CHAPTER- E12 - 1

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR (AAAC)

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OF

ALL ALUMINIUM ALLOY CONDUCTOR

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TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR

1.0 SCOPE

This specification covers design, Engineering, Manufacture, Testing, Inspection before despath, forwarding, packing, transportation to sites, Insurance (both during transit & storage), storage, erection, supervision testing & commissioning of all sizes of All Aluminum Alloy Conductors of the Aluminum–Magnesium-Silicon type for use in the distribution overhead power lines.

The conductor offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

The AAA Conductor shall conform in all respects to highest standards of engineering, design, workmanship complying this specification and the latest revisions of relevant standards at the time of offer and the Owner shall have the power to reject any work or materials, which, in his judgement, is not in full accordance therewith.

2.0 STANDARDS

Except where modified by the specification, the Aluminum Alloy Conductor shall be designed, manufactured and tested in accordance with latest editions of the following standards:

SI.No	International Standard	IS	Description			
1	IEC :1089		Round wire concentric lay overhead electrical standard Conductor			
2		IS 398	Aluminum Alloy Stranded Conductors			
3		IS 9997	Aluminum Alloy redraw rods for electrical purposes			
4	IEC 502 : 1994		Extruded solid dielectric insulated power cables for rated voltages 1.0 kV up to 30 kV			
5	IEC 104		Aluminum Magnesium Silicon alloy wire for overhead line conductors			
6		IS 1778	Reels and drums of bare conductor.			
7	BS : 6485-1971		PVC covered conductors for overhead power lines.			

3.0 GENERAL

The wires shall be of heat treated aluminium, magnesium silicon alloy containing approximately silcon-0.5 to 0.9 %, magnesium-0.6 % to 0.9%, Fe-0.5% (maximum), Copper- 0.1% (max), Mn- 0.03%, Cr-0.03%, Zn-0.1%, B-0.06%, and having the mechanical and electrical properties specified in the table and be smooth and free from all imperfections, such as, spills, splits and scratches.

Neutral grease shall be applied between the layers of wires. The drop point temperature of the grease shall not be less than 120⁰C.

31 Mechanical and Electrical Characteristics of Aluminium Alloy Wires used in the Construction of Stranded Aluminium Alloy Conductors

Nominal Diameter	Minimum Diameter	Max. Diameter	Cross Sectional Area	Mass	Minimum Load Before	Breaking After	Maximum Resistance at 20 ⁰ C
					stranding	stranding	
1	2	3	4	5	6	7	8
mm	mm	mm	mm ²	Kg/km	KN	KN	ohms/km
3.15 *	3.12	3.18	7.793	21.04	2.41	2.29	4.290
4.26 *	4.22	4.30	14.25	38.48	4.40	4.18	2.345

Maximum resistance values given in column 8 have been calculated from the maximum values of the resistively as specified and the cross sectional area based on the minimum diameter.

The minimum breaking load is calculated on nominal diameter at ultimate tensile strength of 0.3 09 KN / mm^2 for wire before stranding and 95% of the ultimate tensile strength after stranding.

4.0 PHYSICAL CONSTANTS FOR ALUMINIUM ALLOY WIRES

4.1 Resistively:

For the purpose of this specification, the standard value of resistively of aluminum alloy wire which shall be used for calculation is to be taken as 0.0325 ohm-mm²/m at 20^{0} C. the maximum value of resistively of any single wire shall not, however, exceed 0.0328 ohm-mm²/m at 20^{0} C.

42 Density:

At a temperature of 20° C, the density of aluminum alloy wire is to be taken as 2700 kg/m³.

4.3 Temperature Coefficient of Linear Expansion:

The temperature coefficient of linear expansion of aluminium alloy wire is to be taken as $23 \times 10^{-6} / {}^{0}$ C.

4.4 Constant – Mass Temperature Coefficient

At a Temperature of 20° C, the constant – mass temperature coefficient of resistance of aluminium alloy wires, measured between two potential points rigidly fixed to the wire, is taken as $0.00360/^{\circ}$ C.

5.0 STANDARD SIZES

5.1 Nominal Sizes of Wires

The aluminium alloy wires for standard constructions covered by this specification shall have the diameters as specified in the table and a tolerance of $\pm 1\%$ shall be permitted on the nominal diameter.

5.2 Standard Conductors

The sizes, resistance and masses (excluding the mass of grease) of stranded aluminium alloy conductors shall be as given in table. The preferred sizes are highlighted in the table.

5.3 Mechanical and Electrical Characteristics of Aluminium Alloy Stranded Conductors

SI. No.	Actual Area	Stranding and Wire Dia	Approx. Overall Dia	Approx. Mass	Calculated Maximum Resistance at 20 ⁰ C	Approx Calculat ed Breaking
	<u> </u>	-		_		
1	2	3	4	5	6	(
	Mm ²	mm	mm	kg/km	ohms/km	KN
2	100	7/4.26	12.78	272.86	0.3390	29.26
3	148	19/3.15	15.75	406.91	0.2290	43.50

5.3.1 Increase in Length due to Stranding

When straightened out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that layer.

5.3.2 Resistance and Mass of Conductor

The resistance of any length of stranded conductor is the resistance of the same length of any one wire multiplied by a constant as set out in the table below.

The mass of each wire in any particular layer of the stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of that layer.

The total mass of any length of an aluminium stranded conductor is, therefore, obtained by multiplying the mass of an equal length of straight wire by an appropriate constant as mentioned below. In calculating the stranding constants as mentioned in the table below, the mean lay ratio, that is the arithmetic mean of the relevant minimum and maximum values in table for lay ratio has been assumed for each layer.

5.3.3 Calculated Breaking Load of Conductor

For a conductor containing **not more than** 37 wires, 95% of the sum of strength of the individual wires calculated from the values of the minimum breaking load given in this specification.

For a conductor containing **more than** 37 wires, 90% of the sum of the strengths of the individual wire calculated from the values of the minimum breaking load given in this specification.

5.3.4 Calculated Area and Maximum Resistance of Conductor

The actual area of a stranded conductor has been taken as the sum of the cross-sectional areas of the individual wires of nominal diameter.

Maximum resistance values of stranded conductor have been calculated on the basis of maximum resistively and the cross-sectional area based on the minimum diameter of wires.

Number of Wires in Conductor	Stranding Constants				
	Mass	Electrical Resistance			
(1)	(2)	(3)			
7	7.091	0.1447			
19	19.34	0.05357			

5.4 Stranding Constants

6.0 JOINTS IN WIRES

6.1 Conductor containing seven wires

There shall be no joint in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.

6.2 Conductors containing more than seven wires

In stranded conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the base rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor. Such joints shall be made by cold pressure butt welding. They

are not required to fulfill the mechanical requirements for un-jointed wires.

7.0 STRANDING

The wire used in the construction of a stranded conductor shall, before and after stranding, satisfy all the relevant requirements of this standard.

The lay ratio of the different layers shall be within the limits given in the table for lay ratio.

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

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

Number of Wires in Conductor		LAY RATIOS							
	3/6 Wire Layer 12 Wire Layer 18 Wire Layer 24 Wire						e Layer		
	Min	Max	Min	Max	Min	Max	Min	Max	
7	10	14							
19	10	16	10	14					

7.1 Lay Ratios for Aluminium Alloy Stranded Conductors

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

8.0 LENGTHS AND VARIATIONS IN LENGTHS:

Unless otherwise agreed between the Owner and the Contractor, stranded aluminium alloy conductors shall be supplied in the manufacturer's usual production lengths to be indicated in the bid Schedule. The Owner reserves the right to specify particular lengths of conductor such that certain drum lengths will be shorter than others. There will in both cases be a permitted variation of -0 + 5% in the length of any one conductor length.

9.0 TESTS

9.1 Type Tests

The following tests should have been carried out as per relevant ISS.

9.1.1 Ultimate Tensile Strength Test

This test is intended to confirm not only the breaking strength of the finished conductor but also that the conductor has been uniformly stranded.

A conductor sample of minimum 5mtr. length fitted with compression dead end clamps at either end shall be mounted in a suitable tensile test machine. Circles perpendicular to the axis of the conductor shall be marked at two places on its surface. Tension on the conductor sample shall be increased at a steady rate upto 50% of the minimum UTS specified and held for one minute. The circles drawn shall not be distorted due to relative movement of the individual strands. Thereafter the load shall be increased at a steady rate to the specified minimum UTS and held at that load for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

9.1.2 D.C Resistance Test

On a conductor sample of minimum 5mtr. length two contact clamps shall be fitted with a predetermined bolt torque. The resistance between the clamps shall be measured using a Kelvin double bridge by initially placing the clamps at zero separation and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20⁰ C, which shall conform to the requirements of this specification.

9.2 Routine Tests

9. 2.1 Measurement of Physical Dimensions:

The samples should meet the desired dimensional requirements before conducting following Routine Tests as per relevant ISS.

9.2.2 Selection of Test Samples

Samples for the tests specified in this specification shall be taken by the manufacturer before stranding, from not less than 10% of the individual lengths of aluminium alloy wire included in any one final heat-treatment batch and which will be included in any one consignment of the stranded conductors to be supplied.

Samples shall then be obtained by cutting 1.2 meters from the outer end of the finished conductor from not more than 10% of the finished reels or drums.

Tests for electrical and mechanical properties of aluminium alloy wire shall ordinarily be made before stranding since wires unlaid from conductors may have different physical properties from those of the wire prior to stranding because of the deformation brought about by stranding and by straightening for test. Spools offered for inspection shall be divided into equal lots, the number of lots being equal to the number of samples to be selected, a fraction of a lot being counted as s complete lot. One sample spool shall be selected at random from each lot.

The following test shall be carried out once on samples of completed line conductor during each production run of up to 500 kms of the conductor from each manufacturing facility.

9.3 Breaking Load Test

The breaking load of one specimen, cut from each of the samples taken shall be determined by means of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm / min and not greater than 100mm /min.

9.4 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined as follows :

The specimen shall be straightened by hand and an original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described above and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm of either mark, and the required elongation is not obtained, the test shall be disregarded and another test should be made.

When tested before and after stranding, the elongation shall not be less than 4% on a gauge length of 200 mm.

9.5 D.C Resistance Test

The electrical resistance test of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20⁰ C by means of the formula

 $R_{20} = R_T [1/(1+\alpha(T-20))]$

Where R_{20} = Resistance corrected at 20°C

 R_T = Resistance measured at T^0C

A = Constant – Mass temperature coefficient of resistance, 0.0036, and

T = ambient temperature during measurement

The resistance corrected at 20° C shall not be more than the maximum values specified .

9.6 Chemical Analysis of Aluminium Alloy

Samples taken from the alloy coils / strands shall be chemically / spectrographically analysed. The results shall conform to the requirements stated in this specification. The Contractor shall make available material

analyses, control documents and certificates from each batch as and when required by the **<OPTCL>**.

Test should be conducted at the independent test house by the Owner in the case of absence of facility at manufacturer. However the cost of such testing shall be borne by the manufacturer/Contractor.

9.7 Dimensional and Lay Length Check

The individual strands of the conductors shall be dimensionally checked and the lay lengths checked to ensure that they conform to the requirements of this specification.

Ten percent drums from each lot shall be rewound in the presence of the Owner or his representative to allow visual checking of the conductor for joints, scratches or other surface imperfections and to ensure that the conductor generally conforms to the requirements this specification. The length of conductor would on the drum shall be re-measured by means of an approved counter / meter during the rewinding process.

9.8 Visual and dimensional Checks on the Conductor Drums.

- 9.8.1 The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification and of IS 1778: Specification for reels and drums of bare conductors. For wooden drums, a suitable barrel batten strength test procedure is required. The Bidder shall state in his bid the tests to be carried out on the drums and shall include those tests in the Quality Assurance Programme.
- 9.8.2 Acceptance Tests :

The following acceptance tests as per IS-398 (PartIV)/1994 with latest amendments if any, shall be carried out on all samples

- i. Measurement of lay ratio
- ii. Measuerement of diameters of individual wire
- iii. Meae of resistance of individual wire
- iv. Breaking load test of individual wire
- v. Elongation test of individual wire
- vi. Torsional test of individual wire

10.0 REJECTION AND RETESTS

10.1 Type Tests

Should the conductor fail any of the type tests specified above, the Owner will not accept any conductor manufactured from the material, nor conductor made by the manufacturing methods used for the conductor which failed the test.

The manufacturer shall propose suitable modifications to his materials and techniques in order that he can produce conductor which will satisfactorily pass the type test requirements.

10.2 Routine Tests

Should any one of the test pieces first selected fail the requirements of the tests, two further samples from the same batch shall be selected for testing, one of which shall be from the length from which the original test sample was taken unless that length has been withdrawn by the manufacturer.

Should the test pieces from both these additional samples satisfy the requirements of the tests, the batch represented by these samples shall be deemed to comply with the standard. Should the test pieces from either of the two additional samples fail, the batch represented shall be deemed not to comply with the standard.

If checked on individual strand diameters, conductor lay lengths and conductor surface condition indicate non-compliance with the requirements of the specification, the particular drum will be rejected. Inspection will then be carried out on two further drums within the same batch. If the conductor on either of the drums is non-complaint, the complete batch will be rejected.

10.3 **Delivery Extension due to Rejection of Conductor**

The rejection of conductor due to its failure to pass either type or routine tests shall not permit the Contractor to apply for any extension to the time period within which he has contracted to complete the Project.

11.0 GUARANTEED TECHNICAL PARTICULARS: The GTP for 100 / 148 mm2 AAAC is furnished at **Chapter- E24**.

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TECHNICAL SPECIFICATION FOR ACSR - ZEBRA

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TECHNICAL SPECIFICATION OF ACSR "ZEBRA" CONDUCTORS

1.0 <u>SCOPE</u> :-

This specification provides for the manufacture, testing, supply and delivery at destination of the steel cored aluminum conductors. The materials shall conform to the technical particulars furnished in the chapter E-24 GTP and be be procured f from vendors as per the list in chapter -E23.

2.0 STANDARDS :-

The conductors shall comply in all respects to the clauses of this specification as indicated below & with the Indian Standard Specification, International standards with latest amendments. Some of the standards are :-

i) IS 398 - Specification for Aluminium Conductors for overhead transmission purposes

IS 398, Part-II-Aluminium conductors for overheadTransmission purpose - Specification

- ii) IS 1521, 1972 Method of tensile testing of steel
- iii) IS 1778 -1989 Reel & drums for bare conductors.
- iv) IEC 1098

3.0 MATERIALS :-

- 3.1The material offered shall be of best quality and workmanship. The steel Cored Aluminum conductor strands will consist of hard-drawn aluminum wire manufactured from 99.5% pure electrolytic aluminum rods of E.C. Grade. The steel wire shall be made from materials produced either by the acid or basic open hearth process or by electric process. No steel wire drawn from pressmen process shall be used. The steel wire shall not contain sulphur or phosphorus exceeding 0.05 percent, and the total of sulphur and phosphorus shall not exceed 0.085 percent.
- 3.2 The steel wires shall be evenly and uniformly coated with zinc complying with Indian Standard 4826-1979 specification for galvanized coatings on round steel wires. The uniformity of zinc coating and the weight of coating shall be in accordance with Appendix-Ilattached at chapter -E24. The coating on the galvanized steel wires may be applied by the hot process or the electrolytic process.

4.0 <u>SIZES</u> :-

4.1 The size of steel-cored Aluminum Conductors shall be as given in Appendixlattached at chapter -E24. The resistance and weights shall be in accordance with the values given in the same appendix.

5.0 <u>TOLERANCES</u>:-

5.1 The following tolerances shall be permitted on standard diameter of aluminum wires. Tolerance on standard diameter of aluminum wire <u>+</u> 1 percent wires.

- Note : The cross-section of any wire shall notdepart from circularity by more than anamount corresponding to a tolerance of 2 percent on the standard diameter.
- 5.2 A tolerance of + 2 percent shall be permitted on the standard diameter of the galvanized steel wires. The variation from the approximate weights shall not be more than plus or minus 5 percent.

6.0 MECHANICAL PROPERTIES: -

6.1 The value of the final modules of elasticity for steel cored aluminum conductor in the average of values obtained from actual stress strain tests. The coefficient of linear expansion for steel Cored Aluminum Conductors has been calculated on the basis of co-efficient of linear expansion of 23.0 x 10-6 per degree centigrade of aluminum and 11.5 x 10-6 per degree centigrade for steel and represent only the average values. These values shall however, be given by the bidder under the guaranteed technical particulars.

7.0 SURFACE CONDITIONS:-

The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp-edges, abrasions or other departures from smoothness or uniformity of surface contour that would increase radio interference and corona losses. When subjected to tension up to 50% of the ultimate strength of the conductor, the surface shall not depart from its cylindrical form nor any part of the component, parts or strands, move relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

8.0 JOINTS IN WIRES: -

8.1 Aluminumwires: No joints shall be permitted in the aluminum 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 meter apart in the complete stranded conductor. Such joints shall be made by cold pressure butt-welding.

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 the extra high voltage lines.

8.2 Galvanized steel wires:- There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steelreinforced aluminum conductor.

Joints have not been permitted in the steel wires after final drawing in order to avoid reduction in the breaking strength of the conductor that may occur as a result of failure of the joints.

9.0 <u>STRANDING</u> :-

- 9.1 The wires used in construction of a stranded conductor shall before stranding, satisfy all requirements of <u>IS-398/ (part-II)1976</u> with latest amendments. For steel-cored aluminum conductors the lay ratio of the different layers shall be within the limits given under <u>Appendix-I</u>attached at chapter -E24.
- 9.2 For all, constructions, each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round

the under laying wire or wires. The final layer of wires shall have a right hand lay.

10.0 PACKING AND MARKING : -

- 10.1 The conductor shall be wound in non-returnable reels or drums conforming to Indian Standard 1978-1961 specification for Reels and Drums for Bare Wire, or any other authoritative standard and marked with the following : -
- a) Trade name, if any
- Contract/Award letter Number
- c) Name of manufacturer
- Name & Address of Consignee
- e) Drum Number

g)

- Length of conductor
- Size of conductor h) Gross Weight of drum with conductor
 - Net and gross of conductor.
- Weight of empty drum j) Net and gross of with lagging.k) Arrow marking of un-winding

b)

d)

f)

- 10.2 The reel shall be of such construction as to assure delivery of conductor in the field from displacement and damage and should be able to withstand all stresses due to handling and the stringing operations so that conductor surface is not dented, scratched or damaged in any way during manufacture, transport and erection. The conductor shall be properly lagged on the drums and the method of lagging to be employed may be clearly stated in the tender. It should be stocked to suit the reel and held in place by steel strapping. Lagging shall not be nailed or bolted in place.
- 10.3 The conductor drum should be suitable for wheel mounting. Before reeling, the card-board or other suitable material shall be secured to the drum and inside flanges of the drums. After reeling the conductor, the exposed surfaces should be wrapped with suitable soft material to prevent the conductor from dirt and grit. Any space between the drum lagging and conductor should be suitably filled with soft filler material compactly packed. The conductor drum shall be made as per the relevant IS.

11.0 <u>LENGTHS</u>: -

11.1 The conductor shall be supplied in the standard lengths **as below** with a permitted variation of 5%. Not less than 90% of the total quantity of the conductor shall be supplied in the standard lengths. Thus the quantity of the conductor in lengths shorter than standard ones shall not exceed 10% of the total quantity to be supplied. Further no single conductor lengths in respect of such 10% (Maximum supply) in random lengths, shall be shorter than 50% of the standard lengths.

Type of conductor

Length per drum.

ZEBRA ACSR 1.1 K.M.or as suitable **12.0TESTS AND TEST CERTIFICATES :-**

The following type tests, (& any other tests if owner decides to do), shall be conducted on the conductor at any Govt. approved laboratory or CPRI, in presence of the representatives of OPTCL, on the samples collected and sealed by the representative of OPTCL from the manufactured & offered drums of conductor at random at free of cost to OPTCL or firm may quote their test charges which will be taken in to account during bid price evaluation. If test charges will not be quoted by the firm, it will be treated as nil during bid price evaluation & firm have to do the type tests at free of cost to OPTCL. Also the tenderer shall furnish valid type test reports, the tests are as per the IS 398 (part-2) conducted in any govt. approved laboratory or CPRI within last 5 years, from the date of opening of the bid (Technocommercial) document, without which their bids will not be considered for evaluation.

- 12.1 Individual wire and finished steel cored Aluminum Conductor shall be subjected to before dispatch from the works, to the tests as per the provision of the Indian Standard Specification 398 (Part-II-1976) with the latest amendments & as per the tests indicated in this specification below.
- 12.2 Samples for individual wires for test shall be taken before stranding form not less than 10 percent of the spiels in the case of aluminum wire and ten percent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 5 meters from the outer end of the finished conductor from not more than 10 percent of the finished reels.
- 12.3 The mechanical tests shall be carried out on single wires only.
- 12.4 The Tensile test shall apply to wires of all diameters forming part of steel cored aluminum conductors. If it is not possible to test the component wires before stranding the test may be made on wires taken from stranded conductors. The tensile strength of any of the wires shall not be less than the minimum values given in <u>Appendix-II</u>attached at chapter -E24.
- 12.5 A suitable tensile testing machine shall be used the accuracy of which can easily be checked and the machine adjusted if necessary. The test sample before being placed in the machine, shall be straightened, if necessary in such a way as to cause the minimum alteration in its physical properties.

The load shall be applied gradually and rate of separation of the Jaws of the testing machine shall not be greater than <u>10cm/min.</u> and less than <u>2.5cm/min.</u>

13.0 <u>TYPE TESTS</u>

13.1 Wrapping Test : -

- 13.1.1 Samples of aluminium wires shall be wrapped round a wire of its own diameter to form a close helix of eight turns. Six turns shall then be unwrapped and again clearly wrapped in the same direction as before. The wire shall not break.
- 13.1.2 Samples of steel wires shall be closely wrapped eight times round a mandrel of diameter equal to four times the wire diameter. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

13.2 Galvanizing Test : -

- 13.2.1 The uniformity of zinc coating and the weight of coating shall be as given in <u>Appendix-II</u> attached at chapter -E24 and shall be determined according to Indian Standard Specification <u>4826-1979</u> with latest amendments.
- 13.2.3 This test shall be made whenever practicable, on wires before stranding and before the specimen has been bent, straightened or tested in any other way.
- 13.3 Ductility Test : -

This test shall be made on galvanized steel wires only by any of the proceedings given in <u>13.1.1 and 13.1.2.</u>

13.4 **Torsion Test** : - One specimen cut from each of the sample shall be gripped at its ends in two vices, one of which shall be free to move longitudinally during the test. A small tensile bond not exceeding 2% of the breaking load of the wire, shall be applied to the sample during testing. The specimen shall be twisted by consisting one of the vices to revolve until fracture occurs and the number of twists shall be indicated by a counter or other suitable device. The rate of twisting shall not exceed <u>60 rev/min.</u>

When tested before stranding, the number of complete twists before fracture occurs shall not be less than <u>18 on</u> a length equal to <u>100 times</u> the diameter of the wire. The fracture shall show a smooth surface at right angles, to the axis of the wire.

When tested after stranding, the number of complete twists before fracture occurs shall be not less than <u>16 on</u> a length equal to <u>100 times</u> the diameter of the wire. The fracture shall show a smooth surface at right angles to the axis of the wire.

13.5 <u>Elongation Test</u> : - The elongation of one specimen cut from each of the samples shall be determined. The specimen shall be straightened by hand and on original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described in 12.5 and the elongation shall be measured after the fractured ends fitted together. If the fracture occurs outside the gauge marks, or within 25mm of either mark and the required elogation is not obtained, the test shall be disregarded and another test made. When tested before stranding, the elongation shall be not less than 4 percent. When tested after stranding, the elongation shall be not less than 3.5 percent.

13.6 Surface Condition Test

A sample of the finished conductor having a minimum recommended length of 5 meters with compression type dead end clamps compressed on both ends in such a manner as to permit the conductor to take its normal straight line shape, shall be subject to a tension of 50% of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place of disturb the longitudinal smoothness of conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminum and steel strands.

13.7 Ultimate Strength (UTS) Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum <u>5m</u>length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to specified 50% of UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to the minimum UTS specified in <u>Appendix-1</u> attached at chapter- E24 and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

13.8 Corona Extinction Voltage Test

One sample of conductor of 5m length shall be strung. In case of twin conductor, two samples shall be arranged with the actual sub-conductor spacing between them. This sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than <u>320</u> KV (rms) for <u>400 KV</u> and <u>176 KV (rms) for 220 KV system</u> line to ground under dry condition. There shall be no evidence of corona on any part of sample when all possible sources of corona are photographed in a darkened room. The test shall be conducted without corona control rings. The voltage shall be corrected for standard atmospheric conditions.

13.9 Radio Interference Voltage Test

Under the conditions as specified in 12.1 above, the conductor samples shall have a radio interference voltage level below <u>1500 microvolts</u> at one MHZ when subjected to 50HZ AC voltage of 1.1 times maximum line to ground voltage under dry condition. This test may be carried out with corona control rings and arcing horns.

13.10 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 degree centigrade as per clause No.12.8 of IS : 398 (part V). The resistance corrected at 20 degree centigrade shall conform to the requirements of this specification.

13.11 Stress-Strain Test

This test is contemplated only to collect the creep data of the conductor from the supplier. A sample of conductor of minimum 10 metres length shall be suitably compressed with dead end clamps.

13.12Test Set-up

- (a) The test sample shall be supported in a trough over its full length and the trough adjusted so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.
- (b)The distance between the clamp and the sleeve mouth shall be monitored with callipers during the test to ensure that, after the test, it does not change by more than 1 mm +/-0.1mm from the value before the test.
- (c) The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps which lock the steel and aluminum wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side-to-side by the maximum amounts expected during the test should introduce no more than 0.3mm error in the reading.

13.13**Test Loads for Complete Conductor**

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows:

- (a) 1 KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set at zero at zero tension.
- (b) For non-continuous stress-strain data, the strain reading at 1 KN intervals at lower tensions and 5KN intervals above 30% of UTS shall be recorded.
- (c)The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released after the hold period.
- (d) Reloading up to 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45, and 60 minutes and then the load shall be released.
- (e) Reloading up to 85% of UTS shall be done and hold for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes and then the load shall be released.
- (f) Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded up to 90 % of UTS at the intervals described under Clause (e).

13.14 Test Loads for Steel core Only.

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows:

- 13.14.1 The test shall consist of successive application of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.
- 13.14.2 The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

13.15 Stress Strain Curves

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1 hour points at 30%, 50%, and 70% of UTS loadings. The presence of any aluminum slack that can be related to any observed extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and design stress-strain curves shall be submitted to the Owner along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 degree centigrade.

13.16 Chemical Analysis of Zinc

Samples taken from the Zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

13.17 Chemical Analysis of Aluminum and Steel

Samples taken from the Aluminum ingots/ coils/ strands shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

14.0ROUTINE/ACCEPTANCE TESTS

14.1 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification. Drum dimensions should confirm to **IS: 1778**. The flange diameter, traverse width, barrel diameter and flange thickness are to be as per relevant standard.

14.2 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conforms to the requirements of this specification.

14.3 **Dimensional Check of Steel and Aluminum Strands**

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

14.4 Check for Lay-ratios of various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification.

14.5 **Breaking load test on welded Aluminum strand & Individual wires** Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the supplier.

14.6Ductility Test

14.7wrapping test

- 14.8Resistance test
- 14.9Galvanising Test

15.0 <u>RETEST AND REJECTION</u> : -

- 15.1 Each coil or spool selected for testing shall be tested for compliance with the requirements of Indian Standard Specification 398 (part-II) 1976 with latest amendment if any selected coil or spool not fulfills any of the test requirements, that particular coil or spool shall be withdrawn. In respect of each failure, two test pieces shall be selected from two different coils in the lot and subjected to the test under which the failure occurred. If either of the two retest pieces fails to pass that test, the lot concerned shall be rejected.
- If samples are taken for test after stranding and if any selected reel fails in the retest, the manufacturer may test each and every reel and submit them for further inspection. All rejected materials shall be suitably marked and segregated.

16.0GUARANTEEDTECHNICAL PARTICULARS: -

The bidder shall fill in the Guaranteed Technical Particulars(attached at Appendix-I, II, & III)furnishedinchapter- E24and submit the same with his tender, without which bid will not be considered.

17.0SAGTENSION CHARTS AND SAG TEMPLATES: -

The contractor shall supply each six copies of sag tension charts and sag templates in respect of each type of the steel core aluminum conductor. The Contractor shall also supply sag template in celluloid which shall be subject to the approval by the Owner and without involving any extra charges. The design

data of the lines on which these conductors will be used are furnished at chapter- E24.

CHAPTER-E12 - 3

TECHNICAL SPECIFICATION

FOR

INSULATOR (DISC)

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DISC INSULATORS

1.0 SCOPE.

This specification provides for design, manufacture, engineering, supply, inspection and testing before dispatch packing and delivery FOR (destination) for Indian manufacturers of disc. Insulators & Post Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulators strings for the suspension and anchoring of the bus-bar conductors. In 11 kV line 70 KN and in 33 kV lines 70 kN disc insulaors of Ball & Socket type will be used. Porcelain discs are normal type.

Following is the list of documents constituting this package.

- (i) Technical specification.
- (ii) Technical data sheet.
- (iii) Drawings of insulators

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

The insulators offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

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

2.0 STANDARDS:

2.1 Except as modified in this specification, the disc insulators shall conform to the following Indian Standards, which shall mean latest revisions and amendments. Equivalent International and Internally recognized standards to which some of these standards generally correspond are also listed below.

SI.	Indian	Title.	International
No.	- Standard		Standard
1.	IS: 206 Method for Chemical Analysis of Slab Zinc.		
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 274 IEC 383
4.	IS: 2071	Method of High Voltage Testing.	
	Part-(I), Part-(II)		
	Part-(III)		
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 120
	Part – III	Locking devices.	IEC: 372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969
			R 26-1963,
			R 262-1969 &
			R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	

13.	IS: 8263	Methods of RIV Test of HV	IEC 437 NEMA
		insulators.	No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse	IEC: 506
		test on HV insulators.	
15.		Thermal mechanical	IEC: 575
		performance test and	
		mechanical performance test on	
		string insulator units.	
16.	IEC	Long Rod Insulators	IEC-433

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards Institution, 101, Pentonvile Road, N-19 ND,U
IEC / CISPR		International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS		Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001, ORISSA
ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44 th . Street New York, NY 10017 USA

3.0 **PRINCIPAL PARAMETERS.**

3.1 **DETAILS OF DISC INSULATORS**:

The Insulator strings shall consist of standard discs for use in three phases, 50 Hz 33/11KV S/s & Lines in a moderately polluted atmosphere and in sea belts. The discs shall be cap and pin, ball and socket type, and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

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

	Table I									
SI.	Type of	Size of disc.	Minimum	No. of	No. of	Electro-				
No	String.	Insulator (mm)	creepage distance of each disc(mm)	standard discs 11KV	standard discs 33KV	mechanical strength of insulator string fittings (KN)				
1.	Single Tension	255x145	430	1x2	1x4	70KN in 33kV/11 kV line				
2.	Double Tension	-do-	-do-	2x2	2x4	2x70KN 33kV/11 kV line				

Notes:- Post Insulator pin type to be provided in 11kV Suspension Point.The technical Spec. for the same is indicated elesewhere in the technical specification for the project

3.2 **SPECIFICATION DRAWINGS**:

The specification in respect of the disc insulators are described. These specification for information and guidance of the Bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

4.0 GENERAL TECHNICAL REQUIREMENTS:

4.1 **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, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by climatic conditions ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through verification.

The insulator shall be made of highest grade, dense, homogeneous, wetprocess porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.2 **Porcelain glaze**:

Surface to come in contact with cement shall be made rough by stand 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 down. The Glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body through out the working temperature range.

5.0 METAL PARTS:

(i) Cap and Ball Pins:

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

(ii) Security Clips:

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

6.0 FILLER MATERIAL:

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

7.0 MATERIALS DESIGN AND WORKMANSHIP:

7.1 GENERAL:

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

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.

7.2 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.

7.3 METAL PARTS:

- 1) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.
- i) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

7.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light,

continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

7.5 CEMENTING:

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

7.6 SECURITY CLIPS (LOCKING DEVICES)

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

7.7 MARKING:

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

7.8 BALL AND SOCKET DESIGNATION:

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

8.0 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

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

a) Diameter of Disc (mm)

	Standard	Maximum	Minimum
70KN Disc	255	266	244

b) Ball to Ball spacing Between Discs (mm)

	Standard	Maximum	Minimum
70 KN Disc	145	149	141

9.0 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.

10.0 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

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

11.0 INSULATOR STRINGS:

11.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 33 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent supports are to be fitted with discs 70KN EMS rating while tension insulator strings for use with Anchor / Tension towers are to be fitted with discs of 70KN KN EMS level rating.

11.2 STRING SIZE:

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

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

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

12.0 DIMENSIONAL TOLERANCE OF INSULATORS DISCS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ISS.

13.0 TESTS (FOR DISC INSULATORS) :

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

13.1 TYPE TEST:

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 Bidder shall indicate his schedule for carrying out these tests.

13.2 ACCEPTANCE TESTS:

This shall mean these 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.

13.3 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.

13.4 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.

13.5 TEST VALUE:

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

13.6 TEST PROCEDURE AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and Ownerr before placement of order. The standards and normal 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 land procedure for the same shall be as mutually agreed to between the supplier and the Ownerr in the quality assurance programme.

13.7 TYPE, ROUTINE & ACCEPTANCE TESTS:

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

1.	On complete insulator string with hardware fittings	Standards
a)	Power frequency voltage withstand test with corona control rings and under wet condition.	BS:137(Part-I)
b)	Impulse voltage withstand test under dry condition.	IEC: 383
c)	Mechanical strength test.	As per this specification.
2.	On Insulators:	
a)	Verification of dimensions.	IS: 731
b)	Thermal mechanical performance test:	IEC:575
c)	Power frequency voltage withstand and flashover	BS: 173
	(I) dry (ii) wet.	
d)	Impulse voltage withstand flashover test (dry)	: IEC: 383
e)	Visible discharge test (dry)	: IS:731
	All the type tests given under clause No.5.14 above shall be conducted on single suspension and Double Tension insulator string along with hardware fittings.	
3.	ACCEPTANCE TESTS:	
	For insulator:	
a)	Visual examination	: IS:731

b)	Verification of dimensions.	: IS:731
c)	Temperature cycle test.	: IS:731
d)	Galvanizing test.	: IS:731
e)	Mechanical performance test.	: IEC:575
f)	Test on locking device for ball and socket coupling.	: IEC:372
g)	Eccentricity test.	As per this specification.
h)	Electro-mechanical strength test.	:
i)	Puncture test.	: IS:731
j)	Porosity test.	: IS:731
4.	ROUTINE TESTS:	
	For insulators:	
a)	Visual inspection.	: IS:731
b)	Mechanical routine test.	:
c)	Electrical routine test.	: IEC:383

5. TEST DURING MANUFACTURE:

Chemical analysis, hardness test and : As per this specification. magnetic particle inspection for forgings.

13.8 ADDITIONAL TESTS:

The Ownerr 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 Ownerr to satisfy that the material complies with the intent of this specification.

13.9 CO-ORDINATION FOR TESTING:

For insulator strings, the supplier shall arrange to conduct testing of their disc insulators with the hardware fittings to be supplied to the Ownerr by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc insulator with the hardware fittings.

NOTE:

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with hardware manufacturer of RIV corona and voltage distribution test and with insulator manufacturer for all other tests.

14.0 TEST CHARGES AND TEST SCHEDULE:

14.1 TYPE TEST:

VOL-II(TS)

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years.

14.2 ACCEPTANCE AND ROUTINE TEST:

- 14.2.1 All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of Ownerr's representative.
- 14.2.2 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the Ownerr to enable him to depute his representative for witnessing the tests.
- 14.2.3 For type tests involving tests on a complete insulator string with hardware fittings, the Ownerr will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.
- 14.2.4 In case of failure of the complete string in any type tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the Ownerr as to the items that has caused the failure in any of the type tests shall be final and binding.

14.3 VOLTAGE DISTRIBUTION TEST:

- a) 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 as to give a total of 100% distribution.
- b) The complete insulator string along with its hardware fitting excluding arcing horn corona controlling/grading ring and suspension assembly/dead end assembly shall be subject to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased already rate to 68% 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 loads reached and the value recorded.

14.4 VIBRATION TEST:

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of
suspensions string a load equal to 600 Kg. shall be applied along with the axis of the suspensions string by means of turn buckle. The insulators string along with hardware fittings and two sub conductors throughout the duration of the test vibration dampers shall not be used on the test span. Both the subconductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string (more than 10Hz) by means of vibration inducing equipment. The amplitude of vibration at the antipode point nearest to the string shall be measured and the same shall not be less than 120.4 being the frequency of vibration. The insulator strings 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 to fatigue fatter 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 disc to be tested
a)	Temperature cycle test followed by	60
	Mechanical performance test.	40

b) Puncture test (for porcelain insulator only)

15.0 INSPECTION:

The Inspection shall be made as per GCC of Volume-I and Chapter E2 of Volume – II of Tender Specification.

16.0 IDENTIFICATION MARKING:

- (a) Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.
- (b) The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

17.0 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING.

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

18.0 TEST 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 Ownerr in quality assurance programme.

19.0 TEST ON CASTING:

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 Ownerr in quality assurance programme.

20.0 HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS:

The test shall be earned out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the suppliers and Ownerr in Quality Assurance Programme.

21.0 THERMAL MECHANICAL PERFORMANCE TEST:

The thermal mechanical performance test shall be carried out on minimum 15 number of disc insulators units as per the procedure given in IEC 575. The performance of the insulator unit shall be determined by the same standard.

22.0 ECCENTRICITY TEST:

The insulator shall be vertically mounted on a future 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 petticoats. 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 veridical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumstance of the disc insulator and disc insulator rotated on its future always maintaining the contact. 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.

23.0 CRACK DETECTION TEST:

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

CHAPTER - E12- 4

TECHNICAL SPECIFICATION FOR

POST INSULATOR (PIN TYPE)

TABLE OF CONTENTS OF POST INSULATOR (PIN TYPE & STATION TYPE)

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POST INSULATOR (PIN TYPE & STATION TYPE)

1.0 STANDARDS

Post insulator (Pin Type & Station Type) shall conform in general to IS 2544, IEC 168 and IEC 815.

SI No.	Parameters	33kV	11kV	
1	Туре	Confirming to IEC 273 (solid core)	Confirming to IEC 273 (solid core)	
2	Voltage class (kV)	36	12	
3	Dry and wet one minute withstand voltage (kV rms)	70	28	
4	Dry lightning impulse withstand voltage (kV p)	170 75		
5	Wet switching surge withstand voltage (kV p)	NA	NA	
6	Max. RIV at corona extinction voltage (micro volts)	NA	NA	
7	Corona extinction voltage (kV rms)			
9	Total minimum cantilever strength (kg)	Not < 300	Not < 300	
10	Minimum torsion moment	As per IEC 273	As per IEC 273	
11	Total height of insulator (mm)	508	254	
12	Minimum PCD (mm) top/bottom	76	57	
13	No. of bolts top/bottom	4/ 8	4/ 8	
14	Diameter of bolt holes (mm) top/bottom	M12 M12		
15	Pollution level as per IEC 815	Heavy	Heavy	
16	Minimum total creepage distance (mm)	900	300	

Technical Parameters

SI No 12 & 13, is not applicable for Pin type Post Insulator. The size of the pin shall given as per IS & should be of galvanized with necessary nuts & washers. The Minimum bending load for 33kV & 11kV Polymer type pin

insulators shall be finalized in accordance with IEC during during detail Engineering

2.0 Constructional features

Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to with stand any shocks to which they may bed subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might after the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.

When operated at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2633, and IS: 4579. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky while deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions. Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

3.0 TEST DETAILS

The following Type, acceptance and routine tests shall be carried out and results given along with certification as appropriate in the Technical Data Schedule and Test Certificates Schedule of this specification.

3.1 TYPE TESTS:

The post insulators shall be subjected to the following type test :

- Visible discharge test
- Impulse voltage withstand test
- Dry power frequency voltage withstand test
- Wet power frequency voltage withstand test
- Mechanical strength test for post insulators as per IEC 168 / IS: 2544.

3.2 Acceptance Tests

The test samples having withstood the routine tests shall be subjected to the following tests according to the sampling procedure of IEC 383 clause 23:

- Verification of dimensions
- Temperature cycle test
- Mechanical strength test for post insulators as per IEC 168/ IS 2544
- Porosity test on post insulators
- Puncture test
- Test for galvanization of ferrous parts

3.3 Routine Tests

- Visual examination
- Power frequency voltage dry test
- Tests to prove mechanical strength.

CHAPTER- E12 - 5

TECHNICAL SPECIFICATION FOR POLYMER INSULATOR

TABLE OF CONTENTS OF POLYMER INSULATOR

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NO. DESCRIPTION

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TECHNICAL SPECIFICATION FOR 33/11 KV POLYMER INSULATORS

1.0 SCOPE :-

- I. This specification covers design, manufacture, testing, inspection, packing and supply of composite insulators for use in the 33/11 KV overhead transmission lines and substations situated in any part of Odisha State.
- II. Long rod insulators for AAAC/ACSR conductors in tension application at dead end/angle/cut point. The insulators shall be of ball and socket type or tongue & Clevis type as desired by the Owner.
- III. Line post insulators or pin insulators for straight line locations

2.0 CLIMATIC CONDITIONS

Please refer Chapter- E3 of Technical Specification on climatic conditions.

3.0 STANDARDS

- 3.1 Following Indian/ International Standards, which shall mean latest revision, with amendments /changes adopted and published, unless specifically stated otherwise in the Specification, shall be referred while accessing conformity of insulators with these specifications.
- 3.2 In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent or better to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Indian Standard	Title	International Standard
	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000 V	IEC : 61109
IS : 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V	IEC : 60883
IS : 2071	Methods of High Voltage Testing	IEC : 60060-1
IS : 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000 V General requirements and tests dimensional	IEC : 60120 IEC : 60732

	Thermal mechanical performance test and mechanical performance test on string insulators units	IEC : 60575		
IS: 13134	Guide for the selection of insulators in respect	IEC : 60815		
10104	Characteristics of string insulator units of the long rod type.	IEC : 60433		
	Hydrophobicity Classification Guide	STRI guide 1.92/1		
	Radio interference characteristics of overhead power lines and high voltage equipments	CISPR:18-2 Part- 2		
IS : 8263	Methods of RI Test of HV Insulators	IEC-60437		
	Standards for insulators -	ANSI C29.13-		
	Composite-Distribution Dead-end	2000		
IS : 4759	Hot dip zinc coatings on structural steel Et	ISO : 1459		
	other allied products	ISO : 1461		
IS : 2629	Recommended practice for Hot Dip	ISO : 1461 (E)		
	Galvanization for iron and steel.			
IS : 6745	Determination of Weight of Zinc Coating on	ISO : 1460		
	Zinc coated iron and steel articles.			
IS : 3203	Methods of testing of local thickness of	ISO :2178		
10 . 0000	electroplated coatings.			
15 : 2633	lesting of uniformity of coasting of zinc			
	Coated annetices.			
	Standard specification for glass liber strands.	ASTN D 578-05		
	Standard test method for compositional analysis ASTME 1131-03			
10 1000				
IS : 4699	Specification for refined secondary Zinc.			

4.0 GENERAL REQUIREMENTS

- 4.1 The Composite insulators will be used on lines on which the conductor will be AAAC of size of 148 Sqmm and 100 sq mm. The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.
- 4.2 Insulator shall be suitable for 3Q 50 Hz effectively earthed 11KV Overhead distribution system in a moderately/heavily polluted atmosphere. Long road insulators shall be of ball Et socket type as specified.
- 4.3 Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 11 KV or above or must have developed proven in house technology and manufacturing process for composite insulators of above rating or possess technical collaboration/association with a manufacturer of composite insulators of rating 11 KV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.

- 4.4 Insulator shall be suitable for both the pin and strain type of load Et shall be of Ball Et Socket type for long Rod Type. The diameter of Composite Insulator shall be less than 200mm. The center-to-center distance between Ball & socket shall be max. 300mm. for 11KV composite insulator.
- 4.5 Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC60815/IS: 13134.
- 4.6. Dimensional Tolerance of Composite Insulators.

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109.

 \pm (0.04d+1.5) mm when d 300 mm \pm (0.025d+6) mm when d > 300mm

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

However, no negative tolerance shall be applicable to creepage distance.

4 4.7 Interchange ability

The composite insulators including the end fitting connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC/IS standards 11kV/33 kV Composite Insulator (B & S Type) only.

4.8 Corona and RI Performance

All surfaces shall be clean, smooth without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal part shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operations conditions.

4.9 Maintenance :

The composite insulators offered shall be suitable for use of hotline maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

5.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS:

- 5.1 Composite Insulators shall be designed to meet the light quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.
 - (a). Core- the internal insulating part

- (b). Housing the external insulating part.
- (c). Metal and fittings for attaching to hardware to support conductor.

5.2 CORE

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP shall be manufactured through Pultrusion process. The FRP rod shall be void free.

5.3 HOUSING (Sheath)

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3 mm minimum. It shall be one-piece housing using injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences, external pollution and humidity. Housing shall conform to the requirement of IEC 61109/92-93 with latest amendments.

It shall be extruded or directly molded on core and shall have chemical bonding with the FRP rod. The strength of the bond shall be greater than the tearing strength of the polymer. Sheath material in the bulk as well as in the sealing/bonding area shall be free from voids.

Manufacturer should furnish a description of its quality assurance programme including fabrication; testing and inspection for any material (i.e rubber). Components (i.e rod) or hardware (i.e. end filings). The manufacturer has had fabricated by others should also be included.

Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer.

5.4 WEATHERSHEDS

The composite polymer Weathersheds made of silicone elastometric compound or silicon alloy shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. The weathersheds should have silicon content of minimum 43% by weight. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

5.5 METAL AND FITTINGS :

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron or forged steel, Metal end fittings shall be suitable for Ball and socket type hardware of respective specified mechanical load and shall be hot dip galvanized in accordance with IS 2629. The material used in fittings shall be corrosion resistant.

Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, silvers, slag, blow-holes shrinkages defects and localized porosity.

They shall be connected to the rod by means of a controlled compression technique. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be property attached to the core by a coaxial or hexagonal compression process and should not damage the individual fibers or crack the core.

The gap between fittings and sheath shall be sealed by flexible silicone elastometric compound or silicone alloy compound sealant, system of attached of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof.

The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/IS:2486 - Part-II/1989.

Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard shown at Sr. No.4.0. No joints in ball and socket or pin will be allowed. Outer portion of ball or socket should be Zinc Sleeved with minimum 99.95% purity of electrolytic high grade Zinc.

The finished surface shall be smooth and shall have a good performance. The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection.

The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either should or vision transmission.

Bottom end metal fitting (Shank) of Pin Insulator should be forged steel as per IS 2002/92. Length of thread on shank should be 100 mm and Shank diameter is 20 mm. Minimum Collar diameter should be 40 mm and its minimum thickness should be of 5 mm. Nuts as per IS 1363 (P-III) and 4 mm thick Spring Washer shall be as per IS 3063 with latest amendments if any, Nuts and spring washer shall be hot dip galvanized (For Pin insulators.)

6.0 WORKMANSHIP

6.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.

- 6.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
- 6.3 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 6.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.
- 6.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.
- 6.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents.

All surfaces of the metal parts shall be perfectly smooth without projecting points of irregularities, which may cause coronoa. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformity.

6.7 All ferrous part shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/Sq.mm or 87 um thickness and shall be in accordance with the requirement of IS 4759. The zinc used for galvanizing shall be of purity 99.5% as per IS: 4699. The zinc coating shall be uniform adherent, smooth, reasonable bright continuous and free from imperfections such as flux, ash rust stains. Bulky white deposits and blisters. The galvanized metal part shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

7.0 TESTS AND STANDARDS :

Insulators offered shall be manufactured with the same configuration Et raw materials as used in the insulators for which design Et type test reports are submitted. The manufacturer shall submit a certificate for the same. The design Et type test reports submitted shall not be more than 5 years old.

(A) DESIGN TEST:

For composite insulators, it is essential to carry out design test as per clause 4.1 of IEC 61109/92-93 with latest amendments. The design test are intended to verify the suitability of the design, materials and method manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which the represented by the one tested and having the following characteristics.

Same materials for the core and sheds and same manufacturing method.

- > Same material of the fittings, the same design, the same method of attachment.
- > Same or greater layer thickness of the shed material over the core (including a sheath where used):
- > Same or smaller ratio of the highest system voltage to insulation length;
- > Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings.
- > Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for design tests as per IEC - 61109 (Clause- 5) along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract.

UV test : The test shall be carried out in line with Clause of ANSI C29.13

(B) TYPE TEST:

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

Following type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings.

Sr.	Description of type test	Test
No.		procedure/standard
1	Dry lightning impulse withstand voltage test.	As per IEC 61109 (Clause 6.1)
2	Wet power frequency test	As per IEC 61109 (Clause 6.2)
3	Mechanical load-time test	As per IEC 61109 (Clause 6.4)
4	Radio interference test	As per IEC 61109 (Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure-B This test may be repeated every 3 years by the

6	Chemical composition test for silicon content	Annexure-B Or any other test method acceptable to the owner.
7	Brittle fracture resistance test	Annexure : B

The bidder shall submit type test reports as per IEC 61109 from NABL approved laboratory along with the bid. Additional type tests required if any shall be carried out be the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

(C)ACCEPTANCE TEST

The test samples after having withstood the type test shall be subject to the following acceptance test-

Sr.No.	Description	Standard
1	Verification of dimensions	Clause 7.2 IEC : 61109
2	Verification of the locking system (if applicable)	Clause 7.3 IEC : 61109
3	Galvanizing Test	IS : 2633 /IS : 6745
4	Verification of the specified mechanical load	Clause 7.4 IEC : 61109

(D)ROUTINE TEST :

Sr.N	Description	Standard
1	Identification of marking	As per IEC : 61109 Clause 8.1
2	Visual inspection.	As per IEC : 61109 Clause 8.2
3	Mechanical routine test	As per IEC : 61109 Clause 8.3

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50% of the SML for at least 10 sec.

(E) TEST DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable :

- (a) Chemical analysis of zinc used for galvanizing.
- (b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
- (c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

(F) ADDITIONAL TESTS:

The Owner reserves the right of getting done any other test(s) of reasonable nature carried out at Owner's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications. In such case all the expenses will be to Suppliers account.

8.0 TEST CERTIFICATE :

The tenderer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications from the NABL laboratory to prove that the composite Insulators offered meet the requirements of the specification. These type Tests should have been carried out within five years prior to the date of opening of this tender.

- (i) The offered composite Insulators are already fully type tested at approved Laboratory within five years prior to the date of opening of this tender.
- (ii) There is no change in the design of type-tested composite Insulators and those offers against this tender.

9.0 TESTING FACILITIES :

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

- (a) The bidders must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine and acceptance Tests. These facilities should be available to MGVCL's Engineers if deputed or carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender.
- (b) The insulators shall be tested in accordance with the procedure detailed in IEC 61109/92-93 with latest amendments.
- (c) Calibration Reports from Government approved testing laboratory of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burelle, thermometer, barometer etc.
- (d) Finished insulator shall be checked for dimension verification and surface finish separately.

Manufacturers of foreign origin shall, in addition to the above, also have arrangements in India, either at works of their authorized representative/ licenses or in the NABL laboratory for conducting sampling test in accordance with IEC 81109/92-93 with latest amendments.

10.0 DRAWINGS :

10.1 The Bidder shall furnish full description and illustration of the material offered.

- 10.2 The Bidder shall furnish along with the bid the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information.
 - (a) Long rod diameter with manufacturing tolerances.
 - (b) Minimum Creepage distance with positive tolerance.
 - (c) Protected creepage distance.
 - (d) Eccentricity of the long rod
 - (i) Axial run out.
 - (ii) Radial run out
 - (e) Unit mechanical and electrical characteristics.
 - (f) Size and weight of ball and socket/ tongue Et Clevis.
 - (g) Weight of composite long rod units.
 - (h) Materials
 - (i) Identification mark.
 - (ii) Manufacturer's catalogue number
- 10.3 After placement of awards, the Supplier shall submit full dimensioned manufacturing insulator drawings containing all the details in four (4) copies to owner for approval. After getting approval from owner and successful completion of all the type tests, the supplier shall submit 10 more copies of the drawing to the owner for further distribution and field use.
- 10.4 After placement of order, the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators for approval of the owner.

11.0 RETEST AND REJECTION :

11.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance Et Routine Tests.

For the sampling tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
N < 300	Subject to agreement	
300 < N < 2000	4	3
2000 < N < 5000	8	4
5000 < N < 10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot. The insulators shall be selected by the Owner's representative from the lost at random.

The samples shall be subjected to the applicable sampling tests. The sampling tests are:

Verification of dimensions- (E1+E2)Verification of the locking system - (E2)Verification of tightness of the interface between end fittings Et - (E2)Insulators housingVerification of the specified mechanical load SML- (E1)Galvanizing test- (E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows:

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests.

If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

11.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

11.3 Verification of the locking system (E2)

This test applied only to the insulators equipped with socket coupling as specified by IEC-120 and is performed according to IEC 383.

11.4 Verification of tightness of the interface between end fittings and insulator housing (E2).

One insulator selected randomly from the sample E2, shall be subjected to crack indication by due penetration, in accordance with ISO 3452, on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and metal and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

- > The surface shall be properly pre-cleaned with the cleaner;
- > The penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface.
- > With in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70% of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero upto 70% f the SML, and then maintained at this value for 1 minute;

> The surface shall be cleaned with the excess penetrant removed, and dried; > The developer shall be applied if necessary;

> The surface shall be inspected.

Some housing materials may be penetrated by the penetrant, In such cases evidence shall be provided to validate the interpretation of the results. After the 1 min, test at 70% of the SML, if any crack occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

11.5 Verification of the specified mechanical load SML.

The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75% of the SML, and then be gradually increased to the SML in a time between 30 sec to 90 sec.

If 100% of the SML is reached in less than 90 s, the load (100% of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1 min withstand test at the SML).

This insulators have passed the test at 13.4 Et 13.5 above if ;

- > No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70% withstand test (a) or during the 1 min. 100% withstand test (b).
- > No cracks are indicated after the dye penetration method described in 13.4 above.
- > The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

11.6 Galvanizing Test :

This test shall be performed according to IS : 2633/IS : 6745 on galvanized parts.

12.0 MARKINGS :

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

- (a) Name or trademark of the manufacture.
- (b) Voltage Et Type
- (c) Month and Year of manufacturing.
- (d) Min.failing load/guaranteed mechanical strength in kilo Newton followed by the word ' kN' to facilitate easy identification.
- (e) Country of Manufacturer.
- (f) Name of OWNER

13.0 PACKING :

- 13.1 All insulators shall be packed in strong corrugated box of min.7 ply duly paletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg. to avoid handling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.
- 13.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 13.3 Suitable cushioning, protective padding of dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 13.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate/corrugated box shall have all the markings stenciled on it in indelible ink.
- 13.5 The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

14.0 INSPECTION :

The Inspection shall be made as per GCC of Volume-I and Chapter- E2 of Volume – II of this Tender.

15.0 GUARANTEE :

(i) The stores covered by this specification should be guaranteed for satisfactory operation and against defects in design, materials and workmanship for a period of at least 36 [thirty six] months from the last date of delivery/demonstration. The above guarantee certificate shall be furnished in triplicate to the Owner for his approval. Any defect noticed during this period should be rectified/replaced by the supplier free of cost to the Owner provided such defects are due to faulty design, bad workmanship or bad materials used, within one month upon written notice from the Owner. The guarantee period for the rectified/replaced equipment shall be further guaranteed for 36 months(thirty six) from the date of rectification/replaced.

(ii) Equipment/material failed or found defective during the guarantee period shall have to be guaranteed after repair/replacement for a further period of 36(thirty six) months from the date of commissioning from the date of receipt at the store/site after such repair/replacement. Date of delivery as used in this clause shall mean the date on which the materials are received in OPTCL'S stores/site in full & good condition which are released for Despatch by the Owner after due inspection

<u>Annexure - A</u> The standards mentioned in this specification are available from

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

Annexure-B

Tests on Insulator units

1. RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10 kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition. The test procedure shall be in accordance with IS:8263 /IEC: 437/CISPR 18-2.

2. Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fittings by applying "1n HNO3 acid" (63 g conc. HNO3 added to 937 g water) to the rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3 Recovery of Hydrophobicity & Corona test The test shall be carried out on 4mm thick samples of 5cm x 7cm.

i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.

ii) The sample shall subjected to mechanical stress by bending the sample over aground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. Tentative arrangement shall be as shown in Annexure - E. The test shall be done for 100 hrs.

iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.

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

4 Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X-ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

ANNEXURE : C

Guaranteed Technical Particulars of 11 kv Insulator

Name of the Manufacturer :

BIDDER HAS TO CONFIRM FOLLOWING IMPORTANT REQUIREMENT:

Sr.	Description	Min. requirement for 1 1 kV 70 KN	Min. requirement	As per firm offer
No.				
1.	Type of Insulator	Polymeric Composite	Polymeric Composit	
2.	Standard according to which the insulators manufactured and tested.	IEC 61109	IEC 61109	
3.	Name of material used in manufacture of the insulator with class/grade)	SILICON Wacker- Germany Dow Corning-USA	SILICON Wacker- Germany Dow Corning-USA	
(a)	Material of core(FRP rod) (I)E-glass of ECR-glass.	ECR or BORRON FREE	ECR or BORRON FREE	
(b)	Material of housing Et weathersheds (silicon content by weight)	SILICON RUBBER 43 %	SILICON RUBBER 43 %	
(C)	Material of end fittings	SGI	SGI	
(d)	Sealing compound for end fittings	RTV SILICON	RTV SILICON	
4.	Colour	GREY	GREY	
5.	Electrical characteristics			
(a)	Nominal system voltage	11 KV	33 KV	
(b)	Highest system voltage	12 KV	36 KV	
(c)	Dry Power frequency withstand voltage	70 KV	105 KV	
(d)	Wet Power frequency withstand voltage	35 KV	75 KV	
(e)	Dry flashover voltage	50 KV	80 KV	
(f)	Wet flash over voltage	40 KV	75 KV	
(g)	Dry lighting impulse withstand voltage		470 1/1/	
	(b) Negative	75 KV 75 KV	170 KV 170 KV	
(h)	Dry lighting impulse flashover voltage a) Positive b) Negative.	80 KV 80 KV	180 KV 180 KV	
(i)	RIV at 1 MHz when energized at 10 kV/30kV (rms) under dry condition.	20	40	

Sr.No.	Description	Min. requirement for 11 kV 70 KN	Min. requirement for 33 kV 70 KN	As per firm offer
(j)	Creepage distance (Min.)	320 MM	900 MM	
6.	Mechanical characteristics	5 KN	10KN	
(a)	Minimum failing load.			
7.	Dimensions of insulator			
0	Weight	1.25	1.6	
(ii)	Dia of FRP rod	16 MM	16 MM	
(iii)	Length of FRP rod	240 MM	440 MM	
(iv)	Dia of weathersheds	90±1 MM	100 MM	
(v)	Thickness of housing	3 MM	3 MM	
(4)	Dry arc distance Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	160±5 MM	382 MM	
8.	Method of fixing of sheds to housing (specify). Single mould or Modular construction (injection moulding/compression moulding)	Injection moulding	Injection moulding	
9.	No of weathersheds	3	8	
10.	Type of sheds			
i)	Aerodynamic	Aerodynamic	Aerodynamic	
ii)	With underribds			
11.	Type of packing	Wooden Box	Wooden Box	
12.	Any other particulars which			
	the bidder may like to give.			
13	The insulators shall have "W" type phosphors Bronze security clips for ball sockets portion of insulators confirming	YES	YES	

CHAPTER- E12- 6

TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS

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TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS

1.0 SCOPE

This Specification covers design manufacture, testing at manufacturer's Works, supply and delivery of power conductor accessories, insulator and hardware fittings for string insulators suitable for use in 33 kV and 11kV Over-head transmission lines and sub-stations of OPTCL. The hard wares to be supplied shall be as per approved drawings of OPTCL. Any change there of shall be with due permission of OPTCL. The firm shall submit his drawings for approval of OPTCL and only after which the manufacturing shall be started.

The materials/equipment offered, shall be complete with all components, which are necessary or usual for the efficient performance and satisfactory maintenance. Such part shall be deemed to be within the scope of contract.

2.0 STANDARDS

The materials covered under this Specification shall comply with the requirement of the latest version of the following standards as amended up to date, except where specified otherwise.

i)	IS:2486 Part-II & III	Insulator fitting for overhead power lines with a nominal voltage greater than 1,000 volts.
ii)	IS:2121 Part I & II	Conductor & earth wire accessories for overhead power lines.
iii)	IS:9708	Stock Bridge Vibration Dampers on overhead power lines.
iv)	IS:2633	Method of testing of uniformity of coating on zinc coated articles
v)	IS:209	Specification for Zinc.
vi)	BS:916	Specification for Hexagonal bolts and nuts.

3.0 MATERIALS AND DESIGN

Aluminium and aluminium alloys, malleable iron and forget steel, having required mechanical strength, corrosion resistance and mach inability depending on the types of application for which accessories / fittings are needed, shall be employed.

In manufacturer of the accessories / fittings, the composition of the aluminium alloys used shall be made available to Owner if required for verification.

The materials offered shall be of first class quality, workmanship, well finished and approved design. All castings shall be free from blow-holes, flaws, cracks of other defects and shall be smooth, close grained and true forms and dimensions. All machined surfaces should be free, smooth and well finished. Metal fittings of specified material for conductor and earth wire accessories and string insulator fittings are required to have excellent mechanical properties such as strength, toughness and high resistance against corrosion. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to the minimum.

All bolts, nuts, bolt-heads shall be the white worth's standard thread. Bolt heads and nuts shall be hexagonal. Nuts shall be locked in an approved manner. The treads in nuts and tapped holes shall be cut after galvanizing and shall be well fabricated and greased. All other treads shall be cut before galvanizing. The bolt treads shall be undercut to take care of increase in diameter due to galvanizing.

All nuts shall be made of materials to Clause 4.8 of IS: 1367 (latest edition) with regard to its mechanical properties.

The general design conductor and earth wire accessories and insulator fittings shall be such as to ensure uniformity, high strength, free from corona formation and high resistance against corrosion even in case of high level of atmosphere pollution.

All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching to the tower or to the line conductor or to the earth wire shall be so designed that the effects of vibration, both on the conductor and the fittings itself, are minimized.

Special attention must be given to ensure smooth finished surface throughout. Adequate bearing area between fittings shall be provided and point or line contacts shall be avoided.

All accessories and hard wares shall be free from cracks, shrinks, slender air holes, burrs or rough edges.

The design of the accessories and hard wares shall be such as to avoid local corona formation or discharge likely to cause interference to tele-transmission signals of any kind.

4.0 GENERAL:

1. All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may however be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro-galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance withIS-2629-1985 and shall satisfy the tests mentioned in IS: 2633-1986. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall be guaranteed to withstand at least six successive dips each lasting one minute under the Standard Preece test for galvanizing.

- 2. The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanizing shall be of grade Zn 99.95 as per IS 209-1979.
- 3. Pin balls shall be checked with the applicable "G" 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.
- 4. Socket ends, before galvanizing shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS 2486/IEC-120. The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.
- 5. All current carrying parts shall be so designed end manufactured that contact resistance is reduced to minimum.
- 6. Welding of aluminum shall be by inert gas shielded tungsten are or inert gas, shielded metal arc process. Welds shall be clean, sound, smooth, and uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions Porosity shall be minimized so that mechanical properties of the aluminum alloys are not affected. All welds shall be properly finished as per good engineering practices.

5.0 Electrical Design:

The normal duty and heavy duty suspension, light duty, normal duty and heavy duty tension insulator sets shall all comply with the technical requirements and satisfy the test requirements

6.0 Mechanical design:

The mechanical strength of the insulators and corresponding insulator fittings must match .The design shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to the development of defects.

Insulating material shall not engage directly with hard metal. All fixing materials shall be of approved quality, shall be applied in an approved manner and shall not enter into chemical action with the metal parts or cause fracture by expansion in service. Where cement is used as a fixing medium, cement thickness shall be as small and even as possible and proper care shall be taken to correctly centre and locate the individual parts during cementing.

7.0 GALVANISING:

All ferrous parts of conductor and ground wire accessories and insulator hard wares shall be galvanized in accordance with IS: 2629-Recommended Practice

for hot dip galvanizing of iron and steel or any other equivalent authoritive standards. The weight of zinc coating shall be determined as per method stipulated in IS: 2633 for testing weights, thickness and uniformity of coating of hot dip galvanized articles or as per any other equivalent authoritative standards. The zinc used or galvanization shall conform to grade Zn 98 of IS: 209. The galvanized parts shall withstand four (4) dips of 1 minute each time while testing uniformity of zinc coating as per IS: 2633.

Spring washers shall be electro galvanized.

8.0 INSULATOR HARDWARES

The insulator disc hardwares and string assemblies to be offered by the tenderer shall be suitable to meet the requirement given in the specific technical particulars as detailed hereinafter.

Hardwares for suspension and tension insulator shall be suitable for insulator with normal pin shank diameter of 20mm. in case of tension string unit and 16mm. for suspension string unit.

Each insulator string shall generally include the following hardware components.

Single Suspension Set.

a) Ball Hook.

b) Tower / Pole side arcing horn

- c) Socket Eye with R-Type security clip.
- d) Line side arcing horn.
- e) Suspension clamps Armoured Grip Suspension AGS Type

Double Suspension Set.

- i) Ball Hook.
- ii) Socket clevis with R-Type security clip-3 Nos.
- ii) Yoke Plate-2 Nos.
- (i) Tower / Pole side arcing horns-2Nos.
- (ii) Ball clevis 2 Nos.
- (iii) Line side arcing homs-2 Nos.
- (iv) Clevis Eye.
- (v) Suspension Clamp. Armoured Grip Suspension AGS Type

Single Tension Set :

- a) Anchor Shackle.
- b) Ball Eye.
- c) Tower / Pole side arcing horn.
- d) Socket Clevis with R-Type security clip.
- e) Line side arcing horn
- f) Bolted type dead end clamp.

- Double Tension Set :
- a) Anchor Shackle.
- b) Chain Link.
- c) Yoke Plate 2Nos.
- d) Tower / Pole side arching horn.
- e) Ball Clevis 2 Nos.
- f) Socket Clevis with R-Type security clip – 2 Nos.
- g) Line side arcing horns.
- h) Bolted type dead end clamps.

9.0 SUSPENSION CLAMPS

This clamp will be AGS type made out of aluminum alloy suitable for accommodating preformed armored rod.

10.0 TENSION CLAMPS

The Tension Clamps shall be made out of aluminum alloy and of 4 **pair** bolted **(M-16)** type suitable for 100 mm² & 148 mm² AAAC conductor .The tension clamps shall not permit slipping or damage to failure of the complete conductor or any part thereof at a load less than 90% of the ultimate strength of conductor. The mechanical efficiency of tension / clamps shall not be affected by method of erection involving come / along or similar clamps or tension stringing operation during or after assembly and erection of tension clamp itself. The tension clamp shall be of a design that will ensure unrestricted flow of current without use of parallel groove clamps.

The clamps shall be as light as possible.

11.0 ARCING HORNS

Each hardware assembly shall have provision for attaching arcing horns of both adjustable and non/adjustable type across the suspension and tension strings or tower side. However each hardware assembly shall be provided with arching horn of fixed type on line side only.

12.0 TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

12.1 The fittings and accessories for the power conductor, insulator and hardwares shall be tested in accordance with IS:2121, IS:2486, BS:916 for hexagonal bolts and nuts Six sets of type and routine test certificates and performance reports are to be submitted by the Contractor.

The Owner however, reserves the right to get all the tests performed in accordance with the relevant I.S. Specification as Acceptance Test in presence of Employer-s representatives.

The tenderer shall clearly state the testing facilities available in the laboratory at his Works and his ability to carry out the tests in accordance with this Specification. All the specified tests shall be carried out without any extra cost.

Acceptance Test for power conductor accessories.

- a) Visual examination
- b) Dimensional verification
- c) Failing load test
- d) Slip strength test (for clamps)
- e) Electrical resistance test
- f) Fatigue test (for vibration dampers)
- g) Mass pull off test (for vibration dampers)
- h) Galvanizing test.

12.2 ACCEPTANCE TEST FOR HARDWARES

- i) Dimensional verification.
- ii) Ultimate tensile test.
- i) Slip strength test.
- ii) Electrical resistance test.
- iii) Heating cycle test
- iv) Breaking strength of full string assembly.
- v) Galvanizing test.

13.0 BONDING PIECES:

a) material		flexible copper bond (37/7/0.417 mm.
		tinned copper flexible stranded cable).
b) Length	:	Not less than 750 mm.
c) Bolt size	:	16mm x 40 mm.
d) Copper area.	:	34 sq.mm.
e) Thickness of log	:	6 mm.
f) Material for connecting socket	:	Tinned Brass

14.0 FASTENERS: Bolts, Nuts & Washers

- 1. All bolts and nuts shall conform to IS-6639-1972. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being truly concentric, and square with the shank, which must be perfectly straight.
- 2. Bolts upto M16 and having length upto ten times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 Mpa minimum as per IS-12427. Bolts should be provided with washer face in accordance with IS-1363 Part-I to ensure proper bearing.
- 3. Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.
- 4. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but not further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and be tight to the point where shank of the bolt connects to the head.
- 5. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS-2016-1967.

- 6. The bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of the bolts and size of holes and any other special details of this nature.
- 7. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.
- 8. Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
- 9. Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolts shall be 5.6.

15.0 Technical Specification for Design, Supply and Testing of Hard ware fittings.

15.1 Type tests:

The following type tests shall be conducted on hardware fittings.

A. On suspension hardware fittings only.

- (i) Magnetic power loss test.
- (ii) Clamp slip strength Vs torque
- (iii) Mechanical strength test.
- (iv) On one test on elastomer.

B. On Tension hard ware fittings only.

(i)	Electrical resistance test for	IS 2486 (Part-I) 1971
	Dead end assembly.	
(ii)	Heating cycle test for	-do-
	Dead end assembly.	

- (iii) Slip strength test for IS 2486 (Part-I) Dead end assembly.
- (iv) Mechanical strength test.

C. On both suspension and tension hardware fittings.

- (i) Visual examination. IS-2486 (Part-I) 1971
- (ii) Verification of dimension. -do-
- (iii) Galvanizing / electroplating test. -do-
- (iv) Mechanical strength test of each component

(including corona control ring/grading ring and arcing horn)

- (v)Mechanical strength test of welded joint.
- (vi) Mechanical strength test for corona control ring/
grading ring and arcing horn. BS-3288 (Part-I)

- (vii) Test on locking device for ball and socket coupling. IEC 3721984
- (viii) Chemical analysis, hardness tests, grain size,

inclusion rating and magnetic particle inspection for forging/casting.

D. On suspension hardware fittings only.

- (i) Clamp slip strength ver as torque test for suspension clamp.
- (ii) Shore hardness test of elastomer cushion for AG suspension clamp.
- (iii) Bend test for armour rod set. IS-2121 (Part-I)
- (iv) Resilience test for armour rod set. -do-

(v)Conductivity test for armour rod set. -do-

All the acceptance tests stated at clause shall also be carried out on composite insulator unit, except the eccentricity test at clause. In addition to these, all the acceptance tests indicated in IEC 1109 shall also be carried out without any extra cost to the employer.

E. For hardware fittings.

- (a) Visual examination. IS-2121 (Part-I)
- (b) Proof & test.
- F. Tests on conductor accessories.
- G. Type tests.
- H. Mid span compression joint for conductor and earth wire.
 - (a) Chemical analysis of materials.
 - (b) Electrical resistance tests. IS-2121 (Part-II) 1981 clause 6.5 & 6.6
 - (c) Heating cycle test. -do-
 - (d) Slip strength test. -do-

CHAPTER- E12-7

TECHNICAL SPECIFICATION

FOR

HG FUSES

TABLE OF CONTENTS OF 33KV & 11KV H.G. FUSE

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TECHNICAL SPECIFICATION FOR 33KV & 11KV, 200A, 3 POLE HG FUSES

1.0 SCOPE

This specification covers the design manufacture, shop testing, loading, transportation and delivery at sub-station site of 33KV, 200Amp, 3Pole & 11KV, 200Amp, 3Pole H.G. Fuse Sets for outdoor installations to be used at 33/11KV Sub-stations.

2.0 STANDARDS: - The H.G. Fuse Set shall conform to the following standards:-

- i) IS- 5792- 1973 (For high voltage expulsion fuses & similar fuses)
- ii) IS-2544-1973 (for porcelain post insulators)
- iii) IS-9385-1979 or its latest amendments if any.
- iv) IS-2633-1979 (For Galvanization of ferrous parts)

3.0 INSULATORS:-

The 12KV & 22KV/ 24KV post insulators complete with pedestal cap duly cemented to be used in the H.G. Fuse sets confirming to IS-2544/1973.

The type of insulation materials, metal fittings, Creepage distance, protected Creepage distance, tensile strength compression strength, torsion strength and cantilever strength shall be as provided in the Guranteed technical particuras at Schedule-I

The bidder shall furnish the type test certificate of the post insulators from their manufacturer for reference & scrutiny.

4.0 TECHNICAL DETAILS:-

The H.G. Fuses shall have adjustable arcing horns made of solid copper rod having 8.23 mm dia. The horns shall be fitted with screwing devices with fly nuts for fixing and tightening the fuse wire. It shall have robust terminal connector of size 80mm x 50 mm x 8 mm made of copper casting (95% minimum copper composition) duly silver plated with two numbers of 12mm dia brass bolts and double nuts with flat brass washers. The connector should be capable of connecting crimp able conductor up to 232 Sq.mm. size (ACSR/AAAC) with bimetallic solder less sockets .The H.G. Fuse Set shall be suitable for horizontal mounting on Sub-station structures. All metal (ferrous) parts shall be galvanized and polished. Only post insulator (original cemented and not pin insulators shall be used for the H.G. Fuse Set.

5.0 DRAWIING & LITERATURES:-

Three copies of drawings of each item of 33KV & 11KV, 200Amp, 3 Pole H.G. Fuse shall be furnished along with the tender for reference. The details of construction and materials of different parts of the H.G Fuse shall clearly be

indicated in the tender and illustrative pamplet/ literature for the same shall be submitted along with the tender.

6.0 TESTS & TEST CERTIFICATE:-

- **6.1 Type Test:-** Certificates for the following type tests conducted within five years proceeding to the date of opening of tender on a prototype set of H.G. Fuse in a Govt. Approved Testing Laboratory preferably at CPRI shall be submitted along with the tender.
 - i) Impulse voltage dry test
 - ii) Power frequency voltage dry test
 - iii) Power frequency voltage wet test
 - iv) Temperate of resistance.
 - v) Test to prove the capability of carrying the rated peak short circuit current and the rated short time current.
 - vi) Mainly active load braking capacity test.
 - vii) Transformer off-load breaking test.
 - viii) Line charging breaking capacity test.
 - ix) Operation tests.
 - x) Mechanical endurance test.
 - xi) Mechanical strength test for the post insulator as per IS:2544/1973, 5350 (Pt-II)/1970 & relevant IEC.
 - xii) Test for galvanization of metal (ferrous) parts as per IS- 2633/1973.

6.2 Routine Tests:-

The following routine tests shall have to be conducted on each sets.

- i) Power frequency voltage dry test.
- ii) Tests to prove satisfactory operation.
- iii) Dimension check.
- iv) Galvanisation test.

7.0 COMPLETENESS OF EQUIPMENT:-

Any fittings accessories or equipment which may not have been specifically mentioned in this specification but which are usually necessary in equipment of similar plant shall be deemed to be included in the specification and shall be supplied by the Bidder without extra charge. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not.

8.0 GURANTEED TECHNICAL PARTICULARS - GURANTEED TECHNICAL PARTICULARS FOR 200 AMP, 3 POLE, H.G. FUSES (Schedule –I) IS FURNISHED AT CHAPTER- E24.

CHAPTER- E12 - 8

TECHNICAL SPECIFICATION FOR EQUIPMET CLAMPS & CONNECTORS

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TECHNICAL SPECIFICATION FOR EQUIPMET CLAMPS & CONNECTORS

1.0 SCOPE

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply and delivery at site of all terminal connectors of 33kV equipment (mainly breaker, isolator, CT, IVT, BPI and SA) and all other clamps and dropper connectors required for the switch yard as per approved lay out and system design.

2.0 STANDARDS

The terminal connectors under this specification shall conform strictly to the requirements of the latest version of the following standards as amended up-to-date, except where specified otherwise.

- i) IS: 556 Power Connectors.
- ii) IS: 617 Aluminium & Aluminium Alloy
- iii) IS: 2629 Recommended Practice for hot dip galvanizing of iron and steel.
- iv) IS: 2633 Method of testing uniformity of coating of zinc coated articles.

The materials conforming to the standards are only acceptable. The salient point of these specifications and points of difference between these and the above specifications shall be clearly brought out in the bid.

3.0 MATERIAL & WORKMANSHIP

The terminal connectors shall be manufactured from Aluminium Silicon Alloy and conform to designation A6 of IS: 617 (latest edition)

The connectors shall be of best quality and workmanship, well finished and of approved design. Specific materials for clamps and connectors should have high current carrying capacity, high corrosion resistance and be free from corona formation.

All connectors or its components to be connected with conductor shall be of bolted type having aluminium purity not less than 99.5%.

All bus bar clamps shall be made preferably from forged aluminium of purity not less than 99.5%. The thickness and contact surface should be maintained in such a way that the clamp should conform to IS:5561/1970 or any latest revision thereof.

4.0 RATING

The connector rating shall match with the rating of the respective equipment for the terminal connectors and the connectors for bus bar and dropper should be of the following rating. Minimum thickness at any part of connector shall be 10(ten) mm. Indicative ratings are given below:

SI No.	Rating	33 KV
1	Main bus bar connectors high level and low level (Amps)	1250
2	High level bus sectionalisation Isolator (Amps)	1250
3	-do- for CT	As per CT rating
4	-do- for Pl	As per PI rating
5	-do- for LA	As per LA rating
6	-do- for PT	As per PT rating

5.0 EQUIPMENT CONNECTORS

Bimetallic connectors shall be used to connect conductors of dissimilar metal. The following bimetallic arrangement shall be preferred.

- a) Copper cladding of minimum 4 mm. thickness on the aluminium portion of connector coming in contact with the copper palm or stud of the equipment.
- b) Alternatively, to provide cold rolled aluminium copper strip between the aluminium portion of the connection, the sheet thickness shall not be less than 2 mm.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangements, but the contact pressure should not be so great as to clause relaxation of the joint by cold flow, the joint should be such that the pressure is maintained within this range under all conditions of service, to avoid excessive local pressure, the contact pressure should be evenly distributed by use of pressure plates, washers or suitable saddles of adequate area of thickness should be less than that of an equal length of conductor where measured individually test results showing the milli drop test and resistance should be enclosed with the bid.

All connectors shall be so designed and manufactured as to offer ease of installation as these are to be used in overhead installations, design shall be such that full tightening of nuts and bolts should be possible with the use of double wrench.

The connectors shall be such as to avoid local corona, sound or visible discharge.

6.0 TEMPERATURE RISE

The temperature rise of connectors when carrying rated current shall not exceed 45° C above reference design temperature of 50° C.

- i) Acceptance Tests
 - (a) Tensile Test
 - (b) Temperature rise test
 - (c) Temperature rise test
- ii) Routine Test
 - (a) Visual Inspection
 - (b) Dimensional Check

Type test reports from a recognized laboratory shall have to be submitted.

7.0 WEIGHTS

Weights of different materials uses in manufacture, such as aluminium, silicon, copper etc. should be clearly indicated in GTP & Drawing.

8.0 INTERCHANGE ABILITY

Corresponding parts of similar clamps and connectors shall be made to gauge or jig and shall be interchangeable in every respect.

9.0 SCHEDULE FOR TECHNICAL REQUIREMENTS:

9.1 TENSION CLAMPS

SI. No.	Details	Suitable for AAAC
	(TENSION CLAMPS)	(148/100mm2)
1	Туре	Compression type tention clamp
2	Material	Ext. Al.Alloy/Ext. Al.
3	Breaking Strenght	95% of UTS of Conductor
4	Slipping Strenght	95% of UTS of Conductor
5	Galvanising	
а	Ferrous Parts	Hot Dip Galvanised
b	Spring Washers	Electro Galvanised
6	Quality of Zinc used	99.95 %
7	Number of dips which the clamp can withstand	4/1 minute dips
8	Standard to which	IS 2633

	Conforming	
9	Electrical conductivity	
a.	Results of heating cycle test carried out	T.C. Attached
b.	Electrical resistance	Not more than 75% of equivalent length of conductor
10	Reference to type tests and other test reports attached	T.C. Attached
11	Make of bolts and Nuts used	Local Make

9.2 SUSPENSION CLAMPS

SI. No.	Details	Requirement:
	(SUSPENSION CLAMPS)	Suitable for AAAC (150/100mm2)
1	Type of material used for retaining rod for AGS assembly giving reference of ISS	Alluminium Alloy 6061/Equivalent
2	Minimum tensile strength of retaning rod material	35 Kg/mm2
3	Chemical composition of retaning rod materials	As per IS:733
4	Electrical conductivity of Armour Rod material(In percentage of the conductivity of IACS i.e. International Annealed Copper Standard	Not less than 40 %of IACS
5	Slipping strength of cushioned suspension assembly	8% to 15% of UTS of Conductor
6	Breaking strength of suspension Clamp	6000 Kgf
7	Minimum Tensile Strenght	2000 Psi
8	Minimum ultimate Elongation	300 %
9	Ageing (guaranteed life of the assembly)	40 Years
10	Hardness	65 to 80 A

9.3 FLEXIBLE COPPER BOND

SI. No.	Details	Requirement:
	(Flexible Cupper Bond)	
1	Stranding	37/ 7/ 0.417
2	Cross sectional area(Sq.mm)	75.6
3	Minimum copper equivalent area(sq.mm)	34(each individual wire)
4	Length of copper cable(mm)	500
5	Material Lugs	Tinned copper
6	Bolt Size	
	(i) Diameter(mm)	16
	(ii) Length(mm)	40
7	Resistance(ohm)	0.0004(as per IS.2121)
8	Total weight of Fexible copper bond(kg)	0.45(approx)

CHAPTER- E12- 10

TECHNICAL SPECIFICATION FOR LT DISTRIBUTION BOX

TABLE OF CONTENTS OF LT DISTRIBUTION BOX

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1.0 DESCRIPTION OF MATERIALS:- The L.T. Distribution Cabinets shall be installed on D.P. Structure for Plinth Mounted 33/.4 KV Substation of the ratings indicated above. These Distribution Cabinets are to be outdoor type and to be fabricated out of 2 mm GI sheet steel. The GI sheet steel shall be by hot dip galvanization process. The body of the boxes shall have sufficient re-enforcement with suitable size of channels keeping a provision for fixing these boxes either on DP structure or plinths.

- 1.1 The Box shall have double door with self locking (When the main MCCB is in close position the inner door can not be opened and after closing of the inner door only the main MCCB can be closed) arrangement and a door handle conforming to general quality conditions. Any compromise on quality of the door handle used shall be liable for rejection. The roof of the box shall be slightly slanting both sides as per drawing with an over hang of 50 mm to the front and back side. Locking arrangement shall be Godrej Type, 3 Position Locking System for better Security. However, a separate provision for manual locking arrangement shall also be provided as stand by.
- 1.2 The nuts, bolts, washers used in the box shall be galvanized to avoid rusting. The door hinges shall not be visible from outside. The box shall have two no.s of solid Earthing points on either side with an arrangement for sufficient ventilation.
- 1.3 The boxes should confirm to IP-55 degree of protection. The bidders shall have to enclose type test certificate for degree of protection (IP-55) after their product duly tested at CPRI or any Govt. approved laboratory failing which their bid is liable for rejection. Preference shall be given to those who have successfully conducted type test as mentioned above.
- 1.4 The box shall have provision of bus bars of Copper mounted on epoxy resin cast bus insulators fixed on suitable fixing arrangement. The bus bars shall be conveniently placed so as to provide adequate clearance from the body of the box conforming to I.E. Rules applicable for L.T. supply with provision for one Bus Bar arrangement with 4 pole MCCB for all capacities of LTDBs & 1 number of outgoing feeder arrangement with 2sets of three pole MCCBs in each feeder for 100KVA LTDB. The Bus-Bar arrangement may be suitably made to house one out-going feeders with sufficient clearance between phases inside the LT Distribution Boxes.

There should be Heat Shrinkable Busbar insulation tubing of Red Yellow-Blue & Black. Alternatively phase coloured insulated paint (not less than 3.0kV) should be applied on the Bus-bars.

- 1.5 The arrangement and dimensions shall be as per the drawing enclosed.
- 1.6 The provision of Earthing is to be made up with Copper Flat of Size 25x4mm. Suitable cable glands of heavy duty, double compression type made up of Brass shall be provided at the bottom of the Box. One for incoming cable and one outgoing cable. Detachable plates shall be provided for fixing of cable glands.

- 1.7 The Drawings shown below are indicative. Prior to manufacturing the bidder shall submit detail drawing with arrangement of Bus bar, MCCB phase indicator lamps etc for approval by the Owner.
- **2.0 MCCB:-** MCCB shall be used from the Vendor List specified in Chapter- **E23** of the tender.

The Owner reserves the right to chose any one out of 4/3 Pole M.C.C.B.

- i) Standard:-IS:60947& IEC Pub 947 2 (1989)
- ii) Rated Voltage : 415V.AC.
- iii) No. of Poles: 4pole for incomer & 3pole for Outgoing feeders' protection.
- iv) Rated current : 200A
- v) Service short circuit breaking capacity = 25 kA &
- vi) Ultimate short circuit breaking capacity = 35 kA

All other features of the MCCB shall conform to the as per IS:60947 & IEC Pub - 947 (Pt. 2) /1989.

vi) Type of protection: - Overload & short circuit protection is a must with static / electromagnetic / thermo magnetic trip release with manual resetting. For Neutral un-balance current protection the bidders are to furnish alternative rates as indicated above.

DRAWING for L.T Distribution Box for 63 KVA, 100KVA to 200 KVA Transformers is as per chapter - E21.

N.B :

Separate terminal bar to be provided for Neutral connection.

Details:-

SI	Dimension /	63 KVA	100 KVA
No	Description		
1	A	700	1000
2	В	600	800
3	С	400	500
4	D	80	170
5	E	90	250
6	Incomer 4Pole MCCB	100 A, with Over Current Setting 80% to 100%	200 A, with Over Current Setting 80% to 100%
7	Cable Size for Incomer	50 mm2,3 1/2 core cable	95 mm2 , 3 1/2 core cable
8	Three Pole MCCB for out- going feeder	50 Amp, with Over Current Setting 80% to 100% (2sets each)	100 Amp, with Over Current Setting 80% to 100% (2sets each)
9	Bus Bar for Incoming & Out going feeders	25 x 6 mm	40 x 6 mm
10	Bus Bar material	Electrolytic Aluminium	Electrolytic Aluminium
11	A neutral Bus bar sim	nilar to phase Bus bar is to	be provided.

N.B. : - 1) 4Pole MCCB for Incomer & 3pole MCCB for outgoing feeder for individual tripping of each phase due to faults in the respective phases in the outgoing feeder, of reputed make to be specified in the tender along with test report from CPRI / Govt. testing lab. It shall confirm to as per IS:60947 with latest amendment. The bidder should also furnish the purchase order of MCCBs with serial number for verification of genuineness of the MCCBs.

The in-coming cable should be connected to the terminals of the M.C.C.B. with Bi-metallic lugs preferably of Usha Martin make duly crimped with Die-less crimping tools. There should be a metallic / heat resistant insulating barrier between the individual M.C.C.Bs so that the heat generated during any fault inside the Box should not pass to the other M.C.C.Bs.

3.0 General Technical Particulars for LT Distribution Boxes : -

- 1) The L.T. Distribution Boxes should be of the dimensions as per the drawing & details in the table furnished.
- 2) The bidders can quote with their own design suitably accommodating the components as indicated in this bid in conforming to the approved clearances and technical requirements. The dimensions are only illustrative. Tolerances of dimensions are 10% over & above the dimensions specified. The

bidder may specify their own dimensions and quote accordingly. The drawing and dimension should be submitted with the bidding document.

- 3) The distribution boxes shall be duly wired with suitable size of PVC insulated single core copper cable or equivalent section copper / aluminum flat.
- 4) Terminal connectors for the earth connections to be provided in the box.
- 5) The distribution cabinet should be preferably of IP-55 protective category, with provision for lighting inside the cabinet. Owner's Name & SI. No. Punching Marks should be given on any one of the sidewalls of each box as an identification of Owner's property, besides furnishing a non-detachable Nameplate, which should exhibit the details of L.T. Distribution Cabinet.
- 6) **TESTS : -** The 4pole & 3pole M.C.C.Bs. to be mounted with Distribution Boxes shall have been fully type tested as per the relevant standard at CPRI/ Govt. approved laboratory. The bid shall be accompanying with type-test reports conducted at Central Power Research Institute / Govt. approved laboratory for the offered materials conducted within last five years before the date of opening of the tender. The Type Test must have been as per OPTCL requirement. If OPTCL desires another type test, it has to be conducted. In such case OPTCL will bear the transportation of equipment/material and type test charges.

4.0 INSPECTION TESTING:-

The Inspection shall be made as per **GCC of Volume-I** and **Chapter- E2** of **Volume – II** of Tender Specification.

The Owner shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Owner without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.

The equipment shall successfully pass all the acceptance tests and routine tests referred to and those listed in the most recent edition of the standards given in this specification.

The Owner reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall have been / shall be carried out at CPRI / National Govt. approved Laboratory and be witnessed by a representative of such laboratoryr. Routine tests shall be carried out by the Supplier at no extra charge at their works.

Adequate facility with calibrated testing equipment must be provided by the manufacturer free of cost to carry out the tests. Type test certificates must be furnished along with the tender for reference of the Owner.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Supplier who shall provide the Owner with all the test facilities which the latter may require, free of charge. The Owner shall have the right to select the samples for test and shall also have the right to assure that

the testing apparatus is duly calibrated and correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Supplier at an approved laboratory and shall be approved by the Owner.

The Supplier shall be responsible for the proper testing of the plant or materials supplied by sub-suppliers to the same extent as if the work, plant or materials were completed or supplied by the Supplier.

Any cost, incurred by the Owner in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or offloading shall be to the account of the Supplier.

The supplier shall submit to the Owner five signed copies of the test certificates, giving the results of the tests as required. No materials shall be despatched until the test certificates have been received by the Ownerand the Supplier has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, The Supplier shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

The Owner at his discretion may re-confirm the Test Results in his own laboratory or laboratory of his choice.

No inspection or lack of inspection or passing by the Owner's Representative of equipment or materials whether supplied by the Supplier or sub-supplier, shall relieve the Supplier from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

5.0 ACCEPTANCE AND ROUTINE TESTS :-

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of owner's representative.

6.0 DOCUMENTATION :-

The Bidder shall furnish the following drawings along with the offer.

General outline and assembly drawing of the L.T. Distribution Box

- 1. Cross Sectional view
- 2. Arrangement of terminals & details of connection studs provided
- 3. Name plate
- 4. Schematic drawing
- 5. Type test reports, in case MCCB has already been type tested

- 6. Test reports, literature of the bought out items and raw materials
- 7. Testing facilities available at the works
- 8. List of customers with detailed address / purchase reference, quantity and year of supply with user certificate for such items.

7.0 COMPLETENESS OF EQUIPMENT

Any fittings accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary in equipment of similar plant shall be deemed to be included in the specification and shall be supplied by the Tenderer without extra charge. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not. CHAPTER- E13

TECHNICAL SPECIFICAION

FOR **EARTHING AND EARTHING COIL**

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PART - A

SUB-STATION EARTHING

1.0 EARTHING:

Earth mat design to be carried out referring to the IEEE-Std 81 before implementation of the same. Design shall be based on the soil resistivity. The measurement of the soil resistivity is to be taken before the representative of Owner by using a latest 4-port Digital Earth Tester duly calibrated having validity period. The design of Earth mat to be furnished by the Contractor for approval of the Owner.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

1.1 GUIDE LINE:

The Earth mat conductor shall be of 75x10 mm GI flats and it shall be laid in both the directions in the Switchyard and the gap between each conductor shall not be more than 2(two) Mtr. However, this gap may be further reduced depending on the design.

Earth risers should be of 50x6 mm GI flats. All equipment & metal parts of the Sub-station should be connected with main earth grid by using 50x6 GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap welding should not less than 150 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using 'C 'clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:3:6) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonite powder (10:1) mix.

All equipment, steel structures etc. should be connected with main earth mat at two points and with separate risers from the main earth mat. All equipment, structures, spikes (if any) should be connected individually with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two separate Pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each Pipe electrodes should not be less than 3 mts. The back filling of Pipe electrodes should be done in layer of Charcoal, loam soil mixed with Bentonite powder. The value of earth resistance should be less than 0.5 ohm with above arrangement. Where there is possibility of not achieving the earth resistance value, special type of earthing device (chemically treated) can also be used to achieve the desired value.

There should be a closely spaced earth grid of size 1.5 mts x 1.5mts by using 75 mm x 10mm GI flat, with 0.3 mts spacing both ways below the mechanism boxes of each Isolators & AB switches. In Sub-station the diameter of Pipe electrode should not be less than 50 mm dia, heavy gauge GI Pipe (perforated). The Flange (50x6) mm GI flat should be welded in all sides with Pipe electrode. In each face of Flange there should be two nos. of 17.5 mm hole to accommodate 16 mm GI Bolt & nut with spring washer.

The fencing of the Switchyard should not directly be connected with main earth mat grid. There should be a separate earth mat by running 75x10 mm GI flat at 2 mts away from outside the fence and should be connected rigidly with the fence at an interval of 5 mts. In addition, another GI Flat of 50x6 mm should run continuously over the fencing and proper welding is also to be made. There should be one 50x6 mm earth flat run over the cable rack and should be connected with main earth mat grid at an interval of 5 mts . The jointing portion of earth flats over the ground should be painted with two coats of Anti-corrosive paints and two coats of good quality of Aluminium paints (Berger/Asian paints).

Provision of watering to earth pits shall have to be provided by using conduit pipe arrangement. The pipes are be connected to the water source provided in the S/s. Each handles of Isolators / AB switches etc should be connected with earth mat grid by using flexible Tinned Copper earth bonds (25mm x 5mm through net). In each earth switches 2(two) nos. flexible earth bonds should be provided. Each earth pits having pipe electrodes should be provided 250 mm Brick wall chambers duly plastered on all the side with RCC cover Slab. The size of the chamber shall be **450x450x600**mm.

2.0 G.I. Flat (75x 10 mm) & G.I.Flat (50 x 6 mm)

The specification covers supply and testing of Galvanized Steel flat for Earthing arrangements.

2.1. APPLICABLE STANDARDS:

Materials shall conform to the latest applicable Indian standards / International standards.

SI. No.	Standard No.	Title
1	IS:2062 Grade 'A' Quality	Specification for M.S. Channel and M.S. Flat
2	IS:2062	Chemical and Physical Composition of material
3	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel products

2.2. INSPECTION AND TEST CERTIFICATE

The Inspection shall be made as per **GCC of Volume-I** and **Chapter E2** of **Volume – II** of Tender Specification.

The routine & acceptance tests shall be in accordance with the latest version of the relevant Indian Standard.

All conductors buried in earth or in concrete or above the ground level shall be galvanized steel. Galvanized steel shall be subject to four one minute dips in copper sulphate solution as per IS:2633/1922).

The materials to be supplied will be subject to inspection and approval by the Owner's representatives before dispatch unless otherwise waived. Inspection before dispatch shall not, however, relieve the Contractor of his responsibility to supply the steel section strictly in accordance with the ISS.

The representative of Owner shall pick up samples at random from the GI Flats offered for carrying out Routine tests as per specified IS. The representative shall make visual inspection on each & every GI flats. The Owner reserves the right to reject the material if the same is found defective at destination.

2.3. METHOD OF GALVANISING:

<u>SI. No.</u>	<u>Tests</u>	For GI Flat
1	Dip test	6 dips of 1 min each
2	Mass of Zinc coating	610 gram/sq.m minimum

Pre dispatch inspection shall be performed to witness following tests:

- i) Freedom from defects,
- ii) Verification of dimensions
- iii) Galvanization tests

iv) Mechanical tests

v) Chemical composition tests

These tests are to be performed and certified at Govt. recognized laboratory. MS flat shall conform to IS 2062 & its latest amendments for steel & Galvanization as per IS 4759 & its Latest amendments.

The flat shall be coated with Zn 98 Zinc grade.

The minimum Zinc coating shall be 610 gm/sqm for thickness more than 5 mm and 460 gm/sqm for item thickness less than 5 mm.

3.0 Earth Electrode (50mm Dia. GI having gauge perforated pipe as per ISS)

3.1. Scope:-

This specification provides for Supply of Earthing Device (**Heavy Duty**) (50x3000 mm), as per enclosed Drawing.

3.2. APPLICABLE STANDARDS:-

The Earthing Device must be made out of 50 mm (Heavy Gauge- No minus Tolerance is allowed on Wall thickness) Hot Dip G.I. Pipe (as per IS: - 1239,m Part-1, 1990 of reputed Make – (i.e. **SAIL/TATA/ RINL/JINDAL)** & 3.0 mtrs length tapered finished smooth at one end for a length of 75 mm & Clamp at the other end.

Staggered drills hole of 12mm Dia. at an interval of 150mm shall be made before galvanization.

The GI Earthing Clamp/ Strip (C -Clamp Type) is to be of 50mm width, 6mm thickness & flange length of 65 mm in each side. This should be suitable for termination of 4 nos. of GI Flat earth electrodes. The Clamp/ Strip & Earthing pipe after fabrication will be hot dip galvanized confirming to IS: 2629/85 with latest amendments. The clamp shall have two holes in both sides suitable for 16 mm GI Bolts & Nuts. There shall be provision of funnel for pouring water through pipes. The height of the funnel shall be such that the watering will be better. Provision of reduced of GI pipe to be converted to the main GI earth pipe & on the top of the funnel is to be provided.

PART – B

TECHNICAL SPECIFICATION FOR **EARHTING COIL**

TECHNICAL SPECIFICATION OF EARHTING COIL

1.0. Qualification Criteria of Manufacturer:-

The material offered shall be procured from a vendor who must have at least three years experience in manufacturing of the sam. The materials shall have been successfully type tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

1.1. SCOPE

The specification covers design, manufacture, testing for use in earthing of the HT poles.

2.0. GENERAL REQUIREMENTS

Earthing coils shall be fabricated from soft GI Wire Hot Dip Galvanized. The Hot Dip galvanized wire shall have clean surface and shall be free from paint enamel or any other poor conducting material. The coil shall be made as per REC constructions standard.

The Hot Dip galvanizing shall conform to IS: 2629/1966, 2633/1972 and 4826/1969 with latest amendments.

3.0. TESTS

I Galvanizing Tests

Minimum Mass of Zinc

On GI Wire used 280 cm/m²

After Coiling-266 gm/m². The certificate from recognized laboratory shall be submitted towards mas of zinc.

II Dip Test

Dip test shall stand 3 dips of 1 minute and one dip of ½ minute before coiling and 4 dips of 1 minute after coiling as per IS: 4826/1979

III Adhesion Test

As per ISS 4826 – 1979.

4.0. DIMENSIONAL REQUIREMENT

Nominal dia of GI Wire -4 mm (Tolerance $\pm 2.5\%$) Minimum no. of turns – 115 Nos. External dia of Coil (Min) – 50 mm Length of Coil (Min) – 460 mm Free length of GI Wire at one end coil (Min.) – 2500 mm Minimum length of wire to be grounded during installation -1000 mm. The turns should be closely bound. Weight of one finished Earthing Coils (min.) – 1.850 Kg.

5.0. EARHTING COIL GUARANTEED TECHNICAL PARTICULARS is furnished at Chapter E-24 of this Technical Specification.

6.0. EXTENSION POLE

Pole with pole extension arrangement up to two **to three** meters (**in case** of 33 KV new **Mini base** GI tower structure) shall be used at low ground level locations for maintaining ground clearance and for road crossings for HT Lines.

7.0 PROVISION OF GUYS/STRUT POLES TO SUPPORTS

- **7.0.1** The arrangement for guys shall be made wherever necessary. Strut poles/flying guys wherever required shall be installed on various pole locations as per REC construction standards. In order to avoid guys/ Strut self supported GI poles/ structures may be used.
- **7.0.2** In this work anchor type guy sets are to be used. These guys shall be provided at following locations where guys are damaged or not provided.
 - (i) Angle locations
 - (ii) Dead end locations
 - (iii) T-off points
 - (iv) Steep gradient locations.
 - (v) Double Pole, & four pole

The stay rod should be placed in a position so that the angle of rod with the vertical face of the pit is 30° to 45° as the case may be maximum movement for tightening or loosening.

- **7.0.3** If the guy wire proves to be hazardous, it should be protected with suitable asbestos pipe filled with concrete of about 2 m length above the ground level, painted with white and black strips so that, it may be visible at night.
- **7.0.4** The guy insulator should have a minimum vertical clearance of 3.5 mtr from the ground.

PART – C

TECHNICAL SPECIFICATION FOR **G.I. EARTH WIRE**

TECHNICAL SPECIFICATION FOR G.I. EARTH WIRE

1.0 SUSPENSION CLAMPS: FOR GROUND WIRE

Clamps of suitable size are required for holding the galvanized steel stranded ground wire at suspension points. The suspension clamps shall be suspended from the lower hanger or 'D' belt of 16mm diameter and should therefore be supplied with a suitable attached that would allow the clamps to swing freely both in the transverse and longitudinal direction. The clamps shall be so designed that the effect of vibration both on the ground wire and the fittings itself is minimum.

The clamps shall be manufactured and finished so as to avoid sharp radia of curvature, ridges which might lead to localized pressure and damage the ground wire in service.

The clamps shall be made of heat treat malleable iron one Eye hook made of forced steel. The entire assembly shall be hot dip galvanized.

The clamping surface shall be smooth and formed to support the ground wire on long easy curves to take care or required steel vertical and horizontal angles.

The clamps shall permit the groundwire to slip before the failure of the latter occurs. The leg of U-bolt holding the keeper piece of the clamps shall be kept sufficient long and shall be provided with threads, nuts and locking nuts for fixing the flexible earthing hond between the suspension clamps and tower structures.

2.0 TENSION CLAMPS (DEAD END ASSEMBLY) FOR GROUND WIRE.

Compression type dead end assembly of G.S.S. ground wire shall be required for use on the tension towers. The dead end assembly shall be supplied with complete jumper terminals, nuts and bolts suitable link pieces between the steel clevis and tower strain plates so as to provide sufficient flexibility not less than that of G.S.S. ground wire and the tensile strength not less than 90% that of the G.S.S. ground wire.

The assemblies shall comprise of compression type dead end clamps and one anchor shackle made of forged steel. The entire assembly shall be hot dip galvanized.

One of bolt holding joint per terminal of dead end assemblies shall be kept sufficiently long and threaded and shall be provided with nuts, washers and locking nuts for fixing the flexible earthing bond between the dead-end clamp and tower structures.

3.0 Basic Technical Requirement, The following Technical requirement is furnished below:

Н	7/3.15mm Galvanised Stranded Steel Wire For Suspension Clamps		
i	Materials	Malleable Cast Iron / Galvansied Steel	
ii	Size	As per Drawing	
iii	Suitable for groundwire	Yes (7/3.15)	
iv	Weight in kg		
V	Slip strength	12-17 KN	
vi	Minimum failing load	70 KN	
vii	Galvanising		
	a.Ferrous parts	Hot Dip Galvanised	
	b.Spring washers	Electro Galvanised	
	c.Quality of Zinc used	99.5%	
	d.Number of dips which the clamp can withstand	4/1 minute dips	
viii	Standard to which conforming	IS 2486 and IS 2633	
I	Compression type dead end assemblies F	For 7/3.15mm Galvanised Stranded Steel Wire	
i	Materials	Forged steel	
ii	Size	As per drawing	
iii	Suitable for ground wire	Yes (7/3.15)	
iv	Weight in kg	3.694	
V	Slipping strength	95% of UTS of Conductor	
vi	Minimum failing load	70 KN	
vii	Galvanising		
	a.Ferrous parts	Hot Dip Galvanised	
	b.Spring washers	Electro Galvanized	
	c. Quality of zinc used	99.5%	
	 Number of dips which the clamp can withstand 	4/1 minute dips	
vii	Standard to which conforming	IS 2486 and IS 2633	
	Flexible copper bond		
i	Drawings enclosed	As per drawing	
ii	Stranding	37/7/0.417mm	
iii	Cross sectional area (Sq.mm)	75.6	
iv	Minimum copper equivalent area	34Sq.mm	
	(Sq.mm)		
vi	Length of copper cable (mm)	500mm	
vii	Material lugs	Tinned Copper	
viii	Bolt Size		
	(a) Diameter (mm)	16	
	(b) Length (mm)	40	
ix	Resistance (Ohm)	0.0004 (as per IS:2121)	
X	Total weight of flexible copper bond (kg)	0.45 (approx)	