the offer.

7.05.5 For foundation in rock, where blasting is unavoidable, care should be taken to minimize the volume of concrete necessary for filling up the blasted area. The blasted area shall be reduced to the minimum possible so that the specified form for the foundation could be obtained. No extra payment for excavation in hard rock shall be allowed if the excavated area exceeds the designed excavation volumes. Similarly, no extra payment shall be made if concrete volume exceeds the designed volume due to excessive blasting.

This is to specify here that during excavation, if hard rock soil is encountered but keeping in view the soil strata actually encountered, soft rock foundation is adopted then the rates for excavation for hard rock shall be limited to the extent of approved rate for excavation in soft rock.

7.05.6 The Contractor shall arrange requisite blasting material, excavation and drilling equipment, necessary license etc., at his own cost and the quoted rates shall be deemed to be inclusive of all such costs.

7.05.7 The decision of the owner shall be final and binding with respect to classification of soil and foundation.

7.06 CLASSIFICATION OF FOUNDATIONS :

7.06.1 The foundation designs have been carried out depending upon the type of Soil, sub-Soil water level and the presence of surface water as follows:

- (ii) Dry Soil : To be used for locations where normal dry cohesive or non-cohesive Soils are met.
- (iii) Wet Soil : To be used for locations :
 - (a) Where sub-Soil water is met at 1.5meter or more below the ground level.
 - (b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

- (iv) Partially Submerged: To be used at locations where sub-soil water level is met between 0.75 meter to 1.5 meter below the ground level.
- (v) Fully Submerged : To be used at locations where sub-soil water level is met less than 0.75 meter below ground level.
- (vi) Black cotton(Dry/Wet): To be used at locations where Soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5meter below ground level.
- (vii) Dry Fissured rock: To be used at locations where decomposed or fissured rock, hard gravel, kanker, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.
- (viii) Submerged Fissured rock: In case of fissured rock locations where water level is met at 1.5meter or more below ground level, submerged fissured rock foundations shall be adopted. If after soil investigation, water level is encountered at less than 1.5meter below ground level, a separate foundation shall be developed.
- (ix) Hard rock : The locations where chiseling, drilling and blasting is required for excavation, hard rock type foundations are to be used.

7.06.2 The foundation of towers will be classified as per above soil strata and as per the instructions of Executive Engineer (EHT-C) and Superintending Engineer (EHT-C) concerned and circulars issued by this office. The decision of MPPTCL in the regard shall be final and binding on the contractor.

7.07 SHORING OF PITS:

Shoring of pits with shuttering on the internal walls surrounding the vertical facing of approved dimensions of the pit shall be done when the Soil condition is so bad that there is likelihood of accident due to falling of surrounding earth in foundation pit. The cost of carrying out shoring & shuttering shall be deemed to be included in the unit rate of excavation of tower and no extra payment shall be made on this account.

7.08 TOWER SITE LEVELLING:

In case of foundations located on sloping ground, it may be necessary to level the ground for locating the tower. In leveling the tower site, only excavation will be allowed. The Contractor shall quote separate rates for excavation for purpose of site leveling for dry Soil, wet Soil, soft and hard rock in respective Schedule. The requirement of tower site leveling will be decided by the Purchaser's site Engineer and will be marked by the Contractor in the profiles while carrying out the check survey work.

7.09 SETTING OF STUBS:

7.09.1 The stub shall be set correctly in accordance with approved method at the exact locations and alignment and imprecisely correct levels. The stub setting Templates shall be used for proper setting of stubs. Stubs shall be set in the presence of purchaser's representative available at site whenever required and for which the contractor shall give adequate advance intimation to the site Engineer.

7.09.2 The foundations are to be made as per designs and drawings approved by the purchaser. Extent of the work as defined by such drawings shall not be exceeded except in very exceptional cases where the prior approval of purchaser has been obtained.

7.09.3 Each tower shall be provided with suitable foundation based on the approved designs after classification of Soil. The Soil classification shall be done after digging minimum section of all foundation pits of a tower up to full depth (excluding hard rock locations). The Soil should be classified strictly as per the details of Soil encountered in the foundation pit. For example, dry Soil foundation should be adopted at the locations where dry Soil is encountered in the full depth of foundation. Similarly the wet type foundation should be adopted at the locations where water level is met at level of 1.5meter or more, below the ground level or in paddy fields or other places, which remain in surface water for long periods with water penetration not exceeding one meter below the ground level. Deviations, if any, from the approved/specified conditions shall be brought to the notice of C.E. (EHT:C&M) through site Engineer before taking up the work and his decision shall be final in this regard and communicated through site Engineer. If at a later date, it is found that the works carried out by the Contractor are not according to the specifications and are without specific approval, the entire payments made to the Contractor for carrying out such works shall be recovered and the Contractor will have to rectify the same at the rates indicated in the order for carrying out such work and without extension of time.

7.09.4 The setting of stubs in hard rock foundation may require cutting of stubs depending on depth at which hard rock is encountered. The cutting of stubs and drilling of new holes for fixing cleats etc. shall be considered inclusive in the rate of foundation of towers in hard rock. However, the cut pieces of stubs shall be returned to MPPTCL.

7.09.5 Setting of stub at each location shall be approved by the purchaser's site Engineer. This approval shall not however, absolve the Contractor of his responsibility of correct setting of stubs and casting of foundations, who will be required to rectify the faulty work at his own expense.

7.10 PLACEMENT OF REINFORCEMENT:

7.10.1 Some of the tower foundations may be designed with steel reinforcement so as to achieve better foundation strength with lesser space. The Contractor will indicate in relevant schedules, the details of reinforcement to be provided alongwith the weight and size of reinforcement rods. The cost of placing of reinforcement steel, binding etc. in the foundation pit shall be deemed to be included in the quoted rates of foundations of towers.

7.10.2 The Contractor shall arrange foundation reinforcement steel etc. at their cost which shall be deemed to be included in the quoted cost of foundations. The reinforcement bars will have to be properly cut, bent in required shape and placed in the foundation in approved manner after due cleaning of oil, grease or organic matter. The reinforcement shall be properly tied by binding wire.

7.10.3 Reinforcement shall conform to IS:1786 for deform and cold twisted bars (Fe 500). Thermo Mechanically Treated (TMT) bars (equivalent grade) in place of cold twisted bars are also accepted. Hard drawn steel wire shall conform to IS:432.

7.11 CONCRETE:

- 7.11.1** The cement concrete used for the foundation shall be of 1:2:4 mix ratio (M150) with 20mm nominal size stone metal for chimney portion and 40mm nominal size stone metal for pyramid or slab portions. 1:3:6 mix ratios (M 100) shall be used for base padding (lean pad). For RCC, the aggregates shall preferably be of 20mm nominal size.
- 7.11.2** Concrete aggregates shall confirm to IS:383
- 7.11.3** The cement required for the purpose of foundations, building revetment walls etc. shall be arranged by the Contractor at his own cost, which shall be deemed to be included in the cost of concreting.
- 7.11.4** The sand used for the concrete shall be arranged by the Contractor at his own cost including necessary license etc., which shall be deemed to be included in the cost of concreting. The sand shall be composed of hard silicate materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts.
- 7.11.5** The aggregate shall be arranged by the contractor at his own cost including necessary license etc, which shall be deemed to be included in the cost of concreting. The aggregate shall be of clean broken hard granite or other stone specified or approved by the purchaser. It shall be of hard and coarse-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matter. 40mm aggregate shall be of size as will pass through a mesh of 40 mm measured in the clear and 20 mm aggregate through 20mm square mesh measured in clear.
- 7.11.6** The water used for mixing concrete shall be arranged by the contractor at his own cost including necessary license etc, which shall be deemed to be included in the cost of concreting. The water used shall be fresh, clean and free from oil, acid and alkali, organic materials or other deleterious substances. Salty/Saline or brackish water should not be used. Potable water is generally satisfactory.
- 7.11.7** The concrete shall be mixed in a mechanical mixer. However in case of locations not accessible for concrete mixers, hand mixing may be permitted at the discretion of our site Engineer.
- 7.11.8** Mixing shall be continued until there is uniform distribution of materials and the mixing is uniform in colour and consistency but in no case the mixing is done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible, the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods, which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences. The transportation cost of these materials shall be deemed to be included in the cost of concreting.
- 7.11.9** The concrete should be mixed as stiff as per the requirements of placing the concrete in the form boxes, with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.
- 7.11.10** Proper form boxes adequately braced to retain proper shape while concreting should be used for chimney or pyramid and slab portions. The form boxes should be made water tight so that cement cream may not come

out leaving only sand and jelly consequently forming of honeycombing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

- 7.11.11** The concrete shall be laid in 150mm layers and consolidated well so that the cement cream works up to the top and no honeycombing is left in the concrete. Concreting is to be done continuously so that the subsequent layers are laid before the initial setting of the bottom layer begins. The consolidation of concrete shall normally be done by using vibrators.
- 7.11.12** After concreting the chimney portion up to the required height, the top surface should be finished smooth, with slight slope towards the outer edge, to drain off the rainwater falling on the coping.
- 7.11.13** In wet locations, the site must be kept completely de-watered both during the placing of the concrete and up to 24 hours after completion. There should be no spilling to concrete by water during this period.
- 7.11.14** The form boxes shall be removed only after at least 24 hours after the completion of concreting. After removal of the forms and boxes the concreted surface wherever required shall be repaired with a mixture of rich cement and sand mortar in the shortest possible time.
- 7.11.15** The cost of carrying out concreting of foundations in all respect, shall be deemed to be included in the unit rates of foundations of tower in different type of Soils quoted by the Bidder.

7.12 BACKFILLING AND REMOVAL OF STUB TEMPLATE:

- 7.12.1** Following opening of form work and removal of shoring and shuttering, if required, backfilling shall be started after 24 hours of casting repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated Soil, unless it consists of large boulders, which shall be broken to a maximum size of 80mm.
- 7.12.2** The backfill materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200mm layers, leveled, and wetted and rammed properly before another layer of earth is deposited. Care shall be taken that the back filling is started from the foundation end only in the pits towards the outer end.
- 7.12.3** The backfilling and grading shall be carried to an elevation of about 150mm above the finished ground level to drain out water. After backfilling, 50mm high earthen embankment (bandh) will be made along the sides of excavated pits and sufficient water will be poured in the backfilled earth for at least next 24 hours.
- 7.12.4** The stub setting Templates shall be opened only after the completion of back-filling.
- 7.12.5** After completing stringing work, if level of backfilling of some of the locations gets settled and it is required to backfill the locations again, the same would be done by the contractor at no extra cost.
- 7.12.6** No extra charge is admissible for carrying out backfilling of foundation pit (including backfilling from borrowed earth if required) and the cost of backfilling including cost of materials shall be deemed to be included in the cost of excavation of towers quoted by the in the bid.

7.13 CURING:

The concrete, after it is 24 hours old, shall be cured by keeping the concrete wet continuously for a period of 14 days after laying. The pit may be backfilled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 14 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing duly ensuring that the bags are kept wet by frequent pouring of water on them. The Contractor may use anti curing paint. However no extra payment shall be made on this account.

7.14 BUILDING STONE REVETMENT:

Stone revetment in 1:6 cement mortars shall be constructed by the Contractor at specified locations. The detailed proposal in consultation with the site Engineer, for carrying out revetment work shall be submitted to the O/o. CHIEF ENGINEER (Procurement), Jabalpur through concerned Superintending Engineer, EHT Construction and approval shall be obtained before carrying out revetment work. The top seal cover of revetment work shall be done with 1:2:4 normal mix. All materials including cement shall be provided by the contractor and cost of building revetment shall be deemed to include cost of such materials also i.e. Cement, sand, metal and stone. Curing of revetment shall be done as specified for tower foundation. The back filling of the inside of the revetment wall with Soil/borrowed earth will be paid for extra on per m³ basis and shall include its compacting and watering. The excavation for revetment foundation shall be paid at the rates as indicated by the Bidder in Price Schedule. The revetment work, wherever necessary, shall have to be completed before taking up final tensioning work in the Section.

7.15 TOWER EARTHING:

7.15.1 For the purpose of earthing, necessary earthing rods (25mm dia, 2 meter long) connecting clamps, and connecting wire will be provided by the Contractor. The earthing rods are to be hammered preferably in the foundation pits and connected to stub by 7/4.00mm earth-wire and with necessary connecting clamps before concreting the foundation. If it is not possible to tie the rods in the foundation pit i.e. in rocky location, they shall be buried near the foundation pit and connected to the stubs. The earthing rods are to be provided on diagonally opposite legs of the tower. Each tower shall be earthed before the foundation is casted.

7.15.2 The tower footing resistance of all towers shall be measured in dry whether after the erection and before the stringing of Ground-wire. The counterpoise earthing shall be resorted to, in accordance with the instructions of the site Engineer, in case the tower footing resistance (TFR) exceeds the specified value. It shall be ensured that the tower footing resistance is less than 10 ohms. Each tower footing resistance shall be intimated (along with the tower location number) while submitting the progress report of tower Erection.

7.15.3 Counterpoise Earthing :

- (a) In case of high resistivity, counterpoise earthing shall be provided which consists of four lengths of galvanized steel stranded wires, 7/4.00mm fitted with each leg of the tower with proper clamps for connection to the tower leg at one end. The counterpoise will be laid radially away from the

tower and will normally be 15 meters in length, buried to the depth of 600mm below the ground level. The length of counterpoise wire may be increased if the resistance requirements are not met. Connecting clamps shall be buried in the chimney portion of the foundation. Contractor shall quote for the laying of counterpoise earthing on per running meter basis, including cost of all materials. The scope of work of connecting the counterpoise to the tower legs shall be deemed to be included in the cost of laying of counterpoise (with cost of materials). The counterpoise connecting wire and clamps will be arranged by the Contractor. The counterpoise shall preferably be laid through soft soil areas if available. The planning of laying counterpoise shall be done as per approval of site Engineer. The cost of laying of counterpoise shall be inclusive of excavation and backfilling work also.

- (b) The Contractor shall have to provide rod earthing at the end of each counterpoise wire and this may lead to T.F.R. values within specified limits. This work of additional rod earthing shall be paid extra on per location basis as per the rates indicated in Price Schedule. Which shall include the cost of providing such earthing and cost of materials i.e. earthing rods (4 Nos. for counterpoise earthing i.e. additional earthing of towers) and connecting arrangements for one tower.

7.16 TOWER ERECTION / ASSEMBLY:

- 7.16.1** Towers shall be erected after the foundation concrete is at least 14 days old, but a gap of 24 days shall be preferred. The method followed for the erection of towers, shall ensure the points mentioned below:
- 7.16.2** Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, Tommy bars not more than 450mm long may be used.
- 7.16.3** Before starting erection of an upper section, the lower section of tower shall be completely braced and all bolts provided in accordance with approved drawings.
- 7.16.4** All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.
- 7.16.5** The bolt positions in assembled towers shall be as per IS: 5613 (Part-II/Sec.2), 1995 with latest amendments.
- 7.16.6** Tower shall be fitted with Number, Phase and Danger Plates which shall be arranged by the Contractor.

7.16.7 Anti-climbing Devices:

Barbed wire will be used at a height of approx. 3 meters and above as an anti-climbing measure, which shall be arranged by the Contractor. At every location three layers of Barbed wires will be provided each inside and outside the tower in horizontal plane. Spacing between the layers with fixing arrangements shall be provided as per the provisions of IS:5613 (Part-II/Sec.1)-1976 with latest amendments. The galvanized angle pieces with notches for accommodating Barbed wire with Bolts Nuts etc. shall be supplied by the Contractor. After the Barbed wire is placed in position in the notches,

the notch opening shall be welded to avoid the theft of Barbed wire and anti-corrosive treatment with cold galvanizing paint shall be given, as also in the case of bolts to be welded below bottom cross arm level. Suitable locking arrangement (pad-lock) shall also be provided.

7.16.8 All blank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of proper size.

7.17 TIGHTENING PUNCHING AND WELDING OF BOLTS AND NUTS:

7.17.1 All nuts shall be tightened properly using correct size of spanners. Before tightening, it will be seen that packing washers and plates are placed in relevant gaps between members, bolts of proper size and length are provided and one spring washer is used under each nut and in case of step bolts, spring washers shall be placed under the outer nut.

7.17.2 The tightening shall progressively be carried out from the top to downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at three positions on the periphery to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall have to be replaced.

7.17.3 The threads of all the bolts projected outside the nuts shall be welded all around the periphery of nut-bolts. The welding of nut-bolts as above shall be carried out from ground level to bottom cross arm level in all towers upto +6M extensions. In case of +10M/18M/25M extension towers and special river crossing towers, nut-bolts welding shall be done up to 25 meter height from ground level.

7.17.4 After welding, cold galvanized paint having at least 90% zinc content shall be applied on the welded portion. At least two coats of the paint shall be applied. The cost of such paint and welding etc., including application of paint etc., shall be deemed to be included in the quoted erection rates.

7.18 INSULATOR HOISTING:

Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead end towers. They shall be fixed on all the towers just prior to the stringing. Damaged Insulators and fittings, if any, shall not be used in the assemblies. Before hoisting, all Insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the Insulator, but in no case shall any oil be used for the purpose. Security clips shall be fitted in position for the Insulators before hoisting. Arcing Horns shall be fitted in an approved manner. Torque wrench shall be used for fixing different line materials and their components, like suspension clamps etc. for Conductor and Ground-wire etc.

7.19 HANDLING OF CONDUCTOR AND EARTHWIRE:

7.19.1 The Contractor shall be entirely responsible for any damage caused to the towers or Conductors during stringing. While running out the Conductors, proper care shall be taken ensuring that the Conductors do not touch and rub against the ground or objects which could cause scratches or damage to the Conductor strands. The Conductors shall be run out of the drums from the top in order to avoid damage due to chafing. The drum stand shall be

provided with a suitable braking device to avoid damage, loose running out and kinking of Conductor. Proper care shall be taken to avoid injury to Conductor while making it pass over the bull wheel of tensioner. After the tensioner, the Conductor will be pulled by pull cable and consequently pass over the running out blocks. The groove of the running out blocks will be of such a design that the seat is semi-circular and larger than the diameter of the Conductor and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to Conductor and shall be mounted on properly lubricated bearings.

- 7.19.2** The running blocks shall be suspended in a manner to suit the design of the cross arm. All running out blocks especially those at the tensioning end, will be fitted on the cross arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. The Conductor shall be continuously observed for loose or broken strands or any other kind of damage. When approaching towards end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully if another length is required to be run out, new length may be joined to the length already run out by the compression joint in approved manner.

The Conductor joints and clamps shall be erected in such a manner that no bird caging, over tensioning of individual wires or layers or other deformities or damage to the conductor shall occur. Clamps or bracing devices shall under erection conditions allow no relative movement of strands or layers of the conductors.

- 7.19.3** Repairs of Conductors, in the event of damage being caused to isolated strands of a conductor during the course of erection, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of Conductor surface with repair sleeve shall be done only in case of minor damage, scuff marks etc., keeping in view both electrical and mechanical safety requirements. Number of damaged strands shall not exceed 1/6th of the total strands in the outer layer. The final Conductor surface shall be clean, smooth and shall be without any projections, sharp points, cuts, abrasions etc. Repair sleeves may be used when the damage is limited to the outermost layer of the Conductor and is equivalent to the severance of not more than one third of the strands of the outermost layer. No repair sleeve shall be fitted within 30 m of tension or suspension clamp or fittings. Further, more than one repair sleeve per Conductor shall not be normally used in any single span.

- 7.19.4** Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The Contractor shall use only such equipment/ methods during Conductor stringing which ensures complete compliance in this regard.

- 7.19.5** Derricks shall be used where roads, rivers, canals, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted and no damage is caused to property. Shut down shall be obtained when working at crossing of overhead power lines.

- 7.19.6** The sequence of running out shall be from top to downwards, i.e. the Ground-wire shall be run out first followed by the Conductors in succession. Imbalances of loads on towers shall be avoided as far as possible i.e. both Ground-wires, then both bundles of top Conductor and then both bundles of

middle Conductor followed by both bundle Conductors of bottom Cross-arm should be strung.

- 7.19.7** The proposed transmission line may run parallel for certain distance with the existing 400/220/132KV lines which will remain energized during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling cables, Conductors and Ground-wires, which although comparatively small in magnitude during normal operations, can be severe during switching and ground fault conditions on the energised lines. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

7.20 STRINGING OF CONDUCTOR AND EARTHWIRE:

- 7.20.1** The stringing of the Conductor shall be done by control in tension method by means of tension stringing equipments. The equipments shall be capable of maintaining a continuous tension. The maximum tension imposed on a conductor during stringing operations shall not exceed than that necessary to clear obstructions on the ground. The contractor shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively for this work.
- 7.20.2** After being pulled, the Conductor/Ground-wire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.
- 7.20.3** The Contractor shall give complete details of the stringing methods, which he proposes to follow. At least one month in advance of the commencement of stringing, the Contractor will submit the stringing charts for the Conductors and Ground-wire showing the initial and final sags and tension for various temperatures and spans, alongwith equivalent spans in the lines, for the approval of the purchaser. The stringing shall be carried out as per the stringing charts approved by the purchaser and in accordance with relevant IS. All the tolerances for the line shall conform to IS :5613 (Part-2/Sec-2) 1995.
- 7.20.4** In hilly terrain and thick forest, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of Purchaser's site Engineer. The contractor shall deploy appropriate tools/equipments/machinery to ensure that the stringing operation is carried out without causing damage to conductor/earth wire and conductor/earth wire is installed at the prescribed sag-tension as per the approved stringing charts.

7.21 JOINTING:

- 7.21.1** The number of joints in Conductor/Ground-wire shall be kept to minimum possible by properly selecting the drums from available lot of respective drums. All the joints on the Conductor and Ground-wire shall be of compression type. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti-corrosive compound, as approved by our Engineer before the final compression is done with the compressors. The cost of such grease etc. used for joints shall not be paid extra and shall be deemed to be included in the stringing rates.
- 7.21.2** All joints shall be made at least 30 meter away from the structures. No joints shall be made in the spans crossing over the main roads, railways, rivers etc.

Not more than one joint per Conductor shall be allowed in one span. Care shall be taken to mark the conductor for properly centering the compression clamp before compressing. During compression operation, the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminum sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

- 7.21.3** Suitable protector shall be used during stringing of Conductor to avoid any damage to the joint while it passes over the traveler.

7.22 SAGGING IN OPERATION:

- 7.22.1** The Conductors shall be pulled up to the desired sag and left in running block for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductor from the running out blocks to the suspension clamps. The Conductors shall be clamped within 36 hours of sagging in.

- 7.22.2** The sag will be checked in the first and the last span of the section in case of sections up to eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be rechecked when the Conductor have been drawn up and transferred from running blocks to the insulator clamps.

- 7.22.3** The running out blocks, when suspended from the transmission structure for sagging shall be so adjusted that the Conductors on running out blocks will be at the same height as that of the suspension clamps to which it is to be secured.

- 7.22.4** At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle. The Conductor and Ground-wire shall be checked on the running out blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the Conductor is clamped.

- 7.22.5** Tensioning and sagging operations shall be carried out in calm weather, when rapid changes in temperature are not likely to occur.

7.23 TENSIONING & SAGGING OF CONDUCTOR AND EARTHWIRE:

The tensioning and sagging shall be done in accordance with the approved stringing charts before the Conductor and Ground-wire is finally attached to the towers through the insulator strings for the Conductor and Ground-wire clamps for the Ground-wire Dynamometers shall be used for measuring tension in the Conductor and Ground-wire.

7.24 CLIPPING IN:

- 7.24.1** Clipping of the Conductors in position shall be done in accordance with the method approved by our Engineer. At suspension location free center type suspension clamp with Armour rod set or AGS type suspension clamp shall be used.

- 7.24.2** The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator string shall be used, if necessary, to restrict the jumper swings to the design values. Jumper connections of transposition towers shall be so

made that adequate clearances are available from tower body as well as phase conductors.

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

7.25 FIXING OF CONDUCTORS AND EARTHWIRE ACCESSORIES :

Spacers, spacer dampers, Vibration dampers (4-R type) and other Conductor and Ground-wire Accessories supplied by the purchaser shall be installed by the Contractor as per the design/drawing requirement and as per instructions of the Engineer. Spacers shall be fitted within 24 hours of the Conductor clamping. While installing the Conductor and Ground-wire Accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the Accessories.

7.26 REPLACEMENT:

If any replacements are to be effected after stringing and tensioning or during maintenance, members and bracing shall not be removed without reducing the tension on the tower with proper guying or releasing the Conductor. If the replacement of cross arms becomes necessary after stringing, the Conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

7.27 FINAL CHECKING TESTING AND COMMISSIONING:

After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly in accordance with the specification and as approved by the purchaser. All the works shall be thoroughly inspected keeping in view the following main points:

- (a) Sufficient back-filled earth is lying over each foundation pit and it is adequately compacted.
- (b) Concrete chimneys and their copings are in good finely shaped conditions.
- (c) All the tower members are correctly used, strictly according to approved drawing and are free from defects or damages, whatsoever.
- (d) All bolts are properly tightened and punched/tack welded as per this specification.
- (e) The stringing of the Conductors and Ground-wire has been done as per the approved sag and tension charts and desired clearances are clearly available.
- (f) All Conductor and Ground-wire Accessories are properly installed.
- (g) All other requirements to complete the work like fixing of Danger Plate, Phase Plate, Number Plate, Anti-climbing devices, Aviation Signal (wherever required) etc. are properly installed and the painting has been done wherever required as per Aviation Rules.
- (h) It should be ensured that revetment is provided, wherever required.
- (i) The line insulation is tested by the Contractor by providing his own equipment labour etc. to the satisfaction of the purchaser to ascertain the insulation condition of the line.
- (j) Conductor continuity test is carried out to verify that each Conductor of the overhead line is properly connected electrically also.

The line may be charged at a low value of Power Frequency Voltage for the purpose of testing.

ANNEXURE- 1**GUARANTEED TECHNICAL PARTICULARS OF CONDUCTOR & EARTH WIRE****(A) ACSR MOOSE CONDUCTOR.**

S.NO.	PARTICULARS	ACSR MOOSE
1	ACSR MOOSE- Stranding and Size in mm	54/7/3.53
2	Stranding and wire dia in mm	
a)	Aluminium	54/3.53
b)	Steel	7/3.53
3	Standard nominal copper area in sq.mm	325
4	Actual aluminium area in sq.mm.	528.5
5	Standard area of cross section in sq.mm.	
a)	Aluminium strand	9.787
b)	Steel strand	9.787
c)	Conductor	597
6	Diameter of complete conductor in mm.	31.77
7	Minimum ultimate tensile stress in Kg./sq.mm.	
a)	Aluminium strand	16.38
b)	Steel strand	134
8	Guaranteed ultimate tensile strength of Conductor in Kg.	Min. 161.20
9	Min. breaking load in KN for	
a)	Aluminium strand	
i)	Before stranding	1.57
ii)	After Stranding	1.49
b)	Steel strand	
i)	Before standing	12.86
ii)	After stranding	12.22
10	Zinc coating of steel strand	
a)	Number and duration of dips	3 dips 1 min.
b)	Minimum weight of coating in gms./sq.mtr.	260
11	No. of standard length in one reel	One
12	Weight in Kg./Km. (Approx.)	
a)	Aluminium	1465
b)	Steel	539
c)	Conductor	2004

S.NO.	PARTICULARS	ACSR MOOSE
13	Resistance in ohms per km at 20 deg. C	0.0552
14 a)	Continuous max. current rating of conductor in still air at 40 deg. C ambient temperature Amps.	900
b)	Temperature rise for the above current deg. C.	35 Deg. C
15	Lay Ratio	
	Steel core : 6 wire layer	16-18
	Aluminium: 12 wire layer	12-14
	18 wire layer	11-13
	24 wire layer	10-12
16	Modulus of elasticity of Conductor Kg/Sq.mm	0.703×10^6
17	Co-efficient of linear expansion per degree centigrade of:	
a)	Aluminium strand Kg./sq.cm	23×10^{-6}
b)	Steel strand Kg./Sq.cm	11.5×10^{-6}
c)	Conductor Kg./sq.cm.	19.3×10^{-6}
18	Percentage of carbon in steel wire	0.50-0.85
19	Standard length of each piece in Km.	1.5
20	Tolerance, if any, on standard length	+/- 5%

The conductor should conform strictly to the "Guaranteed Technical Particulars" as detailed above. The conductor shall conform to IS:398 Part-II – 1996 & as amended up-to-date.

(B) HTGS EARTH WIRE

S.N.	Particulars	HTGS EARTH WIRE
1	Particulars of single steel wire before stranding	
a)	No. of wires	7
b)	Diameter (mm)	3.66 mm
c)	Tolerance	2%
	Plus	3.74
	Minus	3.58
d)	Minimum elongation in 100 mm length	5 mm
e)	Breaking load (Kg.)	
	Standard/Minimum	1179/1000
f)	Minimum ultimate tensile stress (Kg/mm ²)	95
g)	D.C. resistance at 20 deg. C (Ohm/Km)	17.57(Max.)
2	Stranded Wire	
a)	Length of lay (mm)	

S.N.	Particulars	HTGS EARTH WIRE
	Maximum	198
	Minimum	165
b)	Overall diameter of Earth wire(mm)	10.98
c)	Area of cross section of Earth wire (sq. mm.)	73.64
d)	Breaking load (Kg.)	
	Standard/Minimum	7431/6972
e)	Resistance in Ohms per Km. at 20 deg. C.	2.5
f)	Modulus of elasticity of Earth Wire (Kg/cm ²)	19×10^5 Kg/cm ²
g)	Weight of Earth wire (Kg/Km)	583
h)	Co-efficient of linear expansion (per deg. C)	11.5×10^{-6} /deg. C
3	Quality of zinc used (Specify the grading and percentage)	Zn - 99.95 %
4	Coating of zinc on wires In Gms. per sq. mtrs.	260
5	Nos. of Dip	3,one minute&1, half minute
6	Oiling/greasing on Earth wire	Boiled Linseed Oil
7	Tolerance in standard length	Plus/Minus 5%

ANNEXURE-2**GUARANTEED TECHNICAL PARTICULARS OF DISC INSULATORS****(A) GUARANTEED TECHNICAL PARTICULARS
FOR 120KN EMS DISC INSULATORS.**

S.N.	Description	120 KN DISC	
		Single Suspension	Double Suspension
1	Maker's name, address and country		
2	Size and designation of Ball & Socket and standard to which it will conform (mm)	20 mm IS: 2486 (Pt.II)1989	
3	No. of insulator discs per string	23	2*23
4	Outside dia. of the disc – mm	255	255
5	Spacing – mm	145	145
6	Creepage distance of the single disc-mm	320mm	320mm
7	Electro-mechanical strength of single disc – kg.	12237	12237
8	Withstand voltage of single disc-kVp		
	8.1 Power frequency		
	a) Dry – kV (rms)	75	75
	b) Wet – kV (rms)	45	45
	8.2 Impulse voltage 1.2/50 microsecond		
	a) Positive – kV	110	110
	b) Negative – kV	115	115
9	Withstand voltage for the complete string		
	9.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	720 & 725	720 & 725
	b) Wet – kV (rms)	680 & 685	680 & 685
	9.2 Lightning Impulse voltage 1.2/50 microsecond (With and without Corona ring)		
	a) Positive – kVp	1600 & 1605	1600 & 1605
	b) Negative – kVp	1610 & 1615	1610 & 1615
10	Flashover voltage for the disc		
	10.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	80	80
	b) Wet – kV (rms)	50	50
	10.2 .Lightning impulse voltage 1.2/50 microsecond		

S.N.	Description	120 KN DISC	
		Single Suspension	Double Suspension
	a) Positive – kVp	115	115
	b) Negative – kVp	120	120
11.	Flashover voltage for complete string.		
	11.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	745 & 750	745 & 750
	b) Wet – kV (rms)	705 & 710	705 & 710
	11.2 .Lightning impulse voltage 1.2/50 microsecond		
	a) Positive – kVp	1650 & 1655	1650 & 1655
	b) Negative – kVp	1660 & 1665	1660 & 1665
12	Max. voltage (%) across any disc in the string (with and without Corona ring)	9%	9%
13	P.F. Puncture Voltage of each disc insulator KV(rms)	125	125
14	Minimum corona extinction voltage of each disc insulator KV(rms)	18	18
15	Max. RIV with 10 KV (rms) of each disc insulators (Micro volts)	50	50
15	Weight of each disc (Kgs) (approx)	6	6

**(B) GUARANTEED TECHNICAL PARTICULARS
FOR 160KN EMS DISC INSULATORS.**

S.N.	Description	160 KN DISC INSULATORS	
		ON 400 KV	
		Single Tension	Double Tension
1	Maker's name, address and country		
2	Size and designation of Ball & Socket and standard to which it will conform (mm)	20 mm IS: 2486(Pt.II)1989	
3	No. of insulator discs per string	1*24	2*24
4	Outside dia. of the disc – mm	280	280
5	Spacing - mm	170	170
6	Creepage distance of the single disc-mm	330	330
7	Electro-mechanical strength of single disc – kg.	16500	16500
8	Withstand voltage of single disc-kVp		
	8.1 Power frequency		
	a) Dry – kV (rms)	75	75

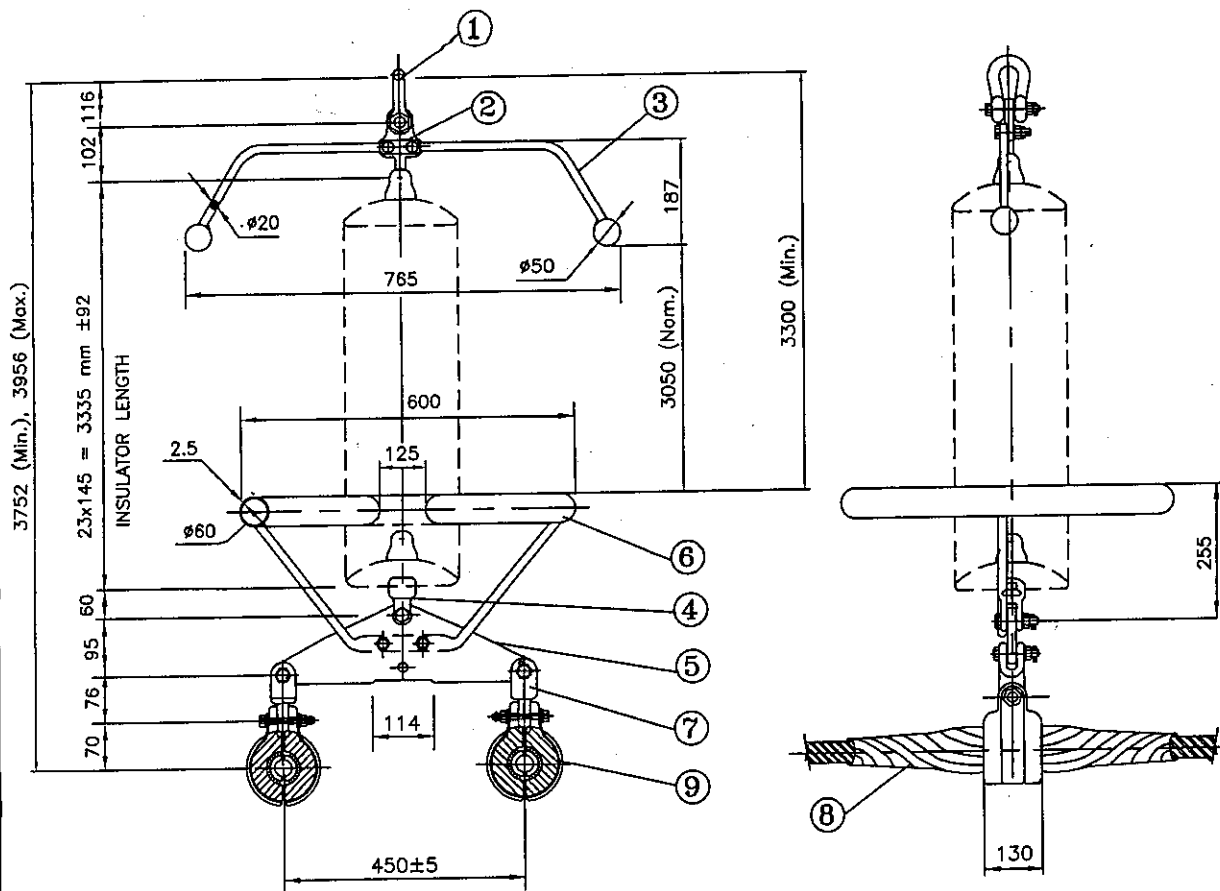
S.N.	Description	160 KN DISC INSULATORS	
		ON 400 KV	
		Single Tension	Double Tension
	b) Wet – kV (rms)	45	45
	8.2 Impulse voltage 1.2/50 microsecond		
	a) Positive – kV	120	120
	b) Negative – kV	120	120
9	Withstand voltage for the complete string		
	9.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	720	720
	b) Wet – kV (rms)	690	690
	9.2 Lightning Impulse voltage 1.2/50 microsecond (With and without Corona ring)		
	a) Positive – kVp	1700	1700
	b) Negative – kVp	1700	1700
10	Flashover voltage for the disc		
	10.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	80	80
	b) Wet – kV (rms)	50	50
	10.2 .Lightning impulse voltage 1.2/50 microsecond		
	a) Positive – kVp	125	125
	b) Negative – kVp	130	130
11.	Flashover voltage for complete string.		
	11.1 Power frequency (with and without Corona ring)		
	a) Dry – kV (rms)	740	740
	b) Wet – kV (rms)	710	710
	11.2 .Lightning impulse voltage 1.2/50 microsecond		
	a) Positive – kVp	1750	1750
	b) Negative – kVp	1750	1750
12	Max. voltage (%) across any disc in the string (with and without Corona ring)	9	9
13	P.F. Puncture Voltage of each disc insulator KV(rms)	125	125
14	Minimum corona extinction voltage of each disc insulator	18	18

S.N.	Description	160 KN DISC INSULATORS	
		ON 400 KV	
		Single Tension	Double Tension
	KV(rms)		
15	Max. RIV with 10 KV (rms) of each disc insulators (Micro volts)	50	50
15	Weight of each disc (Kgs)	8	8
16	Electromechanical strength of complete string (kgs.)	16500	2 x 16500

ANNEXURE-3**LIST OF SAMPLE DRAWINGS**

S.No.	Particulars
1	Outline drawing of 400kV 23 unit single suspension insulator string.
2	Outline drawing of 400kV 2x23 unit double suspension insulator string.
3	Outline drawing of 400kV 1x24 unit single tension insulator string.
4	Outline drawing of 400kV 2x24 unit double tension insulator string.
5	Central Hanger shackle
6	Details of earthing arrangement for towers
7	Armour Grip Type Spacer for conductor
8	Rigid Spacer for Jumper
9	Midspan joints
10	Repair sleeve
11	Vibration damper
12	T-Connector
	Groundwire Accessories:
13	Suspension Clamp Assembly
14	Tension Clamp
15	Midspan joint
16	Vibration damper for earthwire
17	Copper earth bond
18	Number plate for 400kV transmission line

19	Phase plate for 400kV transmission line
20	Danger Board for 400kV transmission line
21	Anticlimbing Device for 400kV Towers.



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH OF CLAMP : 20 TO 29 KN
- 3) BALL & SOCKET SIZE 20 mm. IS:2486 (PART-II)
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 5) GENERAL TOLERANCES $\pm 3\%$
- 6) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 7) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.).
- 8) R.I.V. AT 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 9) TOTAL ASSEMBLY WEIGHT :- 33.00 KGS.

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD,BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

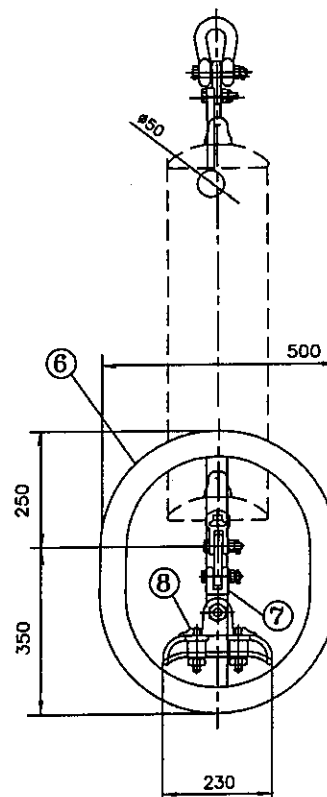
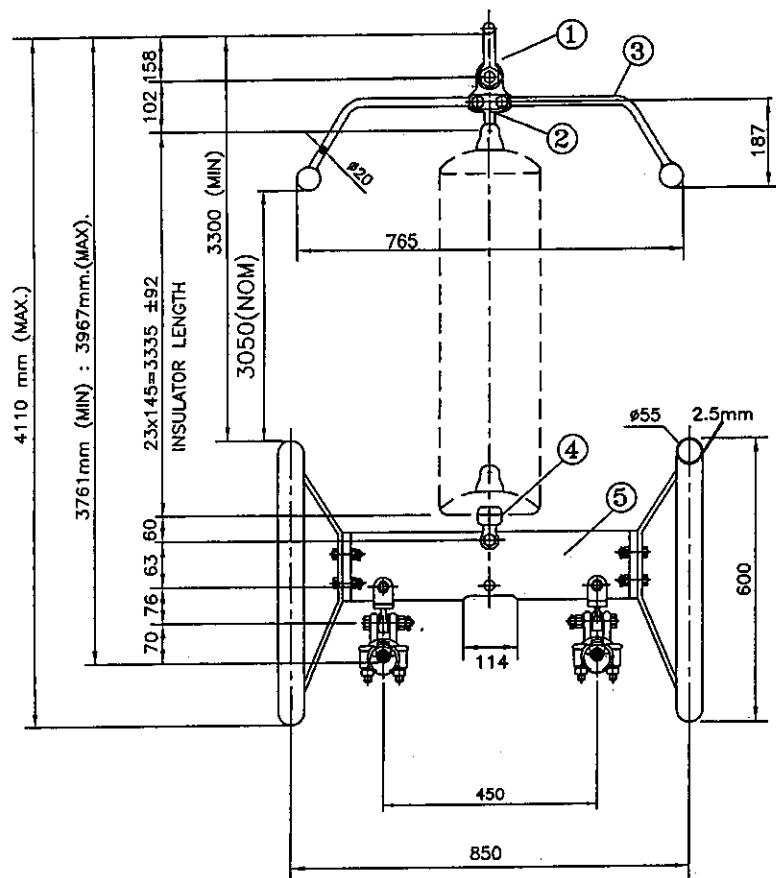
400 KV. SINGLE I SUSPENSION INSULATOR STRING
FOR TWIN "ACSR MOOSE" CONDUCTOR. UTS : 120 KN.

No.	DESCRIPTION	MATERIAL	U.T.S.	WEIGHT	QTY.	FINISH	EMI DRG.NO.
9	SUSPENSION CLAMP	ALUMINIUM ALLOY A-6, IS:617	70 KN	8.100 KG	2,SET	---	EMI/SCAG-677
8	ARMOUR ROD	H.T. ALU. ALLOY 6061/65032 IS:733	35 KG/mm ²	0.708 KG	2	H.D.G.	EMI/CE-409
7	CLEVIS EYE	FORGED STEEL CL-IV, IS:2004	70 KN	1.343 KG	1,SET	---	EMI/GR-1324
6	GRADING RING	ALUMINIUM ALLOY 63400/6063 IS:733	1.5 KN	5.600 KG	1	H.D.G.	EMI/YP-678
5	YOKE PLATE	MILD STEEL Fe-410,IS:2062	120 KN	3.070 KG	1	H.D.G.	EMI/SC-370
4	SOCKET CLEVIS	FORGED STEEL CL-IV, IS:2004	120 KN	0.690 KG	1	H.D.G.	EMI/AH-1984
3	ARCING HORN	MILD STEEL Fe-410 IS:2062	1.5 KN	1.373 KG	1	H.D.G.	EMI/HHBE-391
2	HORN HOLDER BALL EYE	FORGED STEEL CL-IV,IS:2004	120 KN	1.373 KG	1	H.D.G.	EMI/AS-316
1	ANCHOR SHACKLE	FORGED STEEL CL-IV,IS:2004	120 KN	1.373 KG	1	H.D.G.	EMI/AS-316
			U.T.S.	WEIGHT	QTY.	FINISH	EMI DRG.NO.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG. NO.:- EMI/400 KV.12/SST/SCAG-Ø31.77.

REV. 1



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH OF CLAMP 20 TO 29 KN.
- 3) BALL & SOCKET SIZE 20 mm IS:2486 (PART-II)
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 5) GENERAL TOLERANCE $\pm 3\%$
- 6) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 7) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.).
- 8) R.I.V. AT 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 9) TOTAL WEIGHTS : 31.00 KGS (APPROX).

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD, GURGAON & UNIQUE STRUCTURES & TOWERS LTD, BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

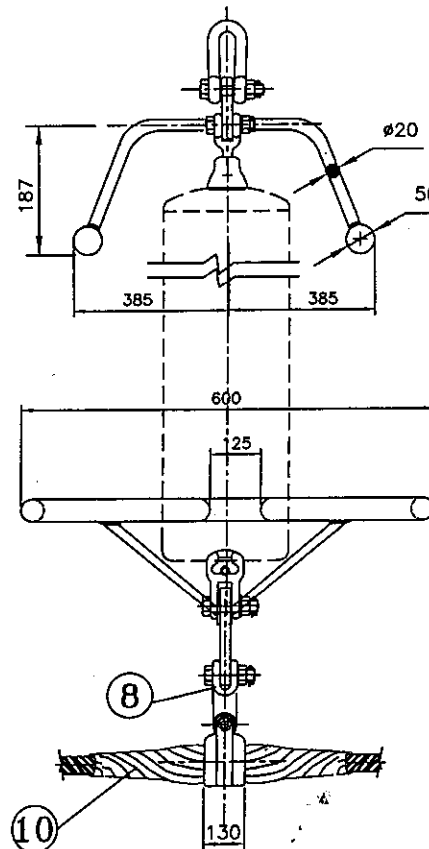
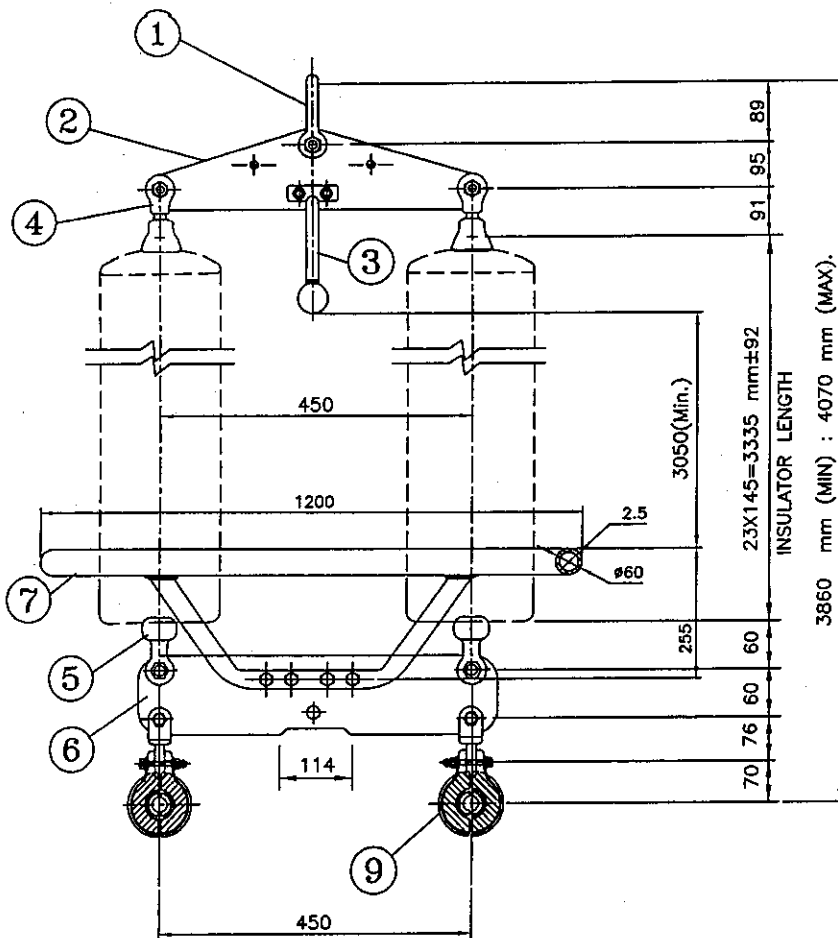
**400 KV. SINGLE I SUSPENSION PILOT INSULATOR
FOR TWIN ACSR MOOSE CONDUCTOR. UTS : 120KN.**

NO.	DATE	DRN.	CHKD.
1	20.07.11	KAPIL	<i>[Signature]</i>

DRG.NO. EMI/400 KV .12/SSPT/SCEN-031.77

REV. 1

No.	DESCRIPTION	MATERIAL	U.T.S.	WEIGHT	QTY.	FINISH	EMI DRG. NO.
8	SUSPENSION CLAMP	ALUMINIUM ALLOY-4600, IS:617	70 KN	2.422 KG	2	---	EMI/SCN-426
7	CLEVIS EYE	FORGED STEEL CL-IV, IS:2004	70 KN	0.844 KG	2	H.D.G.	EMI/CE-429
6	CORONA CONTROL RING	ALUMINIUM ALLOY 63400/6063, IS:733	1.5 KN	2.410 KG	2	---	EMI/CCR-1471
5	YOKE PLATE	MILD STEEL Fe-410, IS:2062	120 KN	12.640 KG	1	H.D.G.	EMI/YP-1360
4	SOCKET CLEVIS	FORGED STEEL CL-IV, IS:2004	120 KN	1.343 KG	1	H.D.G.	EMI/SC-370
3	ARCING HORN	MILD STEEL Fe-410, IS:2062	1.5 KN	3.070 KG	1SET	H.D.G.	EMI/AH-1984
2	HORN HOLDER BALL EYE	FORGED STEEL CL-IV, IS:2004	120 KN	0.690 KG	1	H.D.G.	EMI/HHBE-391
1	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	120 KN	1.613 KG	1	H.D.G.	EMI/AS-341



TECHNICAL DETAILS:

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH OF CLAMP : 20 TO 29 KN
- 3) BALL & SOCKET SIZE 20 mm. IS:2486 (PART-II)
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 5) GENERAL TOLERANCE $\pm 3\%$
- 6) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 7) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.)
- 8) R.I.V. AT 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 9) TOTAL WEIGHT : 51.20 KG.(APPROX.)

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD, GURGAON & UNIQUE STRUCTURES & TOWERS LTD, BHILAI.
C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

10	ARMOUR ROD	H. T. ALUMINIUM ALLOY 65032/6061 IS:733	35 KG/mm ²	8.273 KG	2 SET	---	EMI/SCAG-677 A
9	SUSPENSION CLAMP	ALUMINIUM ALLOY A-6 IS:617	120 KN	0.863 KG	2	---	EMI/CE-429 A
8	CLEVIS EYE	FORGED STEEL CL-IV, IS:2004	120 KN	5.800 KG	1 SET	---	EMI/GR-1156
7	GRADING RING	ALUMINIUM ALLOY 63400/6063 IS:733	1.5 KN	9.500 KG	1	H.D.G.	EMI/YP-4078
6	YOKE PLATE	MILD STEEL Fe-410, IS:2062	240 KN	1.343 KG	2	H.D.G.	EMI/BC-387
5	SOCKET CLEVIS	FORGED STEEL CL-IV, IS:2004	120 KN	0.928 KG	2	H.D.G.	EMI/AH-1986
4	BALL CLEVIS	FORGED STEEL CL-IV IS:2004	120 KN	1.640 KG	1	H.D.G.	EMI/YP-654
3	ARCING HORN	MILD STEEL Fe-410, IS:2062	240 KN	8.300 KG	1	H.D.G.	EMI/AS-345
2	YOKE PLATE	MILD STEEL Fe-410, IS:2062	240 KN	1.500 KG	1	H.D.G.	
1	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	240 KN				
SR.NO	DESCRIPTION	MATERIAL	U.T.S.	WEIGHT	QTY.	FINISH	DRG.No.

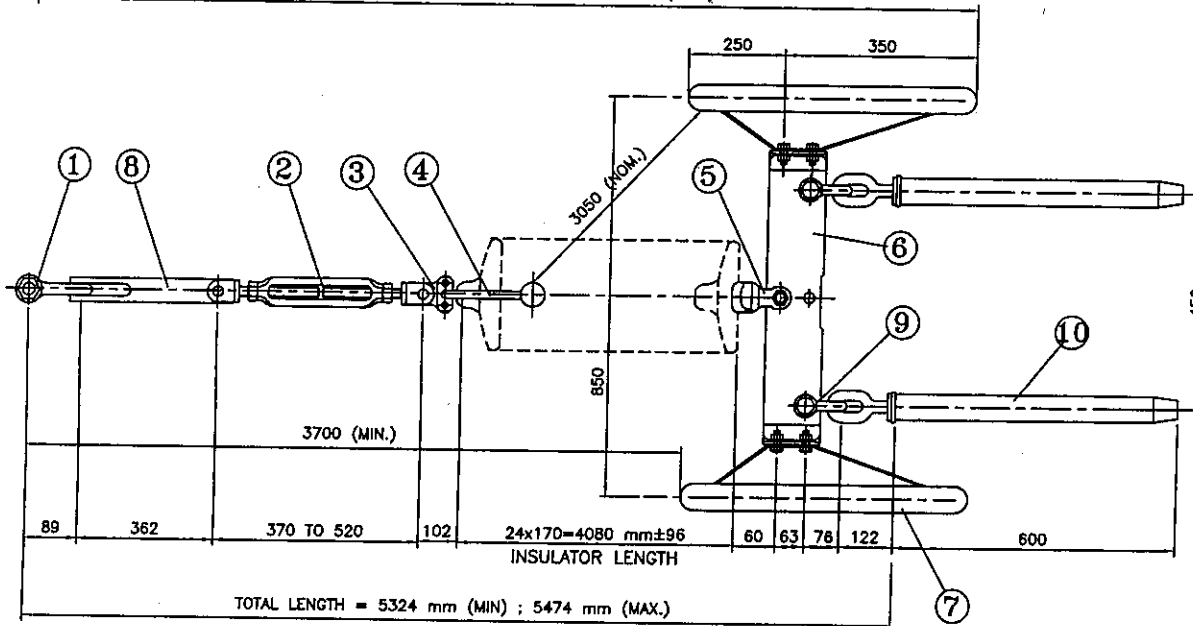
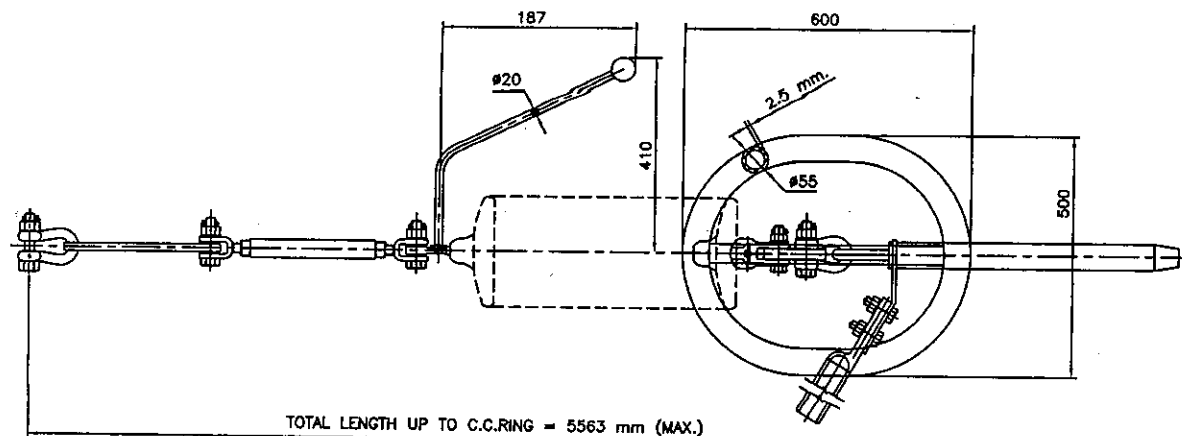
TITLE:-

400 KV. DOUBLE SUSPENSION STRING FOR
"MOOSE" ACSR TWIN CONDUCTOR. UTS : 240 KN.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. EMI/400KV.24/DST/SCAG-031.77

REV. 1



No.	DESCRIPTION	MATERIAL	U.T.S.	WEIGHT	QTY.	FINISH	EMI DRG NO.
10	COMPRESSION DEADEND	ALUMINIUM & STEEL IS:2004,IS:733	153.2KN	6.865 KG	2	----	EMI/DEA-1493
9	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	120 KN	1.163 KG	2	H.D.G	EMI/AS-306
8	EXTENSION LINK	MILD STEEL Fe-410, IS:2062	120 KN	2.400 KG	1	H.D.G	EMI/EL-2800
7	CORONA CONTROL RING	ALUMINIUM ALLOY 63400/6063, IS:733	1.5 KN	2.400 KG	2	----	EMI/CCR-1471
6	YOKE PLATE	MILD STEEL Fe-410, IS:2062	120 KN	12.640 KG	1	H.D.G	EMI/YP-1360
5	SOCKET CLEVIS	FORGED STEEL CL-IV, IS:2004	120 KN	1.343 KG	1	H.D.G	EMI/SC-370
4	ARCING HORN	MILD STEEL Fe-410, IS:2062	1.5 KN	1.500 KG	1	H.D.G	EMI/AH-1987
3	HORN HOLDER BALL EYE	FORGED STEEL CL-IV, IS:2004	120 KN	0.690 KG	1	H.D.G	EMI/HHBE-391
2	TURN BUCKLE	FORGED STEEL CL-IV, IS:2004	120 KN	4.931 KG	1	H.D.G	EMI/TB-407
1	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	120 KN	1.500 KG	1	H.D.G	EMI/AS-345

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH OF CLAMP 153.2 KN (MIN.).
- 3) BALL & SOCKET SIZE 20 mm. IS : 2486 (PART-II)
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 5) GENERAL TOLERANCE $\pm 3\%$
- 6) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 7) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.).
- 8) R.I.V. AT 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 9) TOTAL WEIGHTS :- 46.20 KGS (APPROX).

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:- 400 KV SINGLE TENSION INSULATOR STRING
SUITABLE FOR TWIN ACSR MOOSE CONDUCTOR.

UTS : 120KN.

NO.	DATE	DRN.	CHKD.
1	20.07.11	KAPIL	<i>[Signature]</i>

DRAWN :

KIRAN

CHECKED :

[Signature]

APPROVED :

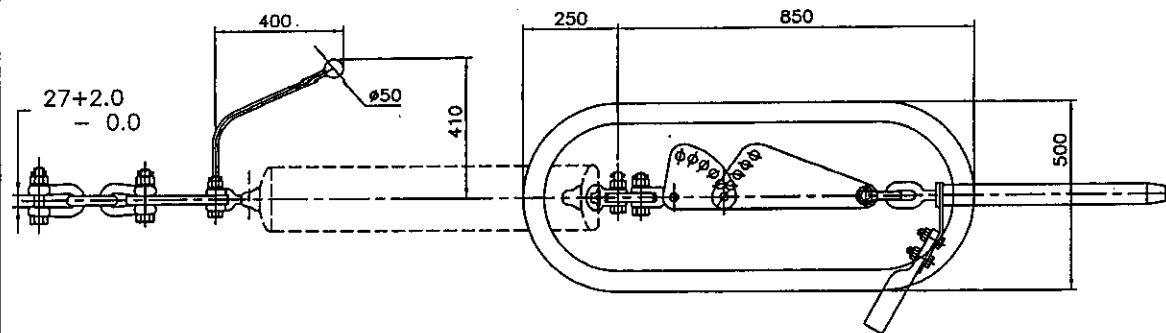
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DATE :

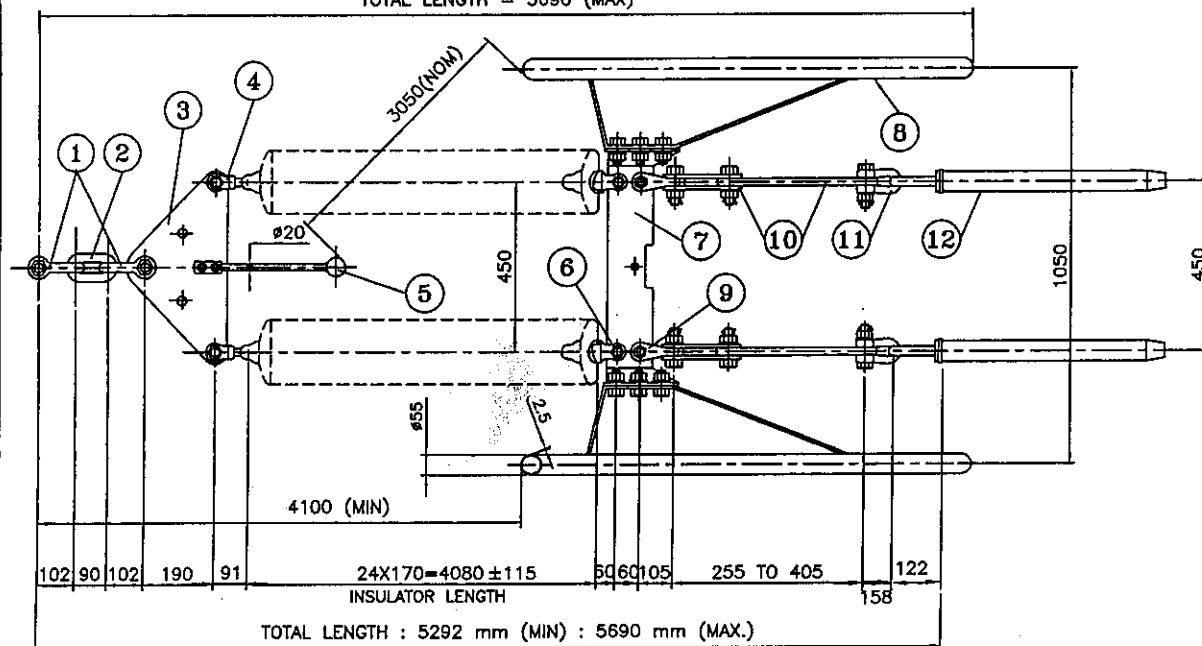
01.06.2011

DRG.NO. : EMI/400 KV.12/STT/DEA-031.77

REV. 1



TOTAL LENGTH = 5690 (MAX)



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH OF CLAMP 153.2 KN (MIN.).
- 3) BALL & SOCKET SIZE 20 mm. IS:2486 (PART-II)
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 5) GENERAL TOLERANCE $\pm 3\%$
- 6) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 7) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.).
- 8) R.I.V. AT 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 9) TOTAL WEIGHTS: 89.60 KGS (APPROX)

APPROVED

[Signature]
 Executive Engineer (Trans.)
 O/o Executive Director (Transmission)
 M.P. Power Transmission Co. Ltd.,
 JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD. JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD, GURGAON & UNIQUE STRUCTURES & TOWERS LTD. BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
 (MUMBAI, INDIA)

TITLE:-

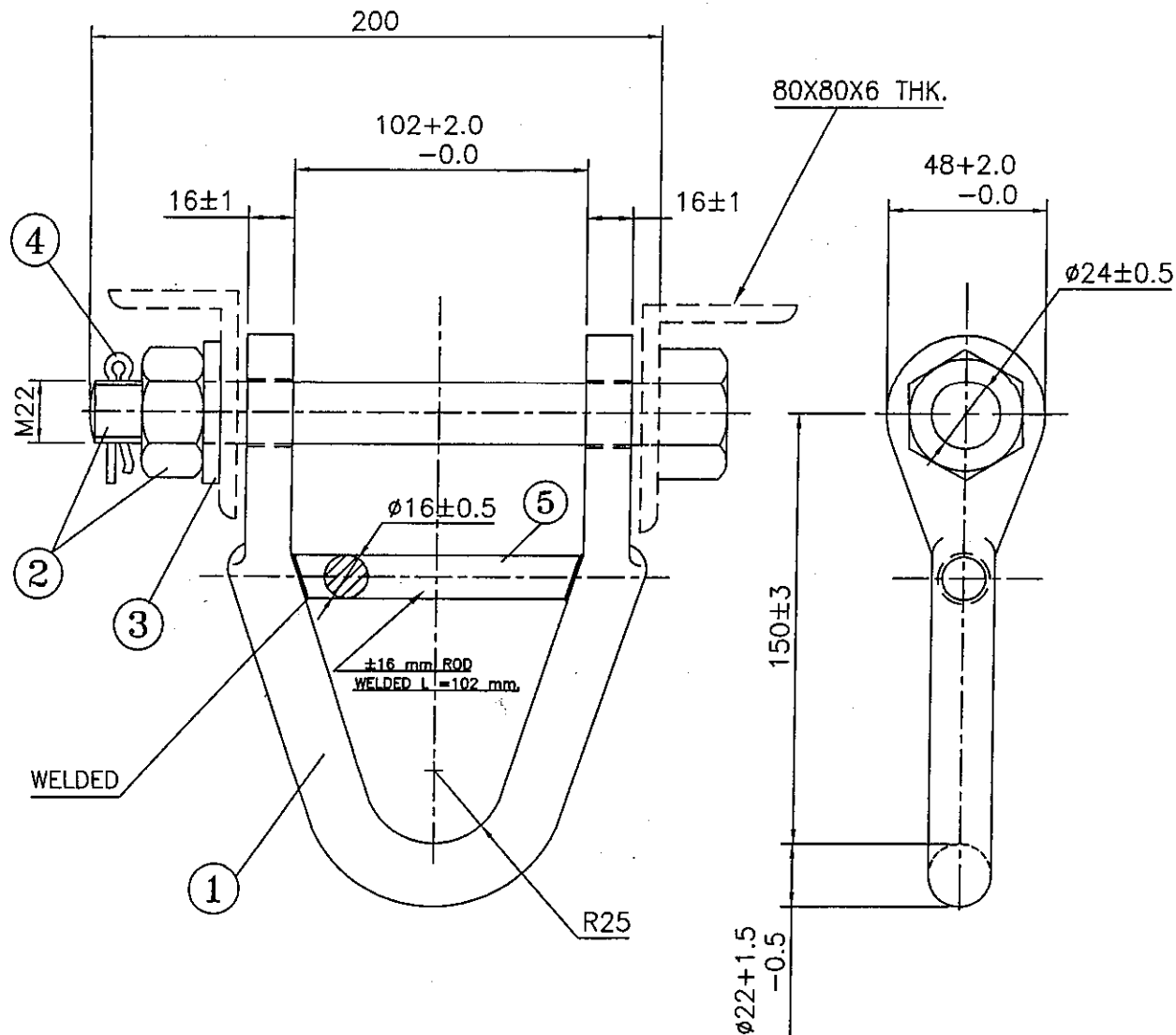
400 KV DOUBLE TENSION INSULATOR STRING
 FOR TWIN ACSR MOOSE CONDUCTOR. UTS : 320 KN.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/400 KV.32/DTT/DEA-031.77

REV. 1

No.	DESCRIPTION	MATERIAL	U.T.S.	WEIGHT	QTY.	SURFACE TREATMENT	EMI DRG NO.
12	COMPRESSION DEADEND	ALUMINIUM ALLOY 19500/1050 IS:733	153.2 KN	6.865 KG	2	---	EMI/DEA-1493
11	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	160 KN	1.704 KG	2	H.D.G.	EMI/AS-341 A
10	SAG ADJUSTABLE PLATE	MILD STEEL Fe-410, IS:2062	160 KN	8.248 KG	2	H.D.G.	EMI/SAP-649
9	CLEVIS EYE	FORGED STEEL CL-IV, IS:2004	160 KN	1.224 KG	2	H.D.G.	EMI/CE-361
8	CORONA CONTROL RING	ALUMINIUM ALLOY 63400/6063, IS:733	1.5 KN	6.542 KG	2	---	EMI/CCR-1325
7	YOKE PLATE	MILD STEEL Fe-410, IS:2062	320 KN	14.310 KG	1	H.D.G.	EMI/YP-472
6	SOCKET CLEVIS	FORGED STEEL CL-IV, IS:2004	160 KN	1.424 KG	2	H.D.G.	EMI/SC-370 A
5	ARCING HORN	MILD STEEL Fe-410, IS:2062	1.5 KN	2.095 KG	1	H.D.G.	EMI/AH-1988
4	BALL CLEVIS	FORGED STEEL CL-IV, IS:2004	160 KN	1.014 KG	2	H.D.G.	EMI/BC-387 A
3	YOKE PLATE	MILD STEEL Fe-410, IS:2062	320 KN	13.280 KG	1	H.D.G.	EMI/YP-656
2	CHAIN LINK	FORGED STEEL CL-IV, IS:2004	320 KN	1.130 KG	1	H.D.G.	EMI/CL-347
1	ANCHOR SHACKLE	FORGED STEEL CL-IV, IS:2004	320 KN	2.400 KG	2	H.D.G.	EMI/AS-323



TECHNICAL DATA

- 1) ALL DIMENSIONS ARE IN mm.
- 2) BR. STRENGTH :11500 KGS.
- 3) GENERAL TOLERANCES $\pm 3\%$
- 4) ALL FERROUS PARTS ARE HOT DIP GALVANISED AS PER MPPTCL SPECIFICATION.
- 5) ALL DIMENSIONS ARE AFTER GALVANISATION EXCEPT DRILLED HOLES.
- 6) MARKING :- EMI YEAR CODE/MONTH CODE/4077

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd.
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

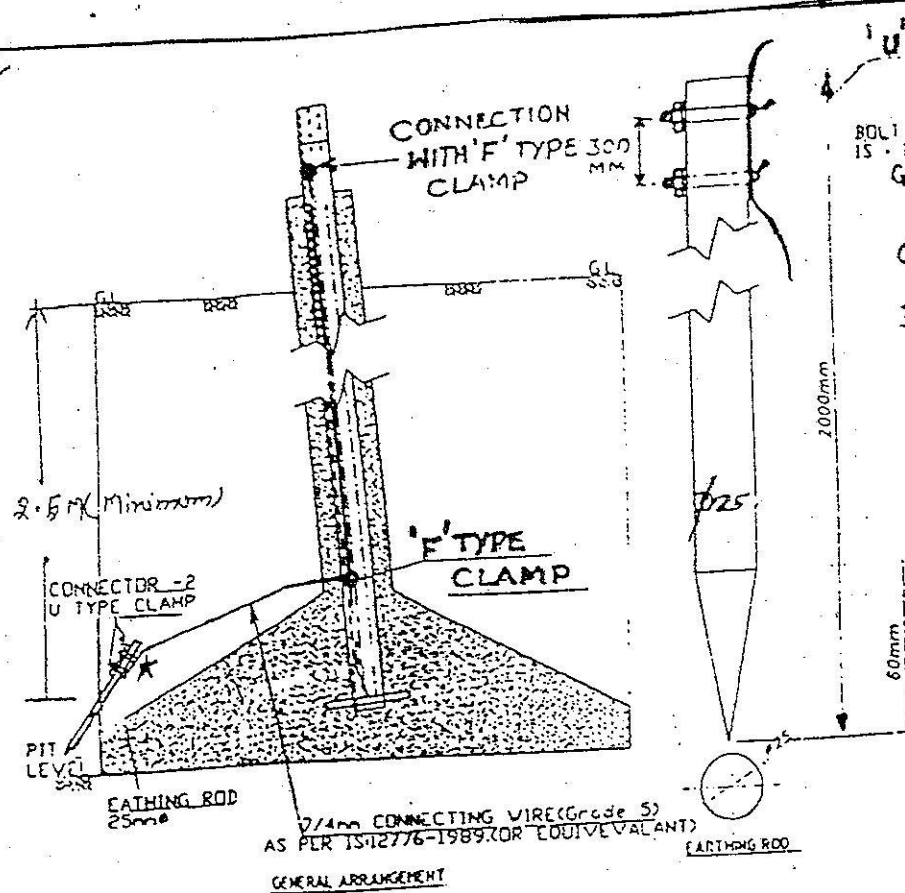
CENTRAL HANGER

NO.	DESCRIPTION	MATERIAL	SURFACE TREATMENT	WEIGHT	QTY.	REF.NO.
5	ROD	MILD STEEL Fe-410, IS:2062	H. D. G.	0.099 KG	1	5010
4	SPLIT PIN	STAINLESS STEEL AISI-304	----	0.006 KG	1	1294
3	PLAIN WASHER	MILD STEEL Fe-410, IS:2062 (50X50X6)	H. D. G.	0.018 KG	1	1282
2	BOLT & NUT (M22X200X45)	GALVD.STEEL GR.5.6 IS:6639,1363 PART-III & 1367 PART-XIII	H. D. G.	0.726 KG	1,1	5014
1	CENTRAL HANGER	FORGED STEEL CL-IV; IS:2004	H. D. G.	1.200 KG	1	4077

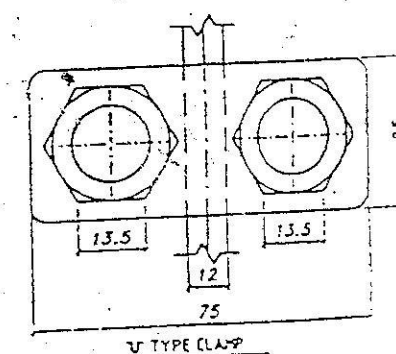
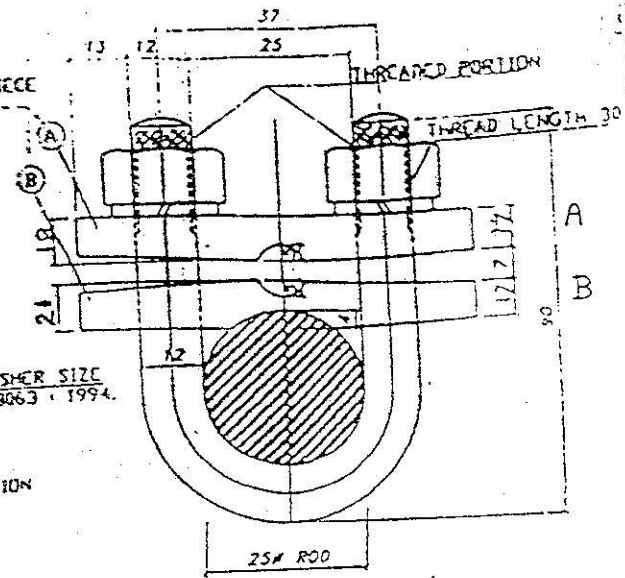
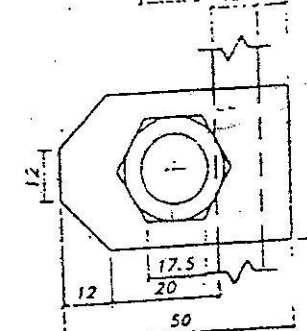
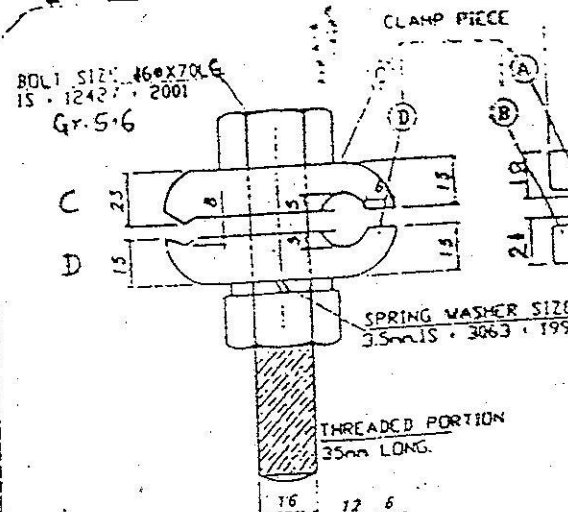
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CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	✓
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO.:EMI/CH-4077

REV. 1



U TYPE CLAMP



BILL OF MATERIAL FOR ONE SET

DESCRIPTION	QTY
25mm DIA EARTHING ROD 2000mm LG	1
U TYPE CLAMP (Part A)	2
U TYPE CLAMP (Part B)	2
F TYPE CLAMP (Part C)	2
F TYPE CLAMP (Part D)	2
U BOLT WITH NUTS & SPRING WASHERS	2
16x70mm BOLT WITH NUT & SPRING WASHER (Gr. 5.6)	2
7/4 MM CONNECTING WIRE (grade 5) 5 Meter	1

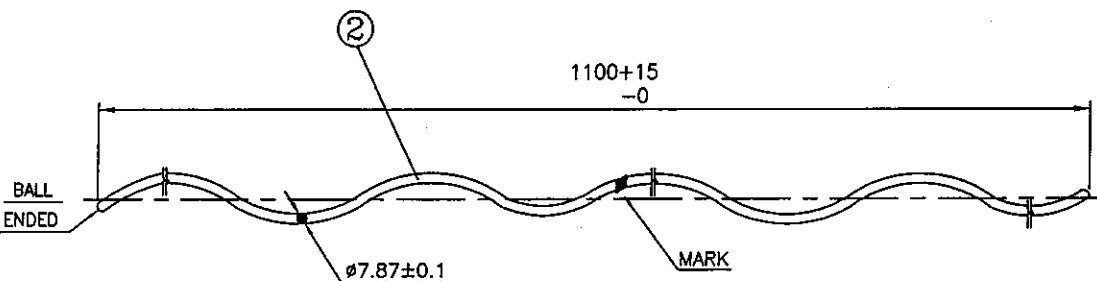
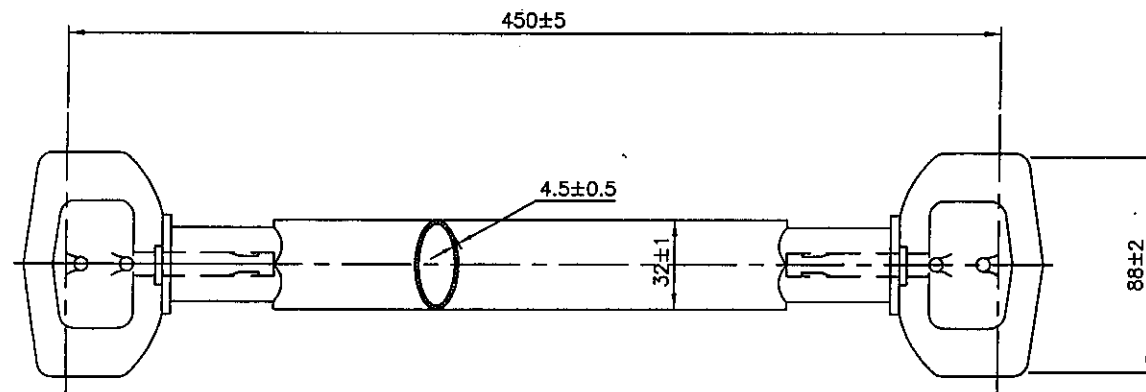
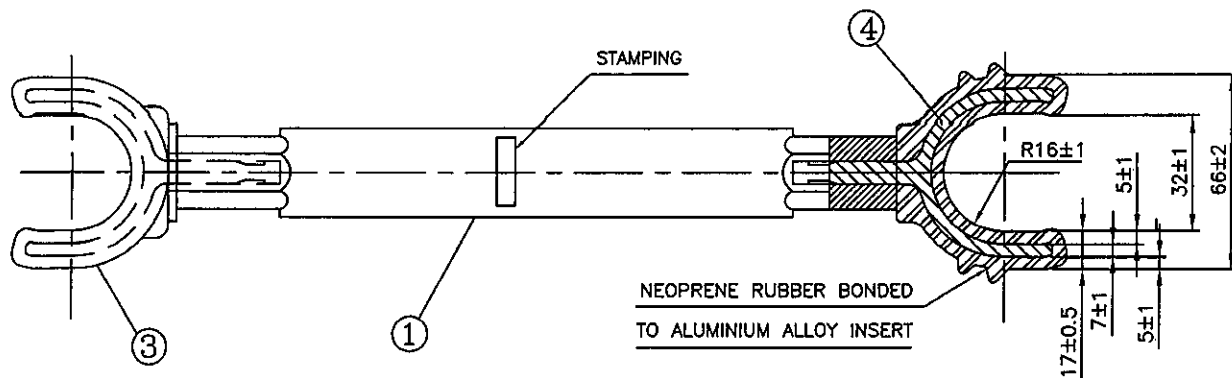
* M.S. ROD MAY BE DRIVEN MINIMUM 0.5M IN ANY SIDE OF FOUR WALLS

NOTE: REQUIREMENT OF EARTHING SETS-4 SETS/TOWER

1	ALL DIMENSION IN MM
2	HOT DIP GALVANISED AS PER IS-1367(P-13)
3	MATERIAL: MILD STEEL (IS 2062, Gr. A)
4	SPRING WASHER AS PER IS 3063 & SHALL BE ELECTRO GALVANISED AS PER IS 1573, SERVICE CONDITION 4.

CHIEF ENGINEER (TRANS)
M. P. P.T.C.L. JABALPUR

DETAILS OF EARTHING ARRANGEMENT	
APPROVED BY	N.T.S.
TRACED	
DRAWING No.	FT/11/44
DATED	21.12.07



No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.
4	ALUMINIUM INSERT	ALUMINIUM ALLOY (6061) IS : 733	----	0.180 KG	2	1431
3	CLAMP GRIP	ALUMINIUM ALLOY (6061) RUBBERISED	----	0.130 KG	2	1432
2	RETAINING ROD (8 NOS.)	ALUMINIUM ALLOY (6061) IS:733	----	1.210 KG	1 SET	1433
1	SPACING TUBE	ALUMINIUM ALLOY (6061) IS:733	----	0.410 KG	1	1430

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN MM.
- 2) MIN.CORONA EXTINCTION VOLTAGE (DRY) : 320 KV (RMS.)
- 3) RIV AT 266 KV. BELOW 500 MICROVOLTS.
- 4) FATIGUE STRENGTH:
 - A) LONGITUDINAL 1000000 CYCLE
 - B) VERTICAL 10000000 CYCLE
 - C) SUBSPAN 1000000 CYCLE
- 5) CLAMP SLIP STRENGTH : 2.5 KN TO 5 KN.
- 6) MIN. TENSILE STRENGTH OF RETAINING ROD = 35 Kg/mm²
- 7) MARKING :- EMI 1430 31.77 mm

APPROVED

[Signature]
 Executive Engineer (Trans.)
 O/o Executive Director (Transmission)
 M.P. Power Transmission Co. Ltd.
 JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.1 (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
 (MUMBAI, INDIA)

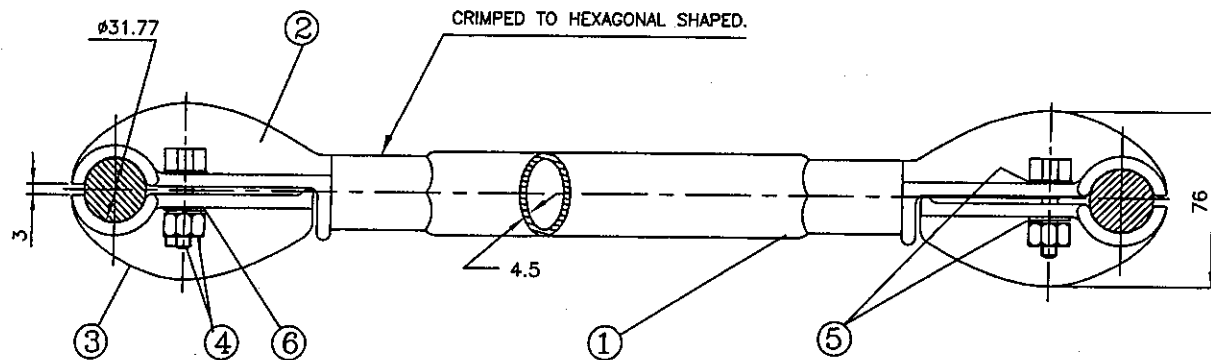
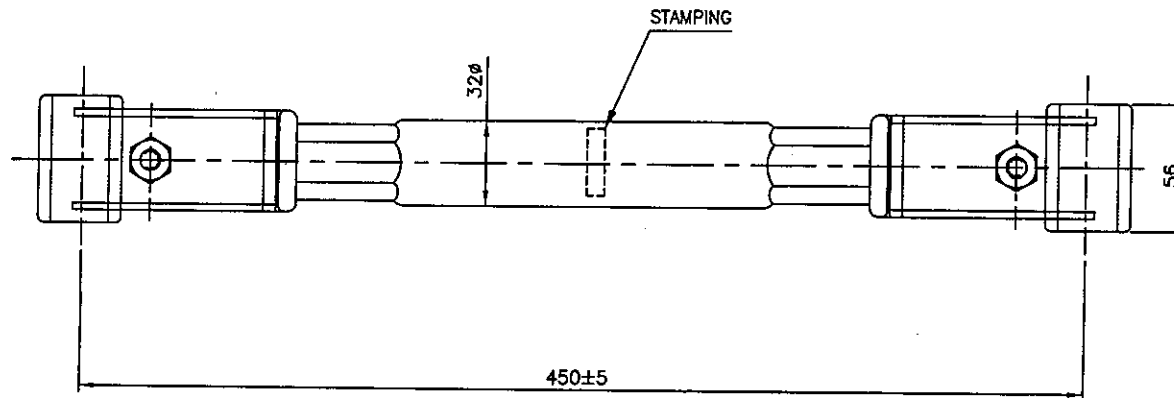
TITLE:-

ARMOUR GRIP TYPE SPACER FOR TWIN ACSR MOOSE CONDUCTOR

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/ASP-1430

REV. 1



No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.
6	SPRING WASHER (M12)	SPRING STEEL IS:3063 & IS : 4072	E.G.	0.004 KG	2	1291
5	PLAIN WASHER (M12)	MILD STEEL Fe-410, IS:2062	H.D.G.	0.006 KG	4	1279
4	BOLT, NUT (M12X50)	MILD STEEL, GR.8.8 IS:8839,1383 PART-II & 1367 PART-III	H.D.G.	0.075 KG	2,2	1202
3	PACKING PIECE	ALUMINIUM ALLOY 4600, IS:617	----	0.170 KG	2	1437
2	CLAMP	ALUMINIUM ALLOY 4600, IS:617	----	0.230 KG	2	1436
1	SPACING TUBE	ALUMINIUM ALLOY 65032/6061,IS:733	----	0.283 KG	1	1435

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm
- 2) CLAMP SLIP STRENGTH : 2.5 KN
- 3) MIN.CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.)
- 4) RIV AT 1 MHZ AND PHASE TO EARTH VOLTAGE OF 266 KV (DRY) :
BELOW 500 MICROVOLTS
- 5) COMPRESSIVE LOAD : 14 KN
- 6) TENSION LOAD : 7 KN
- 7) GENERAL TOLERANCE : ±3%
- 8) FERROUS PARTS H.D.G. & SPRING WASHERS E.G. AS PER MPPTCL SPEC.
- 9) MAGNETIC POWER LOSS NOT MORE THAN 1 WATT AT 600 AMPS.50 HZ.
ALTERNATING CURRENT PER SUB-CONDUCTOR
- 10) TIGHTENING TORQUE : 4 KGM.
- 11) MARKING :- EMI 1435 31.77mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd.
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD. JABALPUR
- B) CONTRACTOR : JV OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) &
04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE
(PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

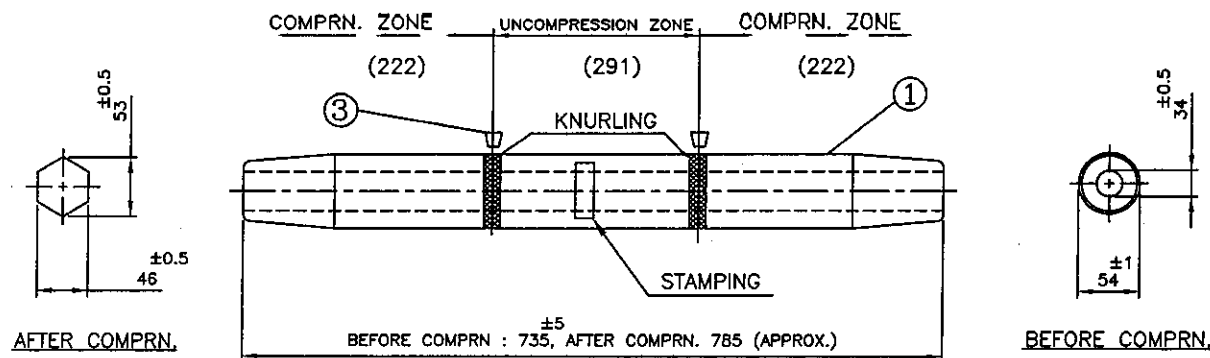
TITLE:-

RIGID SPACER FOR TWIN ACSR MOOSE CONDUCTOR.

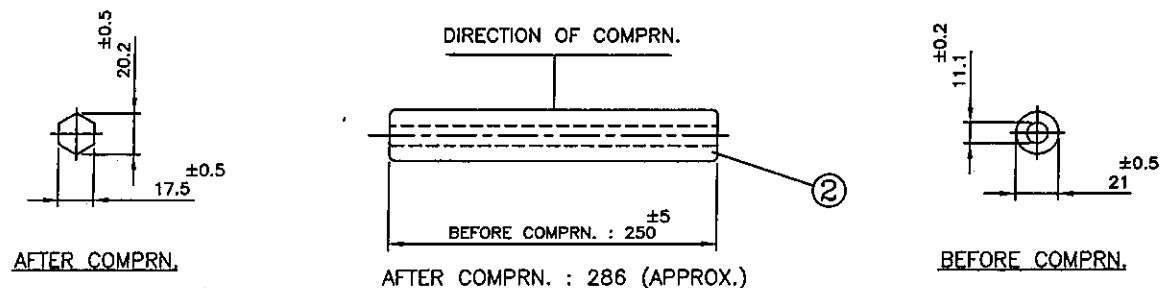
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1	20.07.11	KAPIL	<i>[Signature]</i>

DRG.NO. : EMI/RSP-1435

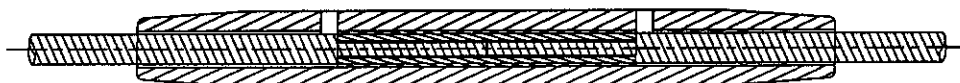
REV. 1



ALUMINIUM SLEEVE



STEEL TUBE



ASSEMBLY

No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.
3	PLUG	ALUMINIUM ALLOY 19500/1050 IS:733	----	0.002 KG	2	1348
2	STEEL TUBE	MILD STEEL Fe-410 IS:2062	H.D.G.	0.480 KG	1	1419
1	ALUMINIUM, SLEEVE	ALUMINIUM ALLOY 19500/1050 IS:733	----	2.600 KG	1	1418

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH (MIN.) : 153.2 KN.
- 3) COMPRESSION PRESSURE-100 TON.
- 4) RESISTIVITY LESS THAN 75% OF RESISTANCE OF EQUIVALENT LENGTH OF ACSR MOOSE CONDUCTOR.
- 5) MIDSPAN COMPRN.JOINT CONFORM TO IS:2121 (II)-1981
- 6) MIN.CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.)
- 7) RIV AT 1 MHZ AT PHASE TO EARTH VOLTAGE OF 266 KV (DRY) : BELOW 500 MICROVOLTS.
- 8) ALL FERROUS PARTS ARE HOT DIP GALVANISED AS PER MPPTCL SPECIFICATION.
- 9) BRINELL HARDNESS OF STEEL SLEEVE- 100 TO 200.
- 10) DIE CAT. NO.:FOR ALUMINIUM-DA-12, FOR STEEL-DS-11.
- 11) MARKING :- EMI 1418 31.77mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JV OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

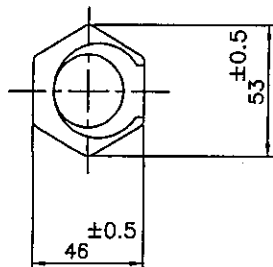
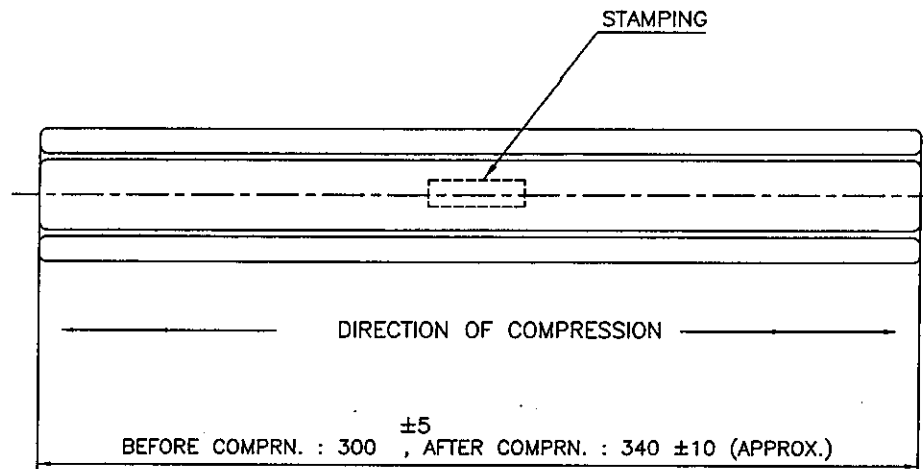
TITLE:-

MID SPAN COMPRESSION JOINT FOR ACSR MOOSE CONDUCTOR

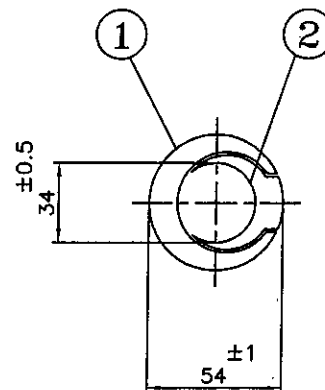
DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/MCJ-1418

REV. 1



AFTER COMPRN.



BEFORE COMPRN.

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) COMPRESSION PRESSURE-- 100 TON.
- 3) RESISTIVITY LESS THAN 75% OF RESISTANCE OF EQUIVALENT LENGTH OF CONDUCTOR.
- 4) REPAIR SLEEVE CONFORM TO IS:2121 (II) 1981
- 5) MIN.CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.)
- 6) RIV AT 1 MHZ AT PHASE TO EARTH VOLTAGE OF 266 KV (DRY) BELOW 500 MICROVOLTS
- 7) DIE CAT. NO.- DA-12.
- 8) MARKING :- EMI 1658 31.77 mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVf OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD,BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

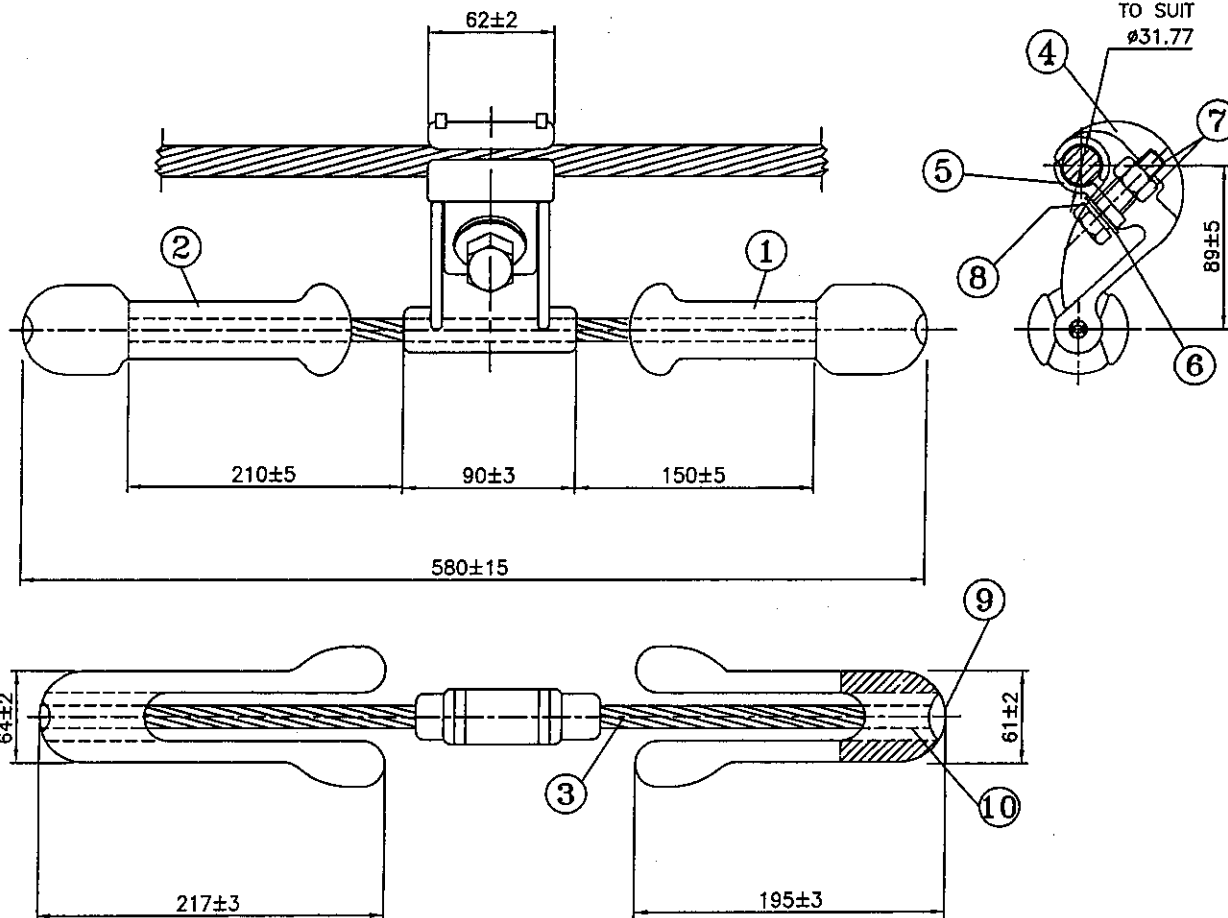
REPAIR SLEEVE FOR ACSR MOOSE CONDUCTOR.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

2	KEEPER PIECE	ALUMINIUM ALLOY 19500/1050 IS:733	----	0.400 KG	1	1659
1	BODY	ALUMINIUM ALLOY 19500/1050 IS:733	----	0.700 KG	1	1658
No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.

DRG.NO. : EMI/RS-1658

REV. 1



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) GENERAL TOLERANCE $\pm 3\%$
- 3) U.T.S. OF MESSENGER CABLE 135 KG./mm² (Min.)
- 4) ALL FERROUS PARTS ARE H.D.G. & SPRING WASHER E.G. AS PER MPPTCL SPECIFICATION.
- 5) INSTALLATION TORQUE: 4 KG. mtr.
- 6) V.D. CONFIRM TO IS:9708 (1993)
- 7) MASS PULL OFF STRENGTH : 5 KN.(MIN)
- 8) RESONANCE FREQUENCIES (Hz) :-1) F1=8±1 2) F2=12±1 F3=18±2 4) F4=30±2
- 9) NO OF STRANDS IN STRANDED CABLE 19/2.59 mm
- 10) CLAMP SLIPPING STRENGTH:- (a) BEFORE FATIGUE : 2.5 KN. (b) AFTER FATIGUE : 2 KN.
- 11) LAY RATIO OF MESSENGER CABLE- 9 mm TO 11 mm.
- 12) MIN CORONA EXTINCTION VOLTAGE (DRY) 320 KV (R.M.S.).
- 13) R.I.V. AT 1 MHZ & PHASE TO EARTH VOLTAGE OF 266 KV (R.M.S.) (DRY) BELOW 500 MICROVOLTS.
- 14) MAGNETIC POWER LOSS FOR 600 A. 50 HZ NOT MORE THAN 1 W
- 15) MARKING :- EMI 1422 31.77mm

APPROVED

Executive Engineer (Trans.)

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD., JABALPUR
 B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD., JABALPUR
 C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
 D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
 E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

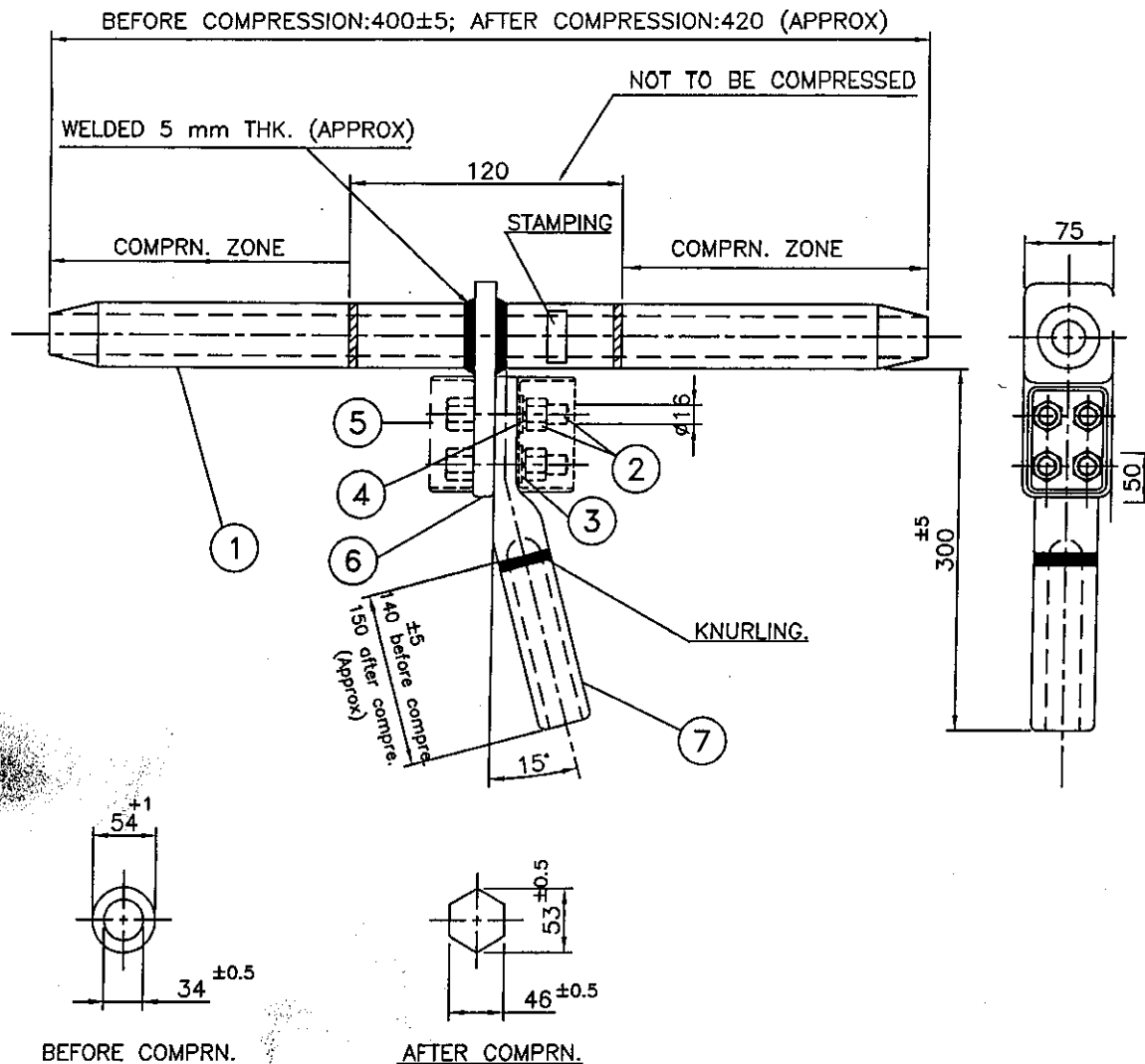
4R VIBRATION DAMPER FOR ACSR MOOSE CONDUCTOR.

10	FIXING TAPER SLEEVE	ALUMINIUM ALLOY 4600, IS:617	----	0.025 KG	2	1427
9	SEALING PLUG	PURE ALUMINIUM 19500/1050 IS:733	----	0.010 KG	2	1428
8	SPRING WASHER	SPRING STEEL IS:4072 & IS:3063	E. G.	0.004 KG	1	1291
7	BOLT & NUT (M12X50)	MILD STEEL, GR.5.6 IS:6839,1363 PART-III & 1367 PART-XII	H. D. G.	0.075 KG	1,1	1202
6	PLAIN WASHER (3 mm THK.)	MILD STEEL Fe-410,IS:2062	H. D. G.	0.006 KG	1	1279
5	COVER HALF CLAMP	ALUMINIUM EXT 6061-T6, IS:733	----	0.130 KG	1	1426
4	HOOK HALF CLAMP	ALUMINIUM ALLOY 4600, IS:617	----	0.380 KG	1	1425
3	MESSENGER CABLE	HIGH TENSILE STEEL IS:4826	H. D. G.	0.475 KG	1	1424
2	DAMPER WEIGHT	CAST IRON IS:210	H. D. G.	3.150 KG	1	1423
1	DAMPER WEIGHT	CAST IRON IS:210	H. D. G.	2.300 KG	1	1422
No.	DESCRIPTION	MATERIAL	SURFACE TREATMENT	WEIGHT	QTY.	REF.NO.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.08.2011				

DRG.NO. : EMI/VD-1422

REV. 1



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) R.I.V. AT 1 MHZ FOR PHASE TO EARTH VOLTAGE OF 266 KV RMS (DRY) BELOW 500 MICROVOLTS.
- 3) CORONA EXTINCTION VOLTAGE MIN : 320 KV(RMS).(DRY).
- 4) COMPRESSION PRESSURE- 100 TON
- 5) GENERAL TOLERANCE $\pm 3\%$.
- 6) ALL FERROUS PARTS ARE HOT DIP GALVANISED AS PER MPPTCL SPECIFICATION.
- 7) AXIAL TENSILE LOAD 30 KN. OF WELDED PORTION.(MIN)
- 8) ALL FERROUS PARTS ARE H.D.G. & SPRING WASHER E.G. AS PER MPPTCL SPECIFICATION.
- 9) DIE CAT. NO.:FOR ALUMINIUM-DA-12.
- 10) MARKING :- EMI 1438 31.77mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd.
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF AZZ MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

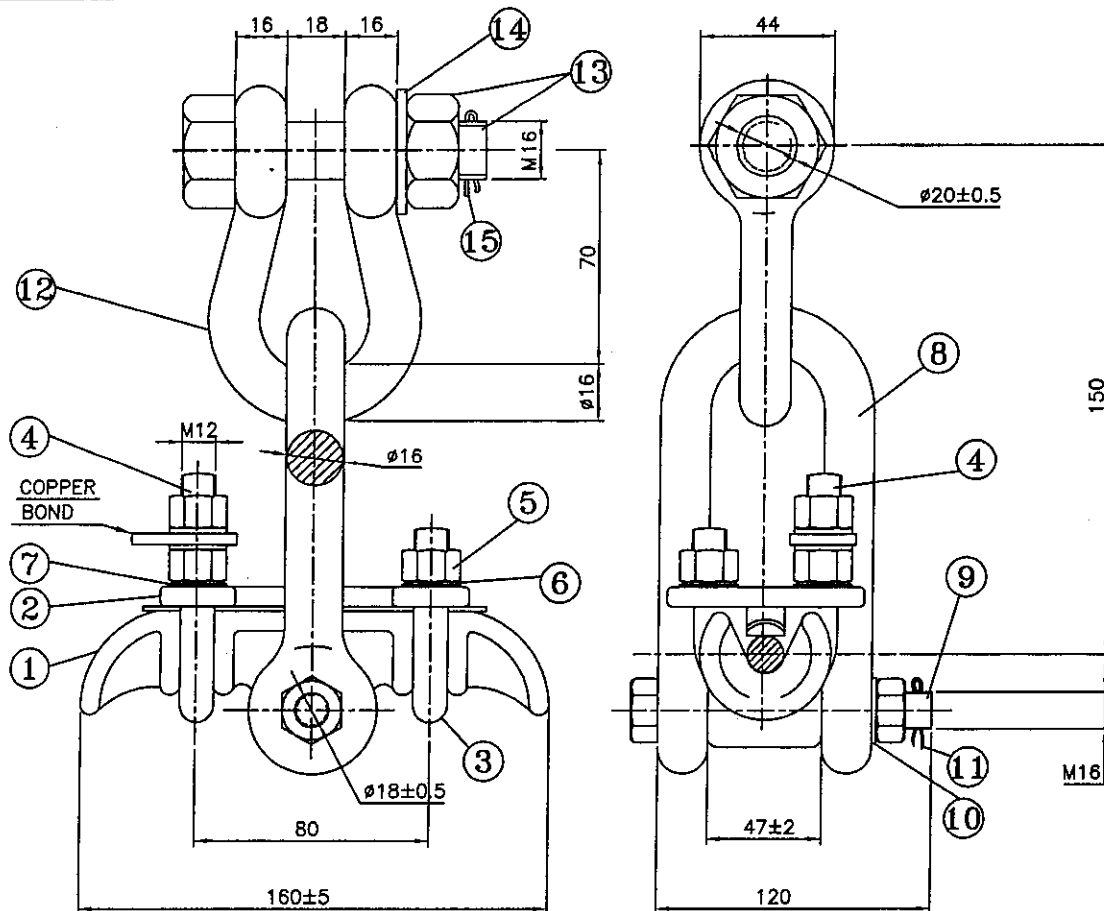
T-CONNECTOR SUITABLE FOR ACSR MOOSE CONDUCTOR

7	JUMPER TUBE.	ALUMINIUM ALLOY 19500/1050 IS:733	----	1.200 KG	1	1439
6	CLAMP PATTI	ALUMINIUM ALLOY 19500/1050 IS:733	----	0.510 KG	1	1330
5	JUMPER BOLT COVER	ALUMINIUM ALLOY A-6/4600 IS:617	----	0.300 KG	2	1440
4	SPRING WASHER (M16)	SPRING STEEL. IS:4072, IS:3063	E. G.	0.010 KG	4	1292
3	PLAIN WASHER (M16)	MILD STEEL Fe-410, IS:2082	H. D. G.	0.010 KG	4	1280
2	BOLT & NUT.(M16x70)	MILD STEEL, GR.8.8 IS:8839, 1303 PART-II & 1357 PART-XII	H. D. G.	0.172 KG	4,4	1214
1	T-CONNECTOR TUBE	ALUMINIUM ALLOY 19500/1050 IS:733	----	1.500 KG	1	1438
No.	DESCRIPTION	MATERIAL	SURFACE TREATMENT	WEIGHT	QTY.	REF.NO.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/T-CON-1438

REV. 1



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) GENERAL TOLERANCES $\pm 3\%$
- 3) BR. STRENGTH NOT LESS THAN : 25 KN.
- 4) SLIPPING STRENGTH : 12 TO 17 KN.
- 5) BOLT TIGHTENING TORQUE : 5 KG.M.
- 6) ALL FERROUS PARTS ARE H.D.G. & SPRING WASHERS E.G. AS PER MPPTCL SPECIFICATION.
- 7) ALL DIMENSIONS ARE AFTER GALVANIZATION EXCEPT DRILLED HOLES.
- 8) MARKING :- EMI 486 10.98mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD, GURGAON & UNIQUE STRUCTURES & TOWERS LTD, BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

15	SPLIT PIN	STAINLESS STEEL AISI-304	----	0.006 KG	1	1294
14	PLAIN WASHER (M16, 3.15mm THK.)	MILD STEEL Fe-410 IS:2062	H. D. G.	0.010 KG	1	1280
13	BOLT & NUT (M16X90)	MILD STEEL, GR.5.8 IS:8839, 1363 PART-III & 1367 PART-XIII	H. D. G.	0.204 KG	1,1	1221
12	ANCHOR SHACKLE	FORGED STEEL CL-IV; IS:2004	H. D. G.	0.500 KG	1	301
11	SPLIT PIN	STAINLESS STEEL AISI-304	----	0.006 KG	1	1294
10	PLAIN WASHER (M16, 3.15mm THK.)	MILD STEEL Fe-410, IS:2062	H. D. G.	0.010 KG	1	1280
9	BOLT & NUT (M16X120)	MILD STEEL, GR.5.8 IS:8839, 1363 PART-III & 1367 PART-XIII	H. D. G.	0.252 KG	1,1	1224
8	BOW SHACKLE	FORGED STEEL CL-IV; IS:2004	H. D. G.	0.615 KG	1	412
7	SPRING WASHER (M12, 2.5mm THK.)	SPRING STEEL IS:4072 & IS:3063	E. G.	0.004 KG	4	1291
6	PLAIN WASHER (M12, 2.5mm THK.)	MILD STEEL Fe-410, IS:2062	H. D. G.	0.006 KG	6	1279
5	NUT (M12)	MILD STEEL Fe-410, IS:2062	H. D. G.	0.015 KG	5	1416
4	J BOLT	MILD STEEL Fe-410, IS:2062	H. D. G.	0.130 KG	1	1415
3	U BOLT	MILD STEEL Fe-410, IS:2062	H. D. G.	0.100 KG	1	1485
2	KEEPER PIECE	MALLEABLE IRON BM:350, IS:14329/S.G.I. IS:1865	H. D. G.	0.505 KG	1	1405
1	CLAMP BODY	MALLEABLE IRON BM:350, IS:14329/S.G.I. IS:1865	H. D. G.	0.705 KG	1	486
No.	DESCRIPTION	MATERIAL	SURFACE TREATMENT	WEIGHT	QTY.	REF. NO.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

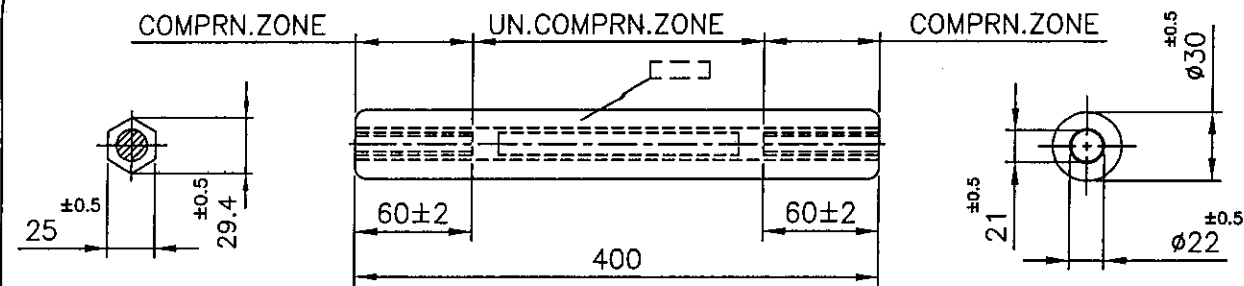
TITLE:-

SUSPENSION CLAMP ASSEMBLY FOR
7/3.66 mm EARTHWIRE

DRAWN :	NO.	DATE	DRN.	CHKD.
CHECKED :	1	20.07.11	KAPIL	
APPROVED :				
DATE :		01.06.2011		

DRG.NO. : EMI/EWSCA-486

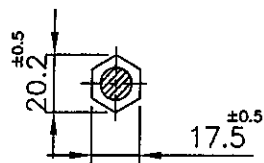
REV. 1



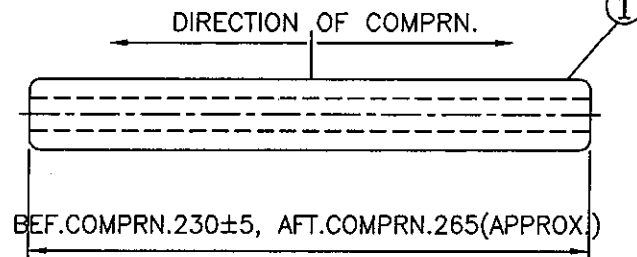
AFTER COMPRN.

ASSEMBLY

BEFORE COMPRN.

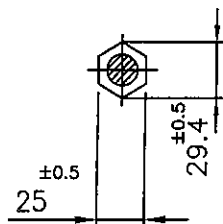


AFTER COMPRN.



STEEL TUBE

BEFORE COMPRN.



AFTER COMPRN.

ALUMINIUM TUBE

BEFORE COMPRN.

No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.
3	ALUMINIUM FILLER SLEEVE	ALU.ALLOY 19500/1050 IS:733	----	0.040 KG	2	1445
2	ALUMINIUM SLEEVE	ALU.ALLOY 19500/1050 IS:733	----	0.352 KG	1	1503
1	STEEL SLEEVE	MILD STEEL Fe-410 IS:2062	H. D. G.	0.440 KG	1	1443

TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) SLIPPING STRENGTH : 65 KN.(Min.)
- 3) COMPRESSION PRESSURE- 100 TON.
- 4) RESISTIVITY LESS THAN 75% OF RESISTANCE OF EQUIVALENT LENGTH OF EARTHWIRE.
- 5) HARDNESS : 120(BHN) TO 200 (BHN).
- 6) MIDSPAN COMPRN.JOINT CONFORM TO IS:2121 (II)-1981
- 7) ALL FERROUS PARTS ARE HOT DIP GALVANIZED AS PER MPPTCL SPECIFICATION.
- 8) DIE CAT. NO. FOR AL.- DA-7.FOR STEEL-EWDS-9.03.
- 9) MARKING :- EMI 1443 10.98mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd.
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD,BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:

EMI

EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

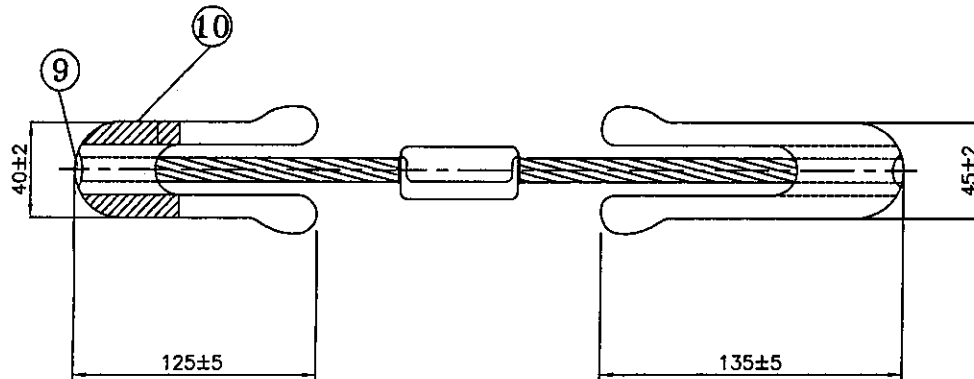
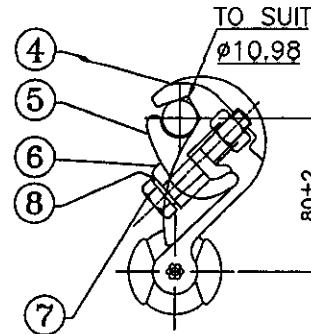
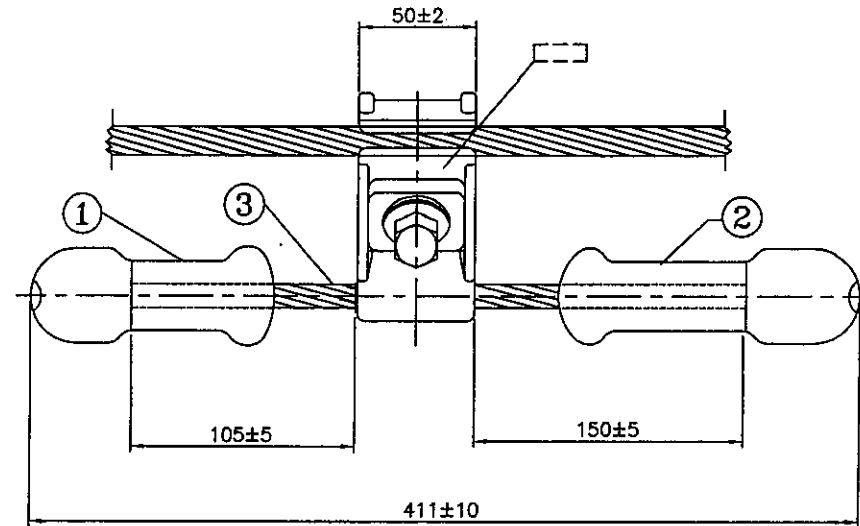
TITLE:-

MID SPAN COMPRESSION JOINT FOR 7/3.66 mm EARTHWIRE

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/EWMCJ-1443

REV. 1



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) GENERAL TOLERANCES $\pm 3\%$
- 3) CLAMP SLIPPING STRENGTH:- (a) BEFORE FATIGUE: 2.5 KN.
(b) AFTER FATIGUE: 2 KN.
- 4) U.T.S. OF MESSENGER CABLE 135 KG./mm² (Min.)
- 5) MASS PULL OFF STRENGTH: 2.5 KN.
- 6) RESONANCE FREQUENCIES(Hz): F₁=12 $\pm$ 1; F₂=18.5 $\pm$ 2
F₃=30 $\pm$ 2 F₄=46 $\pm$ 2.
- 7) LAY RATIO OF STRANDED MESSENGER CABLE: 9 TO 11
- 8) NO OF STRANDS IN STRANDED CABLE 19. DIA.-2 mm.
- 9) ALL FERROUS PARTS HOT DIP GALVANIZED AND SPRING WASHER EG
AS PER MPPTCL SPECIFICATION.
- 10) INSTALLATION TORQUE- 4 KG-M.
- 11) MARKING :- EMI 1397 10.98mm

APPROVED

[Signature]
Executive Engineer (Trans.)
O/o Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON
& UNIQUE STRUCTURES & TOWERS LTD,BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) &
04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE
(PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED
KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

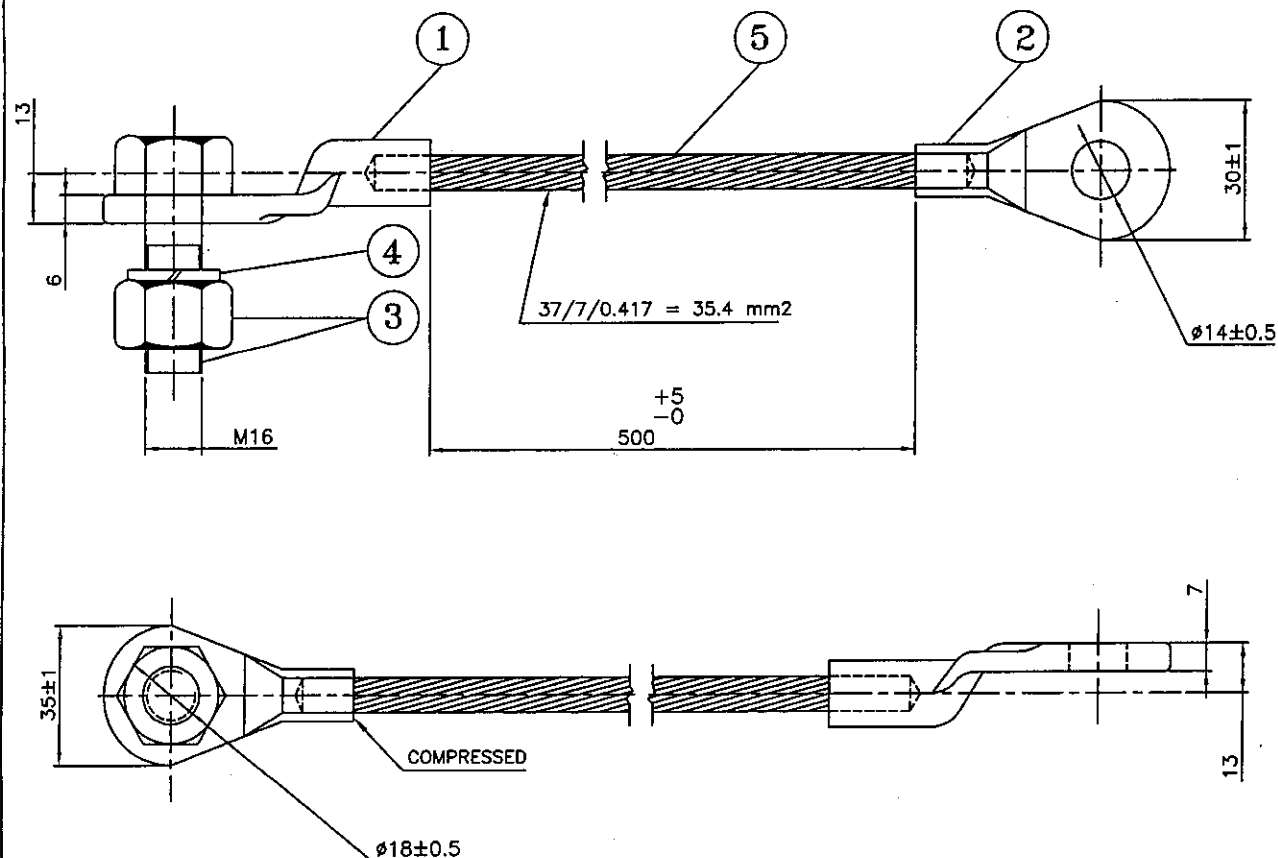
VIBRATION DAMPER FOR 7/3.66 mm EARTHWIRE.

DRAWN :	KIRAN	NO.	DATE	DRN.	CHKD.
CHECKED :	<i>[Signature]</i>	1	20.07.11	KAPIL	<i>[Signature]</i>
APPROVED :	<i>[Signature]</i>				
DATE :	01.06.2011				

DRG.NO. : EMI/EWVD-1397

REV. 1

No.	DESCRIPTION	MATERIAL	SURFACE TREATMENT	WEIGHT	QTY.	REF.NO.
10	FIXING TAPER SLEEVE	ALUMINIUM ALLOY 4600 IS:617	----	0.015 KG	2	1402
9	SEALING PLUG	PURE ALUMINIUM 19500/1050 IS:733	----	0.010 KG	2	1401
8	SPRING WASHER	SPRING STEEL IS:4072 & IS:3063	E. G.	0.004 KG	1	1291
7	BOLT & NUT(M12X65)	MILD STEEL, GR.5.8 IS:6639,1363 PART-III & 1367 PART-XIII	H. D. G.	0.088 KG	1	1205
6	SPECIAL WASHER	ALUMINIUM ALLOY 4600, IS:617	----	0.015 KG	1	1403
5	COVER HALF CLAMP	ALUMINIUM ALLOY 4600, IS:617	----	0.050 KG	1	1400
4	HOOK HALF CLAMP	ALUMINIUM ALLOY 4600, IS:617	----	0.250 KG	1	1399
3	MESSENGER CABLE (19/2mm)	HIGH TENSILE STEEL	H. D. G.	0.180 KG	1	1398
2	DAMPER WEIGHT	CAST IRON IS:210	H. D. G.	0.950 KG	1	1396
1	DAMPER WEIGHT	CAST IRON IS:210	H. D. G.	0.700 KG	1	1397



TECHNICAL DETAILS:-

- 1) ALL DIMENSIONS ARE IN mm.
- 2) GENERAL TOLERANCES $\pm 3\%$.
- 3) SLIPPING STRENGTH : 3 KN.
- 4) RESISTANCE : 0.001429 Ω
- 5) FERROUS PARTS HOT DIP GALVANIZED & SPRING WASHERS ELECTRO GALVANISED AS PER MPPTCL SPECIFICATION.
- 6) MARKING :- EMI 1446 10.98mm

APPROVED

[Signature]
Executive Engineer (Trans.)
o/e Executive Director (Transmission)
M.P. Power Transmission Co. Ltd,
JABALPUR

- A) PURCHASER: MADHYA PRADESH POWER TRANSMISSION CO. LTD, JABALPUR.
- B) CONTRACTOR : JVF OF A2Z MAINTENANCE & ENGINEERING SERVICES LTD,GURGAON & UNIQUE STRUCTURES & TOWERS LTD.BHILAI.
- C) CONTRACT NO. 04-01/12-06510-5-Z-803/Tr.I (PACKAGE-2) & 04-01/12-06511-6-Z-804/Tr. (PACKAGE-3 BOTH DTD 31.01.2011)
- D) PROJECT : MALWA TPH-PITHAMPUR 400 KV DCDS TRANSMISSION LINE (PACKAGE-2 & PACKAGE-3) ON TWIN MOOSE ACSR CONDUCTOR
- E) SUB CONTRACTOR : EMI TRANSMISSION LIMITED, THANE, MAHARASHTRA.

MANUFACTURER:



EMI TRANSMISSION LIMITED

KOLSHET ROAD, THANE
(MUMBAI, INDIA)

TITLE:-

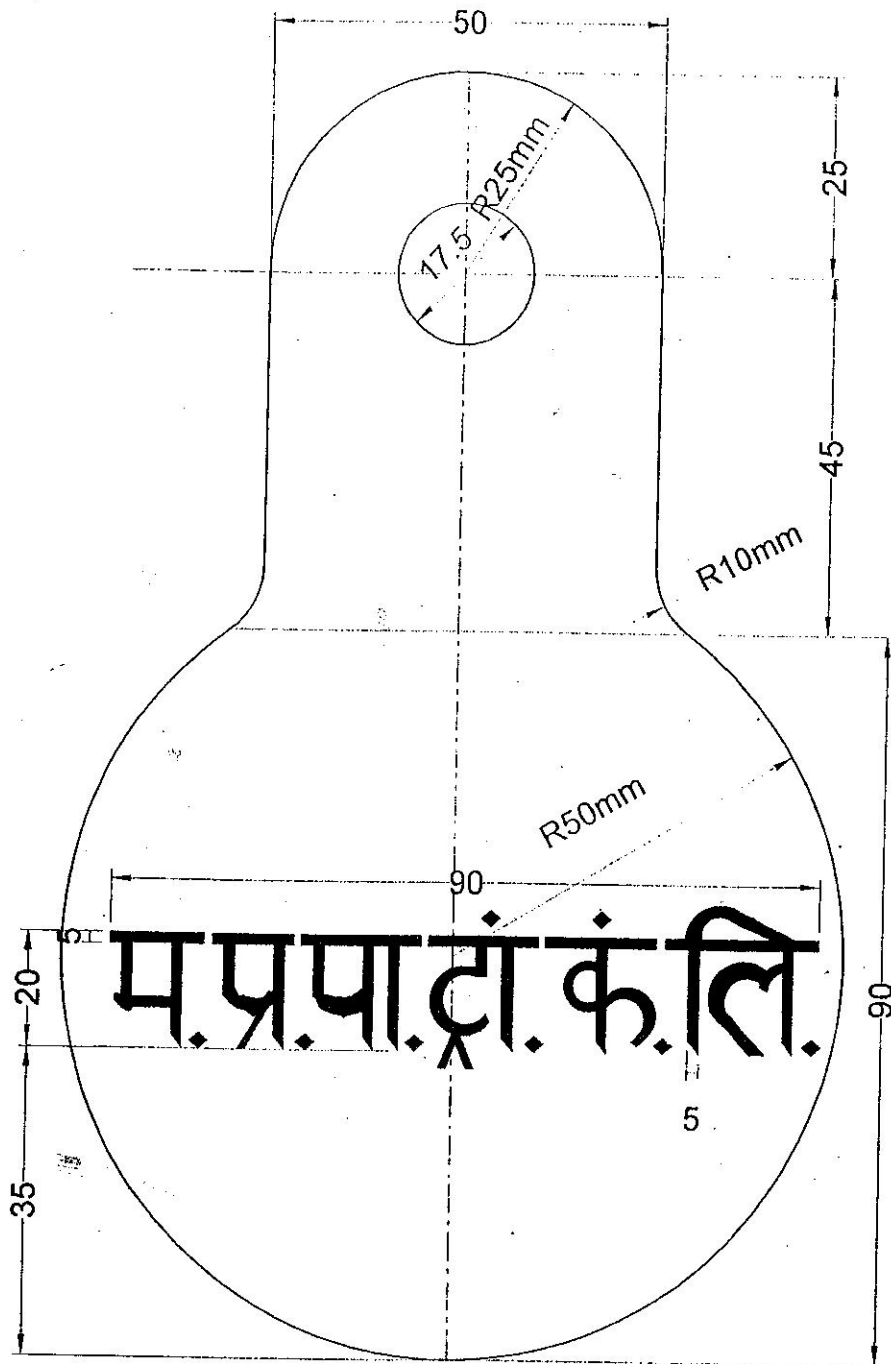
FLEXIBLE COPPER BOND FOR 7/3.66 mm EARTHWIRE

No.	DESCRIPTION	MATERIAL	SURF.TREATMENT	WEIGHT	QTY.	REF.NO.
5	FLEXIBLE BOND WIRE (35.4sq mm AREA)	COPPER (ELECTROLYTIC) IS:9567	TINNED	0.180 KG	1	1448
4	SPRING WASHER	SPRING STEEL IS:4072 & IS:3063	E. G.	0.010 KG	1	1292
3	HEX BOLT & NUT (M16X40)	MILD STEEL, CR.5.8 IS:6839,1363 PART-III & 1367 PART-XIII	H. D. G.	0.141 KG	1,1	1211
2	CONNECTING LUG	COPPER ALLOY (ELECTROLYTIC) IS:9567	TINNED	0.140 KG	1	1447
1	CONNECTING LUG	COPPER ALLOY (ELECTROLYTIC) IS:9567	TINNED	0.140 KG	1	1446

NO.	DATE	DRN.	CHKD.
1	20.07.11	KAPIL	<i>[Signature]</i>

DRG.NO. : EMI/FCB-1446

REV. 1



NOTE:-

1. ALL DIMENSIONS ARE IN MM
2. LETTERING - WHITE ENAMEL
3. BACK SIDE & FRONT
BLUE/RED/YELLOW ENAMEL
4. THICKNESS OF PLATE
1.6 MM (MINIMUM)

REVISION	O/o CHIEF ENGINEER (TRANS.) MP STATE ELECTRICITY BOARD	
R ₁ 07.03.05	PHASE PLATE FOR 400 KV. TRANSMISSION LINE.	
R ₂ 05.12.05	DRN:- M.K.U.	APPRD
	DATE:- 24-10-02	SCALE:- N.T.S.
	DRG.NO. FT. II/201	

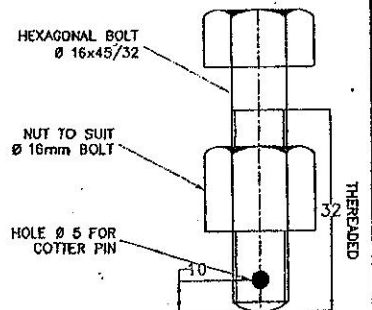


NOTE:-

1. DIMENSIONS ARE IN MM.
2. LETTER & SKELETON - RED ENAMEL
3. GROUND & SKELETON - WHITE ENAMEL
4. BACK SIDE & SKELETON WHITE OR BLACK ENAMEL
5. THICKNESS OF PLATE - 1.8 MM (MINIMUM)
6. HOLE TO HOLE DISTANCE 230mm MUST BE MAINTAINED.

CAD CELL O/O THE CHIEF ENGINEER (PLANNING)

REVISION	O/o CHIEF ENGINEER (TRANS.) MP STATE ELECTRICITY BOARD	
R ₁ 07.03.05	DANGER PLATE FOR 400 KV. TRANSMISSION LINE	
R ₂ 23.2.06		
	DRN:- M.K.U.	APPRD
	DATE:- 24.10.02	SCALE:- N.T.S.
	DRG.NO. FT-II/204	



TOWER	+0M	+3M	+6M	+10M	+18M	+25M
FDO	310ML	-	356ML	387ML	450ML	505M
FD30° FDY	385ML	-	456ML	505ML	-	-
FD60°	466ML	-	555ML	615ML	-	-

<u>ANTICLIMBING DEVICE</u> <u>FOR 400 KV TOWERS</u>			NAME	DATE
		DRAWN		
		CHECKED		
		APPROVED		
		PREPARED	CAD-CELL	05.02 2010
SCALE	O/O THE OFFICER ON SPECIAL DUTY (TR.) M.P. POWER TRANSMISSION COMPANY LTD., JABAL PUR		DRAWING NUMBER XII - FT - 17/04	
N.T.S.				