



**ODISHA POWER TRANSMISSION CORPORATION  
LIMITED**

**TECHNICAL SPECIFICATION  
FOR**

**CONDUCTOR, AL TUBE G.I GROUND WIRE,  
INSULATORS, HARDWARE, CLAMPS & CONNECTORS**

## **SECTION-I**

S.NO.	DESCRIPTION	PAGE NO.
1.	SCOPE	3
2.	STANDARDS	3
3.	MATERIALS	3
4.	SIZES	3
5.	TOLERANCES	3
6.	MECHANICAL PROPERTIES	4
7.	SURFACE CONDITIONS	4
8.	JOINTS IN WIRES	4
9.	STRANDING	4
10.	PACKING AND MARKING	5
11.	LENGTHS	5
12.	TESTS AND CERTIFICATES	6
13.	RETEST AND REJECTION	11
14.	GUARANTEED TECHNICAL PARTICULARS	11
15.	SAG TENSION CHARTS AND SAG TEMPLATES	11

## **CONDUCTORS**

### **SECTION - I**

TECHNICAL SPECIFICATION OF ACSR “MOOSE”, ”ZEBRA”,  
AND “ PANTHER” CONDUCTORS

#### **1. SCOPE :-**

1.1. This specification provides for the manufacture, testing, supply and delivery at destination of the steel cored aluminum conductors as per Appendix-I attached.

## 2. **STANDARDS** :-

2.1 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 overhead Transmission 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. **MATERIALS** :-

3.1 The 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-II. The coating on the galvanized steel wires may be applied by the hot process or the electrolytic process.

## 4. **SIZES** :-

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

## 5. **TOLERANCES** :-

5.1 The following tolerances shall be permitted on standard diameter of aluminum wires.

Tolerance on standard diameter of aluminum wire  $\pm 1$  percent.  
wires.

Note : - The cross-section of any wire shall not depart from circularity by more than an amount 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. **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 co-efficient of linear expansion for steel Cored Aluminum Conductors has been calculated on the basis of co-efficient of linear expansion of  $23.0 \times 10^{-6}$  per degree centigrade of aluminum and  $11.5 \times 10^{-6}$  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. **SURFACE CONDITIONS :-**

7.1 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. **JOINTS IN WIRES :-**

8.1 Aluminium wires : No joints shall be permitted in the aluminium wires in the outermost layer of the ACSR conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 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 steel-reinforced 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. **STRANDING :-**

9.1 The wires used in construction of a stranded conductor shall before stranding, satisfy all requirements of IS-398/ (part-II)1976 with latest amendments. For steel-cored aluminum conductors the lay ratio of the different layers shall be within the limits given under Appendix-I.

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. **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   | b) Contract/Award letter Number        |
| c) Name of manufacturer | d) Name & Address of Consignee         |
| e) Drum Number          | f) Length of conductor                 |
| g) Size of conductor    | h) Gross Weight of drum with conductor |
| i) Weight of empty drum | j) Net and gross of conductor.         |
- with lagging.**
- k) Arrow marking of un-winding

**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. **LENGTHS** : -

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.

<u>Type of conductor</u>	<u>Length per drum.</u>
MOOSE ACSR	1.1 K.M
ZEBRA ACSR	1.1 K.M.
PANTHOR ACSR	2.2 K.M.

## 12. **TESTS AND TEST CERTIFICATES** :-

The following type tests ,(& any other tests if purchaser 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 (Techno-commercial) 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 spools 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 Appendix-II.

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 10cm/min. and less than 2.5cm/min.

## **TYPE TESTS**

### **12.6 Wrapping Test : -**

12.6.1 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.

12.6.2 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.

#### **12.7 Galvanizing Test : -**

12.7.1 The uniformity of zinc coating and the weight of coating shall be as given in Appendix-II and shall be determined according to Indian Standard Specification 4826-1979, with latest amendments.

**12.7.2 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.**

#### **12.8 Ductility Test : -**

This test shall be made on galvanized steel wires only by any of the proceedings given in 12.8.1 and 12.8.2.

12.8.1 **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 60 rev/min.

When tested before stranding, the number of complete twists before fracture occurs shall not be less than 18 on a length equal to 100 times 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 16 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles to the axis of the wire.

12.8.2 **Elongation Test** : - 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 elongation 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.

#### **12.9 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 or 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.

### **12.10 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 5 m 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 Appendix-I and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

### **12.11 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 320 KV (rms) for 400 KV and 176 KV (rms) for 220 KV system 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.

### **12.12 Radio Interference Voltage Test**

Under the conditions as specified in 12.11 above, the conductor samples shall have a radio interference voltage level below 1500 microvolts 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.

### **12.13 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.

### **12.14 Stress-Strain Test**

12.14 (i) 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.

#### **12.14 (ii) Test Set-up**

12.14 (ii) (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.



12.14 (ii) (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  $\pm$  0.1mm from the value before the test.

12.14 (iii) (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.

#### 12.14 (iii) Test Loads for Complete Conductor

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

12.14 (iii) (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.

12.14 (iii) (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.

12.14 (iii) (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.

12.14 (iii) (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.

12.14 (iii) (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.

12.14 (iii) (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 12.14 (iii) (e).

#### 12.14 (iv) Test Loads for Steel core Only.

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

12.14 (iv) (a) 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.

12.14 (iv) (b) 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.

#### **12.14 (v) 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 purchaser along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 degree centigrade.

#### **12.15 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.

#### **12.16 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.

### **ROUTINE/ACCEPTANCE TESTS**

#### **12.17 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.

#### **12.18 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.

#### **12.19 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.

#### **12.20 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.

#### **12.21 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.

#### **12.22 Ductility Test**

#### **12.23 wrapping test**

#### **12.24 Resistance test**

#### **12.25 Galvanising Test**

### **13. RETEST AND REJECTION : -**

13.1 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 fulfill 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.**

**14. GUARANTEED TECHNICAL PARTICULARS : -**

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

**15. SAG TENSION 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 purchaser and without involving any extra charges. The design data of the lines on which these conductors will be used are given in **Appendix-III.**

**APPENDIX - I**

ACSR CONDUCTOR:		MOOSE	ZEBRA
1.	Size of conductor: mm	54/7/3.53 mm	54/7/3.18
2.	Stranding and wire diameter Aluminum	54/3.53 mm	54/3.18 mm
	Steel	7/3.53 mm	7/3.18 mm
3.	Sectional area of Aluminum (in mm <sup>2</sup> )	528.50	428.90
4.	Approximate total mass (in Kgs/KM)	2004	1622
5.	Calculated resistance at 20°C Max.: ( in Ohms/Km.)	0.05552	0.06868

6.	Calculated breaking load of: composite conductor (in KN) (U.T.S.) (Min)	161.20 KN	130.32 KN.
7.	<u>Lay Rating :-</u>		
	Steel core	Max – 18 Min - 16	Max- 28 Min-13
	<u>Aluminium Layers</u>		
	12 Wire Layer (Innermost Layer)	Max – 14 Min – 12	Max-17 Min - 10
	18 Wire Layer (Lay immediately beneath outside Layer)	Max -13 Min – 11	Max - 16 Min - 10
	24 wire layer (outside layer)	Max -12 Min -10	Max - 14 Min - 10
8.	Modulus of elasticity (in Kg / mm <sup>2</sup> ):	6860	8158
		$0.7036 \times 10^6 \text{ Kg} \times \text{CM}^2$ ( 69 GN per Sq. meter )	
9.	Co-efficient of linear expansion of conductor per degree centigrade.	-----19.3 x 10 <sup>-6</sup> -----	
10.	Standard area of Cross Section in mm <sup>2</sup> Sq. mm of conductor.	597.0 mm <sup>2</sup>	484.5
11.	Diameter of complete conductor in	31.77 mm	28.62 mm

## APPENDIX - II

### Solid Steel and Aluminum Wires used in Steel cored

#### Aluminum Conductors

		<u>ZEBRA</u>		<u>MOOSE</u>	
1.	Diameter	Steel	Aluminum	Steel	
	Aluminium				
	Standard (in mm)	3.18	3.18	3.53	3.53
	Maximum (in mm)	3.24	3.21	3.60	3.55
	Minimum (in mm)	3.12	3.15	3.46	3.51
2.	Cross Sectional Area	7.942	7.942	9.791	9.791
	of nominal Diameter				
	Wire (in mm <sup>2</sup> )				
3.	Weight (in Kg/KM)	61.95	21.47		
4.	Minimum tensile strength:	As per relevant ISS			
5.	Minimum breaking load	10.43	1.29	12.86	1.57
	before stranding (in KN)				
6.	Minimum breaking load:	9.91	1.23	12.22	1.49
	after stranding (in KN)				
7.	Zinc coating of steel				
	strands				
	Number and duration:	3 (1 Min. dip)		3 dips of 1min	
	of dips				
	Minimum Weight of :	260		260	
	Coating (in gm/ m <sup>2</sup> )				
	(As per IS-4826 –1979)				
8.	Maximum resistance at:	3.626	2.974	2.921	
	20°C of Aluminum strands				
	( in Ohms / KM)				
9.	Minim Purity of aluminum rod:	-----99.5 %-----			
	----				



## APPENDIX – III

<b>ACSR CONDUCTOR:</b>		<b><u>ZEBRA</u></b>	<b><u>MOOSE</u></b>
1.	Conductor	-----Steel cored Aluminum-----	
	(a) Copper equivalent: mm <sup>2</sup>		
	(b) Stranding (in mm)	54/7/3.18	54/7/3.53
2.	Normal Span.		320 Meters
	Wind Span.		320 Meters
	<u>Weight Span.</u>		
	(a) Max.		500 Meters
	(b) Min.		50 Meters
3.	Wind Pressure on full project area.		52 Kgf per M <sup>2</sup>
4.	Temperature		
	(a) Minimum		5 ° C
	(b) Maximum		67 ° C
	(c) Every day		32°C
5.	Factors of safety : Minimum		
	(i) Every day temperature and no wind.		4.00
	(ii) Minimum temperature and 2/3 maximum wind :		2.00
	(iii) Every day Temperature and full wind		2.00
	This is as per Indian Electricity Rules, 1956.		
6.	Relative Humidity.		
	Maximum.		100 Percent
	Minimum.		60 Percent
7.	Isoceramic level.		100/Years
8.	Number of rainy days per year.		100 days
9.	Average rainfall per year		1150 mm. approx.
10.	Altitude.		Less than 350 Metres.

### Technical parameters

Sl. No.	Description	ACSR MOOSE
1	Stranding and wire diameter	54Al /3.53 mm+7 Steel/3.53 mm
2	Number of Strands	
	Steel centre	1
	1st Steel Layer	6
	1st Aluminium Layer	12
	2nd Aluminium Layer	18
	3rd Aluminium Layer	24
3	Sectional area of aluminium	528.5 mm <sup>2</sup>

4	Total sectional area	597.00 mm²	
5	Overall diameter	31.77 mm	
6	Approximate weight	2004 kg/km	
7	Calculated DC resistance at 20 °C	0.05596 Ω/km	
8	Minimum UTS	161.2 kN	
9	The details of aluminium strand are as follows:		
	Minimum breaking load of strand before stranding	1.57 kN	
	Minimum breaking load of strand after stranding	1.49 kN	
	Maximum DC resistance of strand at 20 °C	2.921Ω/km	
10	The details of steel strand are as follows		
	Minimum breaking load of strand before stranding	12.86 kN	
	Minimum breaking load of strand after stranding	12.22 kN	
11	Minimum number of twist to be with stood in torsion test when tested on a gauge length of 100 times diameter of wire	18 - before stranding	
		16 - after stranding	
12	Tolerances		
12a	Diameter of aluminium strands Standard Maximum Minimum	3.53 mm	
		3.55 mm	
		3.51 mm	
	Diameter of steel strands Standard Maximum Minimum	3.53 mm	
		3.60 mm	
		3.46 mm	
13	Lay ratio of Conductor		
13a	Steel - 6 wire layer Maximum Minimum	18	
		16	
13b	Aluminium - 12 wire layer Maximum Minimum	14	
		12	
13c	Aluminium - 18 wire layer Maximum Minimum	13	
		11	
13d	Aluminium - 24 wire layer Maximum Minimum	12	
		11	
14	Materials composition		
14a	Aluminium	99.5% with copper content less than 0.4%	
14b	Steel Carbon	0.50 to 0.85 %	
		0.50 to 1.10 %	
	Manganese Phosphorous Sulphur	not more than 0.035 %	
		not more than 0.045 %	
	Silicon	0.10 to 0.35 %	
14c	Zinc for galvanising	electrolytic high grade zinc of 99.95% purity conforming to IS 209-1979.	



## APPENDIX – **PANTHER**

1.	Size of conductor	30/7/3.00 mm
2.	Stranding and wire diameter	
	Aluminum	30/3.00 mm
	Steel	7/3.00 mm
3.	Sectional Area of Aluminum	212.10 mm <sup>2</sup>
4.	Approximate total mass	974 Kgs/KM
5.	Calculated resistance at 20° C Max.	0.139 Ohm/KM
6.	Calculated breaking load of composite conductor (U.T.S) (Min)	89.67 KN
7.	<u>Lay Ratio</u> :-	
	Steel Core	Max - 28 Min - 13
	<u>Aluminum Layers</u>	
	12 Wire layer (Layer below outside layer)	Max - 16 Min - 10
	18 Wire layer (Outside Layer)	Max - 14 Min - 10
8.	Modulus of elasticity	0.815 x 10 <sup>6</sup> Kg/CM <sup>2</sup> (80GN/M <sup>2</sup> )
9.	Co-efficient of Linear expansion of conductor.	17.8 x 10 <sup>-6</sup> / °C
10.	Standard area of cross Section in sq. mm of conductor	261.50 Sq. mm
11.	Diameter of complete conductor in mm	21 mm

## APPENDIX - II

### PANTHER

#### Solid Steel and Aluminium Wires used in Steel cored

#### Aluminium Conductors

1.	Diameter	Steel	Aluminum
	Standard	3.00 mm	3.00 mm
	Maximum	3.06 mm	3.03 mm
	Minimum	2.94 mm	2.97 mm
2.	Cross Sectional Area		
	of nominal Diameter Wire	7.069 mm <sup>2</sup>	7.069 mm <sup>2</sup>
3.	Weight	55.13 Kg/KM	19.11Kg/Km
4.	Minimum tensile strength	134Kg/mm <sup>2</sup>	16.87Kg/mm <sup>2</sup>
5.	Minimum breaking load	9.29 KN	1.17 KN
	before stranding		
6.	Minimum breaking load	8.83 KN	1.11 KN
	after stranding		
7.	Zinc coating of steel strands		
	No and duration of dips	3 (1 Min. dip)	
	Minimum Weight of	As per IS 4826-1979	
	coating		
8.	Maximum resistance at		4.079 Ohms/KM
	20°C of Aluminum strands		
9.	Purity of aluminum rod		99.5%

### **APPENDIX - III** **PANTHER**

1.	Conductor	Steel cored Aluminum
	(a) Copper equivalent	130 mm <sup>2</sup>
	(b) Stranding	30/7/3.00 mm
2.	Normal Span.	320 Meters
	Wind Span.	320 Meters
	<u>Weight Span.</u>	
	(a) Max.	500 Meters
	(b) Min.	50 Meters
3.	Wind Pressure on full projected area.	52 Kgf per M <sup>2</sup>
4.	Temperature	
	(a) Minimum	5 °C
	(b) Maximum	67°C
	(c) Every day	32°C
5.	Factors of safety : Minimum	
	(i) Every day temperature and no wind.	4.00
	(ii) Minimum temperature and 2/3 maximum wind :	2.00
	(iii) Every day Temperature and full wind	2.00
	This is as per Indian Electricity Rules, 1956.	
6.	Relative Humidity.	
	Maximum.	100 Percent
	Minimum.	60 Percent
7.	Isoceramic level	100/years
8.	Number of rainy days per year.	100 days
9.	Average rainfall per year	1150 mm. approx.
10.	Altitude.	Less than 350 Meters



# **G.I EARTH WIRE**

## **SECTION – II**

S.NO.	DESCRIPTION	PAGE NO.
1.	SCOPE	22
2.	STANDARDS	22
3.	MATERIALS	22
4.	SIZE AND CONSTRUCTION	22
5.	LENGTH OF JOINING	22
6.	TESTS AND TEST CERTIFICATES	22
7.	PACKING AND MARKING	23
8.	SAG AND TENSION CHARTS AND SAG TEMPLATE	23
9.		OVERHEAD
	EARTH CONDUCTORS	25

## **TECHNICAL SPECIFICATION FOR G.I. GROUND WIRE.( 7/3.15 mm and 7/3.66mm )**

### **1. SCOPE :**

1.1 This specification provides for the manufacture, testing before despatch, supply and delivery of Ground wire for the purpose of earthing and protection of power transmission line, as per the particulars given in Appendix-I attached. The ground wire shall consist of standard galvanized steel wire.

### **2. STANDARDS :**

2.1 The ground wire shall comply in all respect with the Indian Standard (IS) 2141-1979

3. **MATERIALS :**

3.1 The material offered shall be of best quality and workmanship. The steel wires (Strands) shall be manufactured from steel produced by any suitable process. The steel wire shall not contain sulphur and phosphorous exceeding 0.040 percent each as per IS : 2141-1971.

3.2 The steel wires shall be evenly and uniformly coated with zinc complying with IS: 209-1965 specification for zinc (Retired). Only virgin zinc shall be used and reclaimed zinc is not permitted. The virgin zinc shall be of 99.95 percent quality.

3.3 The content of carbon shall not be more than 0.55 percent, manganese and silicon contents shall be 0.40 to 0.90 and 0.15 to 0.35 respectively.

4. **SIZE AND CONSTRUCTION :**

4.1 The size of ground wire shall be as given in Appendix-I. The physical properties have been given in the same Appendix. The lay of the strands shall be of lengths as given in the Appendices. The wires shall be so stranded together that when any evenly distributed pulls applied at the end of the completed strands each wire will take an equal share of the pull.

5. **LENGTH OF JOINING:**

5.1 The ground wire may be supplied in the standard length as per manufacturers standard practice and such length will be specifically indicated in the tender. However random length of ground wire upto a maximum of 10 (Ten) percent may be allowed.

5.2 The length of strand which may be supplied without joints in the individual wires comprising it depends on the length of wire which may be carried by the bobbin in a normal stranding machine. The normal lengths of strand which shall be supplied without joints in individual wires, excluding welds made in the rod before drawing shall be as given in Appendix – I.

5.3 Each coil shall be warranted to contain no weld joints or splice other than in the rod before it is drawn and those permitted in 5.3 above. The wire shall be circular and shall be free from scale or irregularities, imperfections, flaws and other defects. The zinc coating shall be smooth even and bright.

6. **TESTS AND TEST CERTIFICATES:**

6.1 Ground wire shall be subjected to the tests as specified in the IS:2141-1979 before despatch.

6.2 All the coils of the galvanized strand shall be of the same grade, diameter and construction manufactured under similar condition shall be grouped to constitute one lot.

6.3 Samples from each lot shall be tested for ascertaining the conformity to the requirements of the ground wire specified herein. The coils selected shall be tested for length of the lay and joints. The lot shall be declared conforming to the requirements of these characteristics if all the coils are found satisfactory. One test specimen from each wire of the strand shall be drawn, from every selected coil and subjected to tensile tests, ductility test and coating test. One specimen of the completed strand from each coil shall be subjected to tensile strength. The lot shall be declared conforming to the requirements of these characteristics if the entire test specimen satisfies the relevant requirements.

6.4 **Chemical Analysis :** One sample shall be drawn from the lot for chemical analysis. Unless otherwise agreed to between the purchaser and supplier the chemical analysis shall be carried out.

6.5 **Tensile Test** : The wire when tested in accordance with IS : 1521-1960 shall have minimum tensile strength specified in the Appendix – I. The tensile strength of the finished strand shall not be less than 95% of the aggregate of the single wires.

6.6 **Ductility test** : The wire shall be subjected to wrapping test in accordance with IS : 1755-1961. When wrapped eight times round its own diameter and on being subsequently straightened the wire shall not break or split.

6.7 **Coating test** : The uniformity of zinc coating shall be tested as per IS: 2633-1964. The wire shall withstand the number of dips specified in Appendix – I.

6.8 Three copies of manufacturers test certificate shall be submitted by the contractor to the purchaser for approval immediately after such tests have been conducted on the strands and the wire.

6.9 The purchaser reserves the right to inspect the material at Manufacturer's works before despatch.

7. **PACKING AND MARKING :**

7.1 The ground wire shall be supplied in non-returnable reels or drums of non-perishable or treated wood conforming to IS: 1778-1991 specification for Reels and Drums for Bare wire. Each coil shall be provided with a level fixed firmly on the inner part of the coil, bearing the following information.

- (a) Trade name, if any.
- (b) Name of manufacturer
- (c) Type of wire, size and length of wire.
- (d) Net weight of the wire.
- (e) Total weight, and
- (f) Number of lengths on the reel or drum unless otherwise agreed to between the purchaser and the supplier, the stranded wire shall be supplied in 50 Kg. coil.

8. **SAG AND TENSION CHARTS AND SAG TEMPLATE :**

8.1 The successful tenderer shall be required to submit six copies of sag templates and strings charts for different temperatures and spans, One set of charts shall be ink on tracing cloth. The design data of the lines on which the ground wire will be used are given in Appendix – II

## ***A P P E N D I X – I***

### ***TECHNICAL SPECIFICATION OF GROUND WIRE***

(i)	Material	:	Steel
(ii)	Purity of material	:	Sulphur and phosphorous contents not exceeding 0.040 percent each. Carbon content not exceeding 0.55 percent. Total silicon contents shall be 0.15 to 0.35 and Manganese contents shall be 0.40 to 0.90 respectively.
(iii)	Standing and wire diameter	:	7/3.15 mm
(iv)	Weight	:	428 Kg / Km.
(v)	Single wire before stranding		
	Diameter of wire	:	3.15 mm
	Tolerance	:	+ 0.060 mm - 0.030 mm
	Minimum elongation in 100 mm.	:	4 mm.
	Minimum breaking strength	:	857 kg.
	Minimum tensile strength	:	85.7 kgf / mm <sup>2</sup>
(vi)	<b>Stranded wire length of lay</b>		
	Maximum	:	175 mm
	Minimum	:	145 mm
	Minimum breaking load	:	5810 kg
	Over all diameter	:	9.45 mm
	Modulus of elasticity	:	1.938 x 10 <sup>6</sup> Kg/Cm <sup>2</sup>
	Co-efficient of linear expansion	:	11.50 x 10 <sup>-6</sup> per deg. C.
	D.C. resistance at 20 <sup>0</sup> C	:	3.375 Ohms/Km.
(vii)	<b>Zinc coating :</b>		
	Number of one minute dips	:	Three
	Number of half-minute dips	:	One
	Quality of zinc	:	Zn 98 IS:209/1966
	Weight of coating on wire process of galvanising	:	275 g/m <sup>2</sup>
	Process of galvanising	:	Hot-dip.
(viii)	Joints	:	There shall be no joint in any of the wires constituting the ground wire.
)			
(ix)	<b>Lengths -</b>		
	Standard length	:	1500 metres.
	Tolerance on standard length	:	± 5 percent
	Random lengths	:	Not more than 5 percent of the lengths ordered.
(x)	<b>Tests : -</b>	:	A sample of the finished ground wire when tested in tensile testing machine shall not fail at a stress
	Type tests Ultimate tensile strength test.		



- less than 100% of UTS value of the ground wire. The length of the test sample shall be not less than 5 meters.
- |                   |   |  |
|-------------------|---|--|
| Electrical Tests  | : | As per BS : 182/1972 and BS : 3229/1960  |
| Routine Tests     | : | As per clause No. 6 of IS: 2141 1968. In addition to these tests, the weight and adherence of Zinc coating tests shall be conducted as per clause 4 and 5 of IS : 4826/1968.                                 |
| (xi) Test Reports | : | Three copies of manufacturer test certificates shall be submitted by the Contracts to the purchaser for approve immediately after such test have been conducted on the galvanised steel strand and the wire. |

## 9. Overhead earth conductors

### General(7/3.66mm)

Where earth conductors are erected to provide the specified degree of lightning protection, they shall consist of stranded galvanised steel and shall comply with IEC 888 and IEC 1089 in so far as it applies to steel wires.

Galvanising shall comply with the requirements of IS 2141.

The arrangement of earth conductors shall be such that failure of a single conductor cannot predictably result in a fall across both bus bars in a duplicate bus bar substation.

### Technical parameters

SI No.	Parameter	Value
1	Stranding and wire diameter	7/3.66mm
2	Number of strands	1/6
3	Total sectional area	73.65 mm <sup>2</sup>
4	Overall diameter	10.98mm
5	Approximate weight	583 kg/km
6	Calculated DC resistance at 20C	2.5 ohms/m
7	Minimum ultimate tensile strength	68.4kN
8	Direction of outer lay	Right hand
9	Tolerances	
9a	Diameter standard	3.66mm
	maximum	3.75mm
	minimum	3.57mm
9b	Lay length standard	181mm
	maximum	198mm
	minimum	165mm
10	Steel composition Carbon	≤ 0.55%
	Manganese	0.4 to 0.9%
	Phosphorous	≤ 0.04%
	Sulphur	≤ 0.04%
	Silicon	0.1 to 0.35%
11	Zinc for galvanising	Electrolytic high grade zinc of 99.95% purity to 209 1979

**Table for Technical parameters for earth wires**

## INSULATORS

### SECTION-III

S.NO.      DESCRIPTION      PAGE NO.

1. SCOPE
2. STANDARDS
3. PRINCIPAL PARAMETERS
4. GENERAL TECHNICAL REQUIREMENTS
5. DETAILS OF SOLID CORE ROD INSULATORS
6. SPECIFICATION DRAWINGS
7. GENERAL TECHNICAL REQUIREMENTS
8. MATERIAL DESIGN AND WORKMANSHIP
9. TESTS (FOR DISC INSULATORS)
10. INSPECTION
11. QUALITY ASSURANCE PLAN
12. TEST DETAILS

# **INSULATORS**

## **TECHNICAL SPECIFICATION FOR DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORK**

### **1.0 SCOPE.**

- 1.1 This specification provides for design, manufacture, engineering, inspection and testing before despatch packing and delivery FOR (destination) for Indian manufacturers of disc. 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 conductors on EHV transmission line towers.

1.2 Following is the list of documents constituting this package.

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

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

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

## 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.

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 274 IEC 383
4.	IS: 2071 Part-(I) Part-(II) Part-(III)	Method of High Voltage Testing.	
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires 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 insulators.	IEC 437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse test on HV insulators.	IEC: 506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 575
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, Pentonville 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 Hellestrup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44 <sup>th</sup> . Street New York, NY 10017 USA

### 3.0 **PRINCIPAL PARAMETERS.**

#### 3.1 DETAILS OF DISC INSULATORS:

3.1.1 The Insulator strings shall consist of standard discs for use in three phases. 50 Hz effectively earthed 33/132/220 KV transmission system of OPTCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference 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.

3.1.2 The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength

3.1.3 of insulator string along with hardware shall be as follows:

**PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-**

Sl. No.	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc (mm),	No. of standard discs 132 KV /220/400 KV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255 x 145	320	1x9/1x14	70 KN/90 KN Normal Disc Insulator
2.	Double suspension.	-do-	-do-	2x9/2x14	70 KN/90 KN Normal Disc Insulator
3	Single suspension	255 x 145	430	1x9/1x14	70 KN/90 KN Antifog Insulator
4	Double suspension.	-do-	-do-	2x9/2x14	70 KN/90 KN Antifog Disc Insulator
5	Single Tension	280x145	430	1x10/1x15	120 KN Antifog Disc Insulator
6	Double Tension	-do-	-do-	2x10/2x15	120 KN Antifog Disc Insulator
7	Single Tension	305x170	475	1x10/1x15/1 x25	160 KN Antifog Disc Insulator
8	Double Tension	-do-	-do-	2x10/2x15/2 x25	160 KN Antifog Disc Insulator
5	Single Suspension	280x145	430	1x10/1x15/1 X25	120 KN Antifog Disc Insulator
6	Double Suspension	-do-	-do-	2x10/2x15/2 X25	120 KN Antifog Disc Insulator

**3.2 SPECIFICATION DRAWINGS:**

3.2.1 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 vetrification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process 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.

#### 4.1.1 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.

## 4.2 **METAL PARTS:**

### 4.2.1 **Cap and Ball Pins:**

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

### 4.2.2 **Security Clips:**

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

#### **4.3 FILTER 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.

#### **4.4 MATERIALS DESIGN AND WORKMANSHIP:**

##### **4.4.1 GENERAL:**

(II) 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.

(III) 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.

##### **4.4.2 INSULATOR SHELL:**

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

##### **4.4.3 METAL PARTS:**

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

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

##### **4.4.4 GALVANIZING:**



All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 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.

**4.4.5 CEMENTING:**

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

**4.4.6 SECURITY CLIPS (LOCKING DEVICES)**

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

**4.4.7 MARKING:**

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

**4.5 BALL AND SOCKET DESIGNATION:**

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

**4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:**

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

**4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:**

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

(a)

Sl. No.	Diameter of Disc (mm)	Standard mm	in	Maximum	Minimum
1.	70 KN/90 KN & 120 KN	255/255 & 280		As per IS	As per IS
2.	160 KN	305		As per IS	As per IS

(b)

Sl. No.	Ball to Ball spacing Between Discs (mm)	Standard mm	in	Maximum	Minimum
1.	70 KN/90 KN/120 KN	145		As per IS	As per IS
2.	160 KN	170		As per IS	As per IS

(C) **GUARANTEED TECHNICAL PARTICULARS**  
**FOR ANTIFOG DISC INSULATORS**

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

7.4	Impulse Flashover voltage 1.2/50 micro second 1.Positive –kV(peak) 2.Negative –kV (peak)	135 130	135 130	140 135	145 140
-----	---	------------	------------	------------	------------

\* **Tolerance as per relevant IS (Latest edition).**

#### 4.7 **INTERCHANGEABILITY:**

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

#### 4.8 **CORONA AND RIV PERFORMANCE:**

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

#### 4.9 **SUITABILITY FOR LIVE LINE MAINTENANCE:**

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

#### 4.10 **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.

#### 4.11 **INSULATOR STRINGS:**

##### 4.11.1 **TYPE AND RATING:**

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/22 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent towers are to be fitted with discs 70/90 KN EMS rating while tension insulator strings for use with Anchor/ Tension towers are to be fitted with discs of 120 KN / 160 KN EMS level rating.

##### 4.11.2 **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 clause 3.12

#### 4.12 **STRING CHARACTERISTICS:**

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

Sl. No.	Description.	Suspension.		Tension.	
		132K V	220kV	132KV	220KV

I	Switching surge withstand voltage (dry & wet) KV peak.	-	-	-	-
li	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
lii	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
lv.	Corona extinction voltage level KV rms	-	176	-	176
v.	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). ... hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
vi.	Mechanical failing load for each sting (kgf)	6500	11500	11500	15500
Vii.	No deformation load for each string (kgf)	-	7705	-	10385
Viii.	Max. voltage across any disc.	13%	13%	13%	13%

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

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

#### 5.0 DETAILS OF SOLID CORE LONG ROD INSULATORS:

5.1 The insulator shall consist of standard-discs for a three-phase 50 Hz effectively earthed 132 KV transmission system heavily polluted atmosphere. The insulator shall be ball and socket type.

5.2 The size of long rod 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:

Sl. No.	Type of string.	Size of long rod insulator (mm)/(Unit) 132/220 KV	Minimum creepage distance (mm) 132/220 KV	No.of unit 132/220 KV)	Electromechanical strength of insulator (KN) 132/220 KV)
1.	Single suspension	200X 1305 /210X2030	4000 / 6125	'1/2	90 KN
2.	Double suspension	-do-	-do-	'2/4	90 KN
3.	Single tension.	205 X 1450 / 215X2550	4300/7130	'1/2	120 KN/160 KN
4.	Double	-do-	-do-	'2/4	120 KN/160 KN

	Tension.				
--	----------	--	--	--	--

## 6.0 **SPECIFICATION DRAWINGS:**

6.1 The specification in respect of the long rod insulators indicated above is given at Annexure-II. These specification is for information and guidance of the bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and shall be in line with the specification.

## 7.0 **GENERAL TECHNICAL REQUIREMENT:**

### 7.1 **PORCELAIN:**

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

### 7.2 **PORCELAIN GLAZE:**

Surfaces 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 brown. 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 throughout the working temperature range.

### 7.3 **METAL PARTS:**

#### 7.3.1 **Cap and Ball pins:**

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip g galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

#### 7.3.2 **SECURITY CLIPS:**

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

### 7.4 **FILLER MATERIAL:**

Cement to be used as a filler material shall be quick setting, for 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.

## **8.0 MATERIAL DESIGN AND WORKMANSHIP:**

### **8.1 GENERAL:**

- i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials quality control and to stage testing quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.
- ii) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion good finish, elimination of sharp edges and corners to limit corona and radio interference voltage

### **8.2 INSULATOR SHELL:**

The design of the insulator shell 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 temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

### **8.3 METAL PARTS:**

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

### **8.4 GALVANIZING:**

All ferrous parts shall be hot dip galvanized six times 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.

**8.4.1 CEMENTING:**

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

**8.5 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 some adding after installation to prevent complete withdrawal from the socket. The locking device shall be resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fitting 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

**8.6 BALL AND SOCKET DESIGNATION:**

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

**8.7 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.

**9.0 TESTS (FOR DISC INSULATORS) :**

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

**9.2 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.

9.3 **ACCEPTANCE:**

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.

9.4 **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.

9.5 **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.

9.6 **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.

9.7 **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 purchaser 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 and procedure for the same shall be as specified in Annexure-IV attached hereto as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

9.8 **TYPE TESTS:**

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

9.8.1 On the complete insulator string with hardware fittings.

- |    |   |                              |
|----|---|------------------------------|
| a) | Power frequency voltage withstand test with corona control rings and under wet condition. | : BS:137(Part-I)             |
| b) | Switching surge voltage withstand test under wet condition (400 only)                     | :                            |
| c) | Impulse voltage withstand test under dry condition.                                       | : IEC: 383                   |
| d) | Impulse voltage flashover test under dry condition.                                       | :                            |
| e) | Voltage distribution test.  | :                            |
| f) | Corona & RIV test under dry condition.  | : As per this specification. |
| g) | Mechanical strength test.   | : As per this                |



- h) Vibration. : specification.
- 9.8.2 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
- f) RIV test (dry) : IS:8263
- 9.8.3 All the type tests given under clause No.6.8.1 above shall be conducted on single suspension and Double Tension insulator string alongwith hardware fittings.
- 9.9 **ACCEPTANCE TESTS:**
- 9.9.1 **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
- 9.10 **ROUTINE TESTS:**
- 9.10.1 For insulators:
- a) Visual inspection. : IS:731
- b) Mechanical routine test. :
- c) Electrical routine test. : IEC:383
- 9.11 **TEST DURING MANUFACTURE:**  
On all components as applicable.
- a) Chemical analysis of zinc used for galvanizing. :
- b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings. :
- c) Chemical analysis, hardness test and magnetic particle inspection for forgings. : As per this specification.
- d) Hydraulic Internal Pressure tests on shell. :
- e) Crack detection test for metal parts. :
- 9.12 **ADDITIONAL TEST:**

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

**9.13 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 purchaser 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.

**9.14 TEST CHARGES AND TEST SCHEDULE:**

**9.14.1 TYPE TEST:**

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 alongwith the offer. These tests must not have been conducted earlier than five years. The purchaser reserves the right to demand repetition of some or all type tests in the presence of purchasers' carrying representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this specification, purchaser reserves the right to demand repetition of tests without any extra cost.

**9.14.2 ACCEPTANCE AND ROUTINE TEST:**

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

9.14.3 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

9.14.4 For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

9.14.5 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 purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

10. **INSPECTION:**

- 10.1 i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.
- ii. The supplier shall keep the purchaser informed in advance of the time of starting and of progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.
- iii. No material shall be dispatched from its point of manufacture unless the materials has been satisfactorily inspected and tested.
- iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

10.2 **IDENTIFICATION MARKING:**

10.2.1 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.

10.2.2 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.

11. **QUALITY ASSURANCE PLAN:**

11.1 The bidder hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection.

- i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw materials in presence of bidder's representative, copies of test certificates.
- ii. Informations and copies of test certificates as in (i) above in respect of bought out materials.
- iii. List of manufacturing facilities available.
- iv. Level of automation achieved and lists of area where manual processing exists.

- v. List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspection.
- vi. Special features provided in the equipment to make it maintenance free.
- vii. List of testing equipping available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

11.2 The supplier shall within 30 days of placement of order submit the following information to the owner.

- i) List of raw material and the names of sub-suppliers selected from those furnished alongwith the offer.

### **POST INSULATORS.**

Post insulator shall conform in general to IS 2544, IEC 168 and IEC 815.

#### **3.1 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 be 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 affect 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 white 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.

## **12. TEST DETAILS.**

### **1. VOLTAGE DISTRIBUTION TEST:**

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied as to give a total of 100% distribution. The voltage across any disc. Not exceed the values given in clause 4-12.1

### **2. CORONA EXTINCTION VOLTAGE TEST (DRY):**

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than the value specified at clause 4.12.1 (iv) under dry condition. There shall be no evidence of corona on any part of the sample when all possible sources of corona are photographed in a darkened room.

### **3. RIV TEST (DRY):**

Under the conditions as specified in (2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 500 micro volts at one MHz when subjected to 50 Hz AC voltage of 1.1 times maximum time to ground voltage under dry condition. The test procedure shall be in accordance with IS: 8263.

4. 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.

5. **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 sub-conductors 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 Mechanical performance test.	60 40
b) Puncture test (for porcelain insulator only)	

6. **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%.

7. **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 purchaser in quality assurance programme.

1. **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 purchaser in quality assurance programme.

2. **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 purchaser in Quality Assurance Programme.

3. **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.

4. **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.

5. **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.

## **6. Tubular bus conductors:**

### **General**

Aluminium used shall be grade 63401 WP conforming to IS 5082. The tube shall be seamless and shall be manufactured by either of the following processes:

- Hot extrusion process through die and mandrel (Hollow billet process). Heat treatment shall be carried out after hot extrusion of tube.
- Bridge extrusion process and then cold drawn. Heat treatment shall be carried out after cold drawing of tube.

### **Constructional features**

For outside diameter (OD) and thickness of the tube there shall be no minus tolerance, other requirements being as per IS 2678 and IS 2673.

The aluminium tube shall be supplied in suitable cut length to minimise wastage.

## Technical parameters

Sl No.	Size	4" IPS (EH type)	3"IPS (EH type)	4.5"IPS (EH type)
1	Outer diameter (mm)	114.20	88.9	120.0
2	Thickness (mm) :	8.51	7.62	12.0
3	Cross-sectional area (sq.mm) :	2825.61	2373.63	4071.5
4	Weight (kg/m) :	7.7	6.44	10.993
5	Chemical composition			
	i) Cu	0.05 max	0.05 max	0.05 max
	ii) Mg	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9
	iii) Si	0.3 to 0.7	0.3 to 0.7	0.3 to 0.7
	iv) Fe	0.5 max	0.5 max	0.5 max
	v) Mn	0.03 max	0.03 max	0.03 max
	vi) Al	Remainder	Remainder	Remainder
6	Minimum ultimate Tensile strength Kg/Sq mm	20.5	20.5	20.5
7	Temp co-eff of resistance	0.00364 per Deg C		
8	Minimum electrical conductivity at 20 deg C	55% of IACS		
9	Modulus of Elasticity	6700 Kg/sq mm		

## 7. Post insulators:

Post insulators shall conform in general to IS 2544, IEC 168 and IEC 815.

### 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 withstand any shocks to which they may be 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 affect 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 operating 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 galvanised in accordance with the latest edition of IS 2633, and IS 4579. The zinc used for galvanising 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 white 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 bevelled 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.

## Services to be performed by the equipment being furnished

The equipment shall be able to withstand forces due to wind load on the equipment and approach conductor and due to short circuit, all forces considered together.

The Contractor shall submit detailed calculations proving the satisfactory performance of the equipment under short circuit conditions to meet the layout requirements.

## Technical Parameters

SI No.	Parameter	400kV	245kV	132kV	33kV
1	Type	Confirming to IEC 273 (solid core )			
2	Voltage class (kV)	420	245	145	36
3	Dry and wet one minute withstand voltage (kVrms)	630	460	235	70
4	Dry lightning impulse withstand voltage (kVp)	± 1550	± 1050	± 650	± 250
5	Wet switching surge withstand voltage (kVp)	± 1175	NA	NA	NA
6	Max. RIV at corona extinction voltage (microvolts)	500	500	500	NA
7	Corona extinction voltage (kVrms)	320 (min)	156 (min)	105	
9	Total minimum cantilever strength (kg)	not< 800	not< 800	not< 600	not< 600
10	Minimum torsional moment	As per IEC 273			
11	Total height of insulator (mm)	3650	2300	1100	325
12	PCD (mm) top/bottom	127/300	127/254	127/254	76/76
13	No. of bolts top/bottom	4/8	4/8	4/8	4/8
14	Diameter of bolt holes (mm) top/bottom	M16/18	M16/18	M16/18	M16/18
15	Pollution level as per IEC 815	Heavy	Heavy	Heavy	Heavy
16	Minimum total creepage distance (mm)	10500	6125	3625	900

If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Supplier.

## **8. Spacers**

### **General**

Spacers shall conform to IS 10162. Spacers are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of sub conductors during short circuit conditions.

### **Constructional features**

No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

Spacer design shall be made to take care of fixing and removing during installation and maintenance.

The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

## **SECTION-IV    HARDWARES**

<b>S.NO.</b>	<b>DESCRIPTION</b>	<b>PAGE NO.</b>
1.	SCOPE	

2.	STANDARDS	
3.	MATERIALS AND DESIGN	
4.	GALVANISING	
5.	ACCESSORIES FOR CONDUCTOR AND GROUND WIRE	
6.	VIBRATION DAMPER FOR ACSR PANTHER, ZEBRA, MOOSE 54 AND GROUND WIRE	
7.	REPAIR SLEEVE FOR ACSR PANTHER, ZEBRA, MOOSE AND GROUND WIRE	54
8.	SUSPENSION CLAMPS : FOR GROUND WIRE	
9.	TENSION CLAMPS (DEAD AND ASSEMBLY) FOR GROUND WIRE	
10.	BONDING PIECES	
11.	INSULATORS HARDWARE	
12.	CLAMP	
13.	TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS 58	

## TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS.

SUITABLE FOR GALVANISED STEEL STRANDED  
GROUNDWIRE (7/3.15mm and 7/3.66 mm) ACCESSORIES

## AND POWER CONDUCTOR ACSR PANTHER ,ACSR ZEBRA AND MOOSE.

### 1.0 SCOPE

This Specification covers design (if required), manufacture, testing at manufacturer's Works, supply and delivery of GSS), power conductor and ground wire accessories, insulator and hardware fittings for string insulators suitable for use in 220 and 132 KV 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 Sr. G.M (CPC).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 upto 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 forged steel, having required mechanical strength, corrosion resistance and machinability 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 Employer 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 threads in

nuts and tapped holes shall be cut after galvanising and shall be well fabricated and greased. All other threads shall be cut before galvanising. The bolt threads shall be undercut to take care of increase in diameter due to galvanising.

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 earthwire 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 hardware shall be free from cracks, shrinks, slender air holes, burrs or rough edges.

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

#### **4.0 GALVANISING :**

All ferrous parts of conductor and ground wire accessories and insulator hardware shall be galvanised in accordance with IS:2629-Recommended Practice for hot dip galvanising of iron and steel or any other equivalent authoritative 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 galvanised articles or as per any other equivalent authoritative standards. The zinc used or galvanisation shall conform to grade Zn 98 of IS:209. The galvanised 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 galvanised.**

#### **5.0 ACCESSORIES FOR CONDUCTOR AND GROUND WIRE, MID SPAN COMPRESSION JOINTS:FOR ACSR- PANTHER, ZEBRA, MOOSE AND GROUNDWIRE OF 7/3.15 and 7/3.66 mm.**

The Mid-Span Joints for conductor and earthwire shall be of compression type. The conductor mid-span joints shall comprise of outer aluminium sleeve of extruded aluminium (99.5% purity) and inner sleeve HDG Steel. All filler plug shall also be provided. The ground wire mid-span joints shall be of HDG steel. The sleeves shall be of circular shape suitable for compression into hexagonal shape.

The compression type mid-span straight joints shall be suitable for making joints in the ACSR "PANTHER, ZEBRA & MOOSE" conductor or in the galvanised steel stranded ground wire.

The joints shall be so designed that when installed no air space is left within the finished joints. The joints shall have the conductivity as specified in relevant Clause.

The joints shall conform to IS:2121 (latest edition) unless specified otherwise. The details of the joints both suitable for ACSR- Panther,Zebra & Moose and ground wire are given in the technical particulars.

The inner and outer diameters and lengths of the offered joints before and after compression shall be clearly shown in the drawings.

## **6.0 VIBRATION DAMPER FOR ACSR PANTHER,ZEBRA MOOSE AND GROUND WIRE(7/3.15 and 7/3.66 mm)**

Vibration Damper having 4 resonance frequency characteristic commonly called 4R Damper shall be offered. The Damper shall eliminate fatigue on the conductor due to vibration and damp out the vibration effectively so that no damage due to vibration is caused to conductor / ground wire / string.

The dampers are proposed to be used at all tension locations and also at suspension locations. One or more dampers are proposed to be used on tension/suspension locations depending upon the span.

Bidder shall also recommend the number of damper required to effectively damp out conductor or ground wire vibration for different values of span lengths and the distance of fixation.

Vibration dampers shall be of approved design. The clamps of the vibration dampers shall be made of aluminium alloy, so designed as to prevent any damage while fixing on the conductor during erection or in continued operation. The fastening bolts should be approved by the Employer. The spring washers should be electro galvanised and of minimum 2 mm thickness.

The messenger cable shall be made from high tensile strength steel strands in order to prevent subsequent drop of weight in service.

Clamping bolts shall be provided with self locking nuts as designed to prevent corrosion of the threads. All ferrous parts including the messenger cable shall be hot dip galvanised. The end of the messenger cable shall be effectively sealed to prevent corrosion.

The vibration dampers and its attachment shall have smooth surface so that no corona occurs on them.

The clamps of the stock bridge vibration dampers shall be so designed that in case of loosening of the bolt or changing free parts of the clamp, it does not allow the damper to disengage from the conductor.

## **7.0 REPAIR SLEEVE FOR ACSR PANTHER,ZEBRA,MOOSE AND GROUNDWIRE :**

Compression type repair sleeves shall be offered to provide reinforcement for conductor with broken or damaged aluminium strands/galvanised steel ground wire broken in damaged steel strands. The repair sleeve shall be designed to make good a conductor of which not more than one-sixth ( $1/6^{\text{th}}$ ) of the strands in the outermost layer and damaged or severed. The repair sleeves after compression should present a smooth surface.

## **8.0 SUSPENSION CLAMPS : FOR GROUND WIRE**

Suspension clamps of suitable size are required for holding the galvanised steel stranded ground wire at suspension points. The suspension clamps shall be suspended from the lower hanger or 'D' belt of 16 mm. dia. 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 groundwire and the fittings itself is minimum.

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

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

The clamping surface shall be smooth and formed to support the groundwire on long easy curves to take care of 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 bond between the suspension clamps and tower structures.

## **9.0 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 galvanised.

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.

## **10.0 BONDING PIECES (FLEXIBLE COPPER EARTHING BOND FOR EARTH WIRE 7/3.15 and 7/3.66 mm)**

The tenderer shall offer flexible copper earthing bonding pieces for connecting the ground wire suspension and tension clamps and tower legs suitable for earthing.

Each bond piece shall have suitable compression type galvanised steel lug or thimble on either end for making connections to clamp and tower legs. The size, strength, etc. of the bonding piece is given in this Specification.

## **11.0 INSULATOR HARDWARES**

The insulator disc hardware 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 20 mm. 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 side arcing horn**
- c) **Socket Eye with R-Type security clip.**
- d) **Line side arcing horn.**
- e) **Armour grip suspension clamps**

#### Single Tension Set :

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

#### Double Suspension Set.

- a) **Ball Hook.**
- b) **Socket clevis with R-Type security clip-3 Nos.**
- c) **Yoke Plate-2 Nos.**
- d) **Tower side arcing horns-2Nos.**
- e) **Ball clevis – 2 Nos.**
- f) **Line side arcing horns-2 Nos.**
- g) **Clevis Eye.**
- h) **Armour Grip Suspension Clamp.**

#### Double Tension Set :

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

## 12.0 CLAMP

### 12.1 ARMOUR GRIP SUSPENSION CLAMPS

Armour Grip Suspension Clamp shall consist of 2 neoprene insert, one set of armour rods made of aluminium alloy, two aluminium housing having inner profile matching with the profile of the armour rods and supporting strap made of aluminium alloy. The A.G. type suspension clamp shall be designed, manufactured and finished as to have a suitable shape without sharp edges at the end and to hold the respective conductor properly. It should, however, have sufficient contact surface to minimise damage due to fault current. The clamp shall be of Armour Grip Type.

The A.G. type suspension clamp shall permit the conductor to slip before the occurrence of failure of the conductor and shall have sufficient slip strength to resist the conductor tension under broken wire conditions. The clamp shall have slip strength of not less than 15 % of respective conductors.

### 12.2 TENSION CLAMPS

The Tension Clamps shall be made out of aluminium alloy and of compression type suitable for PANTHER, ZEBRA & MOOSE 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.

### 12.3 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.

### 12.4 UNIVERSAL JOINTING COMPOUND

**BENDEX-HV' Universal jointing compound which is a chemically inert compound to be used as filler for the compression joints and dead end clamps to be supplied.**

## 13.0 TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

The fittings and accessories for the power conductor and G.S.S. ground wire, insulator and hardware shall be tested in accordance with IS:2121, IS:2486, IS:9708 (For V Dampers), BS:916 for hexagonal bolts and nuts or any other authoritative equivalent standards. Six sets of type and routine test certificates and performance reports are to be submitted by the bidder.

The Employer 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 and G.S.S. ground wire accessories.

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

### 13.1 ACCEPTANCE TEST FOR HARDWARES

- a) Dimensional verification.
- b) Ultimate tensile test.
- c) Slip strength test.
- d) Electrical resistance test.
- e) Heating cycle test
- f) Breaking strength of full string assembly.

g) Galvanising test.

## 13.2 SPECIFIC TECHNICAL REQUIREMENTS FOR CONDUCTOR ACCESSORIES AND INSULATOR HARDWARES

Conductor		Panther/zebra/Moose	GSS ground wire
a)	Type	ACSR Panther/zebra/Moose	Ground wire.
b)	Material	Aluminium conductor steel reinforced.	Galvanised stranded steel wire.
c)	Strand & Wire diameter.	Panther/Zebra/Moose Aluminium 30/3mm Steel 7/3mm,/all.54/3.18mm steel-7/3.18mm,/ all.54/3.53mm steel-7/3.53mm resp.	7/3.15 mm. and 7/3.66 mm
d)	Weight per Km.	974/1622 /2004Kg/Km. 21/28.62/31.7 mm	426 Kg/Km.and 583Kg/Km 9.4mm. and 10.98 mm
e)	Overall diameter	0.13750/0.06915/0.05552 Ohms/KM.	3.375 Ohms/KM
f)	D.C. Resistance at 20 deg. C when corrected to standard weight.	144/13289/16120 Kg	5710 Kg.and 10580 Kg
g)	Minimum Breaking load/Ultimate tensile strength.	3806/4325 Kg.	1393 Kg.
h)	Maximum working tension at minimum temperature & 2/3 full wind.	6120/9240 mm.	5150mm.
i)	Maximum Sag at maximum temperature & no wind.		

### DISC Insulator (for suspension & tension Insulator strings) (132 ,220 and 400 KV)

Disc Insulators	Suspension	Tension
-----------------	------------	---------

a)	Type	Ball & Socket	Ball & Socket.
b)	Ball size	16mm. Alt. B	20mm. Alt.
c)	Diameter	(IS:2486 Pt.II)	B/20mm
d)	Spacing	254/255 mm.	(IS:2486 Pt.II)
e)	E.M.	146/145 mm.	255/280 mm
	strength	90/120 KN,.	145/170mm.
			120/160 KN.

	Single Suspension	Single Tension	Double Suspension	Double Tension
132 KV / 220 KV /400 KV				
String Arrangements :				
a) No. of insulator discs.	10/14/25	10/14/25	2x10/2X14 /2X25	2x10/2 X14/
b) Length of string assembly (mm)	1672/2340	1851/3003	1837/2243	2X25 2132/30 82

## GENERAL REQUIREMENT FOR POWER CONDUCTOR & GROUND WIRE:

### I) ACCESSORIES.

#### GENERAL REQUIREMENTS

#### POWER CONDUCTOR AND GROUND WIRE ACCESSORIES

#### A) MID-SPAN COMPRESSION JOINTS

	Suitable for ACSR “Panther”/zebra/Moose	Suitable for G.S.S. groundwire 7/3.15 and 7/3.66 mm.
i) Type	Compression	Compression
ii) Material	Extruded Aluminium	Extruded aluminium.
a) Outer sleeve		
b) Inner sleeve	Steel (galvanised)	Steel (Galvanised)
	Before Compression	After Compression
		Before Compression
		After Compression
iii) Dimension of Compression joint	Outer dia:38mm	Adjacent Size 32

for part.	Aluminium	Inner Dia:23mm. Minimum length : 610mm. Minimum weight 1.2 kg. (approx)	mm. Diagonal Size : 37mm.
-----------	-----------	--	------------------------------

iv) Dimension of compression joint for Steel Part	Outer dia:18mm Inner dia. 9.3 mm Adjacent Size : 15.1mm Minimum Length : 203mm. Minimum weight : 0.28Kg (app.)	Adjacent size : 15.1mm. 10mm. Minimum m	Outer dia.18mm. Inner dia : 17.4mm Length 203mm.	Adjacent Size : Diagonal
---	--	---	--	--------------------------

v) Minimum failing load.	95% of ultimate tensile strength of conductor	95% of ultimate tensile strength of groundwire
--------------------------	---	--

vi) Electrical resistance 20 Deg. C	75% of measured resistance of the equivalent length of conductor.
-------------------------------------	---

vii) Galvanising :

a) Ferrous Parts.	Hot-dip galvanised (HDG)	Hot dip galvanised .
-------------------	--------------------------	----------------------

b) No.of dips 4 4 dips

dips for 1 4 dips  
minute  
withstand.

viii) 110% of maximum  
Minimum line to ground  
Corona voltage  
formation  
voltage

## B) VIBRATION DAMPERS:

(SUITABLE FOR ACSR CONDUCTOR: PANTHER/ZEBRA /MOOSE AND G.S.S. GROUND WIRE 7/3.15 and 7/3.66 mm.

- i) Type : 4R Stock Bridge Type
- ii) Distance between conductor : 74.5 mm. & axis of the Vibration Damper.
- iii) Messenger Cable : 130 Kg/mm sq. quality (19 strands)
- iv) Bolt size : 16 mm. (dia.)
- v) Slip strength of messenger Cable : 500 Kgs.
- vi) Mass pull-of : As per I.S.S.

## C) REPAIR SLEEVES:

SUITABLE FOR ACSR PANTHER/ZEBRA/MOOSE CONDUCTOR AND G.S.S. GROUND WIRE.

	Suitable for ACSR panther/Zebra/Moose.	Suitable for G.S.S. Ground wire.
i) Type	Compression	Compression.
ii) Material	Extruded aluminium.	Steel
iii) Min. failing load	95% of UTS of conductor.	95% of UTS of ground wire.
iv) Length	241/279 mm.	200 mm (150 mm. min.)
v) Dimension :		

a) After compression                      21mm                      11.5 mm  
    (i) Adjacent side

(b) Before Compression  
:                      21mm.  
(i) Outer diameter                      11.5mm.  
38/48mm.  
(ii) Inner diameter  
23/40mm

vii) Electrical Resistance at 20 deg. C                      Not more than 75% of the resistance of equivalent length of conductor.

vii) Galvanising :

Hot – dip galvanized

a) Ferrous parts

b) No. of dips for one-minute stand.                      4 dips

#### **D) SUSPENSION CLAMP: FOR GROUND WIRE 7/3.15 and 7/3.66 mm**

i) Type : Envelop type  
ii) Material : Forged Steel / NCL.

iii) Minimum slip strength : 25% of UTS of ground wire.

iv) Dimension :

(a) Overall length : 230mm

(b) Inner dia. (before compression). : 10mm.

(c) Outer diameter (before compression). : 18mm.

(d) After Compression :

Adjacent : 15.1 mm.

Diagonal side : 17.4mm.

(e) Galvanising :

(i) Ferrous parts. : Hot-dip galvanised.

(ii) No. of dips for one-minute withstand. : 4 dips

## **E) 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 long	:	6 mm.
f) Material for connecting socket.	:	Tinned Brass

## **F) INSULATOR HARDWARES**

A) String hardware :

Material and strength

	Description of item.	Material	UTS
i)	Bolt hook	Forged Steel	11,500 Kgs (90 KN)
ii)	Anchor Shackle	-do-	15,500 Kgs (120 KN)
iii)	Socket Eye Horn Holder.	- do-	11,500 Kgs (90 KN)
iv)	Socket Clevis.-do-		15,500 Kgs.
v)	Ball Clevis	-do-	15,500 Kgs.
vi)	Clevis Eye	-do-	15,500 Kgs.
vii)	Socket Eye.	-do-	15,500 Kgs.

vii) **Bottom / Top Yoke plate :**

**Double suspension Mild Steel      11,500 Kgs.**

**Double Tension      -do-      15,500 Kgs.**

ix) **Arcing Horn      -do-      —**

x) **Suspension Clamp.      Aluminium Alloy and Neoprene.      —**

xi) **Tension Clamp.      All.Alloy & Steel.      11,500 Kgs.**

xii) **Ball Pin      High tensile forged steel (hot-dip galvanised)      90% of UTS of conductor.**

xiii) **Security Clip      Brass (R-Type)**  
**Mininum failing load      Single Suspension      : 11,500**  
**String (KN)      Single Tension      : 11,500/15,500**  
**Double Suspension      : 11,500**  
**Double Tension      : 11,500/15,500**

## II) CLAMPS.

	<b>Single suspension string</b>	<b>Single tension string</b>	<b>Double suspension string</b>	<b>Double tension string.</b>
i) Type	AGS Type	Compression Type	AGS Type	Compression Type
ii) Material	<b><u>Aluminium Alloy and neoprene</u></b>	Aluminium Alloy and Steel	Aluminium Alloy and Neoprene	Aluminium Alloy and Steel
ii) Minimum slip strength	Not less than 15%	90% of UTS of conductor	Not less than 15% of UTS of conductor	90% of UTS of conductor
iv) Minimum failing load (kg)	11,500	90% of UTS of conductor	11,500 90%	Of UTS of conductor



### III). Suspension assembly: armour grip clamp.

1. The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum reinforcements and AGS preformed rod set.
2. Elastomer insert shall be resistant to the effects of temperature up to 85 deg. C, ozone, Ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS preformed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.
3. The AGS preformed rod set shall be as detailed above in general except that the length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavourable stress on the conductor under all operating conditions.

### IV) 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 times 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.

### **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 with IS-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 and manufactured that contact resistance is reduced to minimum.
6. Welding of aluminum shall be by inert gas shielded tungsten arc 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.

### **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 of schedule C and satisfy the test requirements stated in Section-7.

### **Mechanical design:**

The mechanical strength of the insulators and insulator fittings shall be as stated in Schedule-C

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.

### **Technical Specification for Design, Supply and Testing of Hardware fittings.**

Type tests:

The following type tests shall be conducted on hardware fittings.

#### **A. On suspension hardware fittings only.**

- (a) Magnetic power loss test.
- (b) Clamp slip strength Vs torque
- (c) Mechanical strength test.
- (d) On one test on elastomer.

#### **B. On Tension hardware fittings only.**

Electrical resistance test for IS 2486 (Part-I) 1971  
Dead end assembly.

- (a) Heating cycle test for -do-

dead end assembly.

- (b) Slip strength test for dead end assembly. IS 2486 (Part-I)

- (c) Mechanical strength test.

C. **On both suspension and tension hardware fittings.**

- (a) Visual examination. IS-2486 (Part-I) 1971
- (b) Verification of dimension. -do-
- (c) Galvanizing / electroplating test. -do-
- (d) Mechanical strength test of each component (including corona control ring/grading ring and arcing horn)
- (e) Mechanical strength test of welded joint.
- (f) Mechanical strength test for corona control ring/grading ring and arcing horn. BS-3288 (Part-I)
- (g) Test on locking device for ball and socket coupling. IEC – 3721984
- (h) Chemical analysis, hardness tests, grain size, inclusion rating and magnetic particle inspection for forging/casting.

D. **On suspension hardware fittings only.**

- (a) Clamp slip strength ver as torque test for suspension clamp.
- (b) Shore hardness test of elastomer cushion for AG suspension clamp.
- (c) Bend test for armour rod set. IS-2121 (Part-I)
- (d) Resilience test for armour rod set. -do-
- (e) Conductivity test for armour rod set. -do-

E. **On tension hardware fittings only**

	Unit.	37/4.00 mm <sup>2</sup>
<b>MID SPAN COMPRESSION JOINTS FOR CONDUCTORS.</b>		
Weight of the joint.	Kg.	1.27
Slipping strength.	KN	129.6
Resistance of the completed joint.	Ohms.	0.000027
Materials of the joints specify alloy type		6201

and its aluminum contents.		
Before compression dia of sleeve.	mm	
(a) Inner diameter.		31+/-0.5
(b) Outer diameter.		48+/-1.0
Dimensions after compression.	mm	
(a) Corner to corner.		46+/-0.5
(b) Surface to surface.		40+/-0.5
Length of the sleeve.	mm	
(a) Before compression.		500+/-5.0
(b) After compression.		540+/-5.0
Compression pressure.	Tone	100
Whether designed for intermittent or continuous compression.		Continuous compression.
Minimum corona extinction voltage under dry condition.	Kv	154
Radio interference voltage under conditions.	Micro volt.	Below 1000
<b>REPAIR SLEEVE FOR CONDUCTOR</b>		
Weight of the sleeve.	Kgs.	0.63
Before compression dia of sleeve.		
(a) Inner diameter.	mm	31.05
(b) Outer diameter.	mm	48.10
Dimensions after compression.		
(a) Corner to corner.	mm	48.05
(b) Surface to surface.	mm	40.05
Length of sleeve.		
(a) Before compression.	mm	279.50
(b) After compression.	mm	300.50
Compression pressure.	Tone.	100
Minimum corona extinction voltage under dry condition.	Kv.	154
Radio interference voltage under condition.	Micro volt.	Below 1000

(a) Slip strength test for dead end assembly. IS-2121 (Part-I)

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.

#### **F. For hardware fittings.**

(a) Visual examination. IS-2121 (Part-I)

(b) Proof & test.

**G. Tests on conductor accessories.**

H. Type tests.

I. Mid span compression joint for conductor and earthwire.

(a) Chemical analysis of materials.

(b) Electrical resistance tests.  
clause 6.5 & 6.6

IS-2121 (Part-II) 1981

(c) Heating cycle test.

-do-

(d) Slip strength test.

-do-

(e) Corona extinction voltage test (dry)

(f) Radio interference voltage test (dry)

J. Repair sleeve for conductor.

(a) Chemical analysis of materials.

**VIBRATION DAMPER FOR CONDUCTOR.**

Vibration Damper for AAC 37/4.00 mm	Unit.	
Total weight of the damper.	Kgs.	4.5
Weight of each damper mass.	Kgs.	Left. 1.6 Right. 2.2
Resonance frequencies.		
1. First frequency.	Hz	12+/- 1 18+/- 2
2. Second frequency.	Hz	28+/- 2 36+/- 2
Dimension of each damper mass.	Mm	55 Ox165 60 Ox195
Material of:		
1. Damper mass.		Cast iron hot dip galvanized.
2. Messenger cable.		High tensile galvanized steel wire.
No. of strands in messenger cable strands.		19
Lay ratio of messenger cable strands.		9-11
Min tensile strength of messenger cable.	Kg./ Sq.mm	135
Miss pull-off strength.	KN	5
Clamping force.	Kg.m	7
Slipping strength of the damper clamp.	KN	
1. Before fatigue test.		2.5
2. After fatigue test.		2.0
Magnetic power loss per vibration damper.	Watts.	1 watt at 500 amps.

Min. corona extinction voltage under dry conditions.	Kv.	154
Radio interference voltage under dry condition 1MHz, at 154 KV.	Microv olt.	Below 1000
Percentage variation in reactance after fatigue test in compassion with that before the fatigue test.	%	20

## **SECTION – V**

### **CLAMPS AND CONNECTORS**

S.NO.	DESCRIPTION	PAGE NO.
-------	-------------	----------

#### (A) TECHNICAL SPECIFICATION FOR CLAMPS & CONNECTORS

1.	SCOPE	75
2	STANDARDS	75
3.	MATERIAL AND WORKMANSHIP	75
4.	RATING	76
5.	EQUIPMENT CONNECTORS	76
6.	TEMPRATURE RISE	77
7.	WEIGHTS	77
8.	INTERCHANGE ABILITY	77

#### (B) TECHNICAL SPECIFICATION FOR ACSR BUS-BAR

1.	SCOPE	77
2.	MATERIALS	77
3.	MECHANICAL CHARACTERISTICS	77
4.	DIMENSIONAL TOLERANCE	78
5.	CHEMICAL COMPOSITION	78
6.	ELECTRICAL & MECHANICAL CHARACTERISTICS AND CURRENT RATINGS	78



# TECHNICAL SPECIFICATION

## CLAMPS AND CONNECTORS

### (A) TECHNICAL SPECIFICATION FOR CLAMPS & CONNECTORS

#### 1. SCOPE

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply and delivery at site of all terminal connectors of 220,132 & 33KV equipments (mainly breaker, isolator, CT,PT,CVT,BPI and LA) and all other clamps and dropper connectors required for the switch yard as per approved lay out and system design.

#### 2. 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: 5561 | 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 any other authoritative standards which ensure equal or better performance shall also be 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. 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 ACSR conductor shall be of compression 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. **RATING**

The connector rating shall match with the rating of the respective equipments 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:

Rating	400/220 / 132 KV
1. Main bus bar connectors high level and low level (Amps)	3600/2000/2000
2. High level bus sectionalisation isolator(Amps)	3600/2000/2000
3. Connectors along the bay (Amps)	3600/2000/2000
4. Terminal connectors for CB(Amp.)	as per rating of CB
5. -do- for Isolator(Amps)	as per rating of ISO
6. -do- for CT	As per CT rating
7. -do- for PI	As per PI rating
8. -do- for LA	As per LA rating
9. -do- for PT	As per PT rating
10. -do- for CVT	As per CVT rating
11. -do- for WT	As per WT rating.

#### 5. **EQUIPMENT CONNECTORS**

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

- i) 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.
- ii) 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 cause 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. TEMPRATURE 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
  - © 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. WEIGHTS**

Weights of different materials uses in manufacture, such as aluminium, silicon, copper etc. should be clearly indicated in the bid.

## **8. INTERCHANGE ABILITY**

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

## **(B) TECHNICAL SPECIFICATION FOR ACSR BUS-BAR**

### **1. SCOPE**

The specification covers design, engineering, manufacture, testing at manufacturer's works, supply and delivery of heavy duty ACSR bus-bar for use in 220 KV and 132 kV sub-station.

### **2. MATERIALS**

The ACSR bus bar shall be drawn by using MOOSE/ZEBRA as per system requirement.

The strung ACSR bus-bar shall be of heavy duty type and design to operate within set temperature limits and to withstand thermal and electromechanical forces developed due to short circuits.

### **3. MECHANICAL CHARACTERISTICS**

The mechanical strength of the strung ACSR bus-bar shall be limited to be maximum allowable tension for specific size of conductor as per ISS.

4. **DIMENSIONAL TOLERANCE**

Dimensional tolerances shall be as per relevant ISS.

5. **CHEMICAL COMPOSITION**

The chemical composition for ACSR conductors (MOOSE/ZEBRA) shall be holding good under all operating condition.

6. **ELECTRICAL & MECHANICAL CHARACTERISTICS AND CURRENT RATINGS**

Electrical and mechanical characteristics and current ratings for ACSR bus-bar shall be same as stipulated for MOOSE/ZEBRA ACSR conductors, the details of which has been specified.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

LINE HARDWARE AND ACCESSORIES FOR 132/220 KV & GROUND WIRE 7/3.15mm

A	HARDWARES	Suspension	Tension
i	Maker's name and Address	ERI-TECH LIMITED	
ii	Size and designation of ball and socket with standard specification to which conforming	16mmB as per IS 2486	20mm as per IS 2486
iii	Material		
a	Anchor shackle	NA	Forged steel Galvanised
b	Chain Link	NA	Forged Steel galvanised
c	Ball hook / Ball Link (HH)	Forged Steel galvanized	Forged Steel galvanised
d	Socket Eye (HH)	Forged Steel galvanized	NA
e	Ball Clevis	Forged Steel galvanized	Forged Steel galvanised
f	Socket Clevis	Forged Steel galvanized	Forged Steel galvanised
g	Yoke Plate	Mild Steel Galvanised	Mild Steel Galvanised
h	Arcing Horn	Mild Steel Galvanised	Mild Steel Galvanised
i	Clamp Suspension	A.G.S. Clamp	NA
j	Dead End/Cross arm strap	NA	NA
k	Dead end clamp(Compression)	NA	Ext. Al. Alloy
iv	Standard specification to which the Hardwares conform	IS 2486, IS: 2004,IS:617, IS-2633, & IS-733	
v	Standard specification to which conforming	IS: 2486	
vi	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		
vii	Standard to which conforming	IS 2633		
viii	Reference to drawing No.	Drg. Attached		
ix	Minimum failing load in kg	For AAAC & ACSR Panther (132 kv)	For AAAC & ACSR Zebra (220 kv)	For AAAC & ACSR Moose (220 kv/400 KV)
a	For Single Tension Hardwire Fittings	120 kN	160 kN	160 kN
b	For Double Tension Hardwire Fittings	120 kN	160 kN	160 kN
c	For Single Suspension Hardwire Fittings	70 kN	70 kN	90/120 kN
d	For Double Suspension Hardwire Fittings	70 kN	70 kN	120 kN
<b>B.</b>	<b>TENSION CLAMPS</b>	Suitable for Panther, Zebra & Moose (AAAC/ACSR)		
i	Type	Compression type tension clamp		
ii	Material	Ext. Al. Alloy/ Ext. Al.		
iii	Breaking Strength	95% of UTS of Conductor		
iv	Slipping strength	95% of UTS of Conductor		
v	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		
vi	Standard to which conforming	IS 2633		
vii	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		
viii	Reference to type tests and other tests reports attached	T.C. Attached		
ix	Make of bolts and nuts used	Local Make		
<b>C</b>	<b>SUSPENSION CLAMPS</b>	<b>Panther (AAAC/ACSR)</b>	<b>Zebra (AAAC/ACSR)</b>	<b>Moose (AAAC/ACSR)</b>
i	Type	AGS Type		
ii	Type of material used for retaining rod for AGS assembly giving reference of ISS	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent
iii	minimum tensile strength of	35 kg/mm <sup>2</sup>	35 kg/mm <sup>2</sup>	35 kg/mm <sup>2</sup>

	retaining rod material				
iv	Chemical composition of retaining rod material	As per IS:733	As per IS:733	As per IS:733	
v	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	Not less than 40% of IACS	Not less than 40% of IACS	
vi	Slipping strength of cushioned suspension assembly	8% to 15% of UTS of Conductor	20 to 29 KN of UTS of Conductor	20 to 29 KN of UTS of Conductor	
vii	Breaking strength of suspension Clamp	7000kgf	7000kgf	9000kgf	
viii	Physical properties of neoprene cushion				
a	Minimum Tensile Strength	2000 psi	2000 psi	2000 psi	
b	Minimum ultimate Elongation	300%	300%	300%	
ix	Ageing (guaranteed life of the assembly)	40 years	40 years	40 years	
x	Hardness	65 to 80 A	65 to 80 A	65 to 80 A	
D	Midspan compressions joints for	Panther		Zebra	
		AAAC	ACSR	AAAC	ACSR
i	Type	Compression Type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAAC Zebra	ACSR Zebra
iii	Materials				
a	Outer Sleeve	Ex. Al. Alloy	Ex. Al.	Ex. Al. Alloy	Ex. Al.
b	Inner Sleeve	N.A.	Galvanised Steel	N.A.	Galvanised Steel
iv	Outer Sleeve				
a	Outer Dia. Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	Flat to Flat After compression (mm)	32	32	40	40
v	Length of Outer Sleeve				
a	Before compression (mm)	610	610	711	711
b	After compression (mm)	655	660	760	768
vi	Inner Sleeve				
a	Outer Dia. Before compression (mm)	N.A.	Ø 18	N.A.	Ø 19.2
b	Flat to Flat After compression (mm)	N.A.	15.1	N.A.	16.1
vii	Length of Inner Sleeve				
a	Before compression (mm)	N.A.	203	N.A.	241
b	After compression (mm)	N.A.	230	N.A.	273
viii	Weight of Sleeve				
a	Aluminium (kg)	1.2	1.2	2.032	2.032
b	Galvanised Steel (kg)	N.A.	0.295	N.A.	0.410
ix	Galvanising				
a	Ferrous parts	Hot Dip Galvanised			

b	Spring washers	Electro Galvanized			
c	Quality of zinc used	99.5%			
d	Number of dips which the clamp can withstand	4/ 1 minute dips			
x	Standard to which conforming	IS 2633			
xi	Slipping strength of mid span joint expressed as percentage of UTS of conductor	95%			
xii	Breaking strength of mid span joint expressed as percentage of UTS of conduct	95%			
xiii	Conductivity of Compression joint expressed as percentage of conductivity of cable	100% of equivalent length of conductor			
xiv	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductor			
E	Repair Sleeve	AAAC & ACSR Panther		AAAC & ACSR Zebra	
i	Type	Compression type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAA C Zebr a	ACSR Zebra
iii	Outside diameter or length of sleeve				
a	Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	After compression Flat to Flat (mm)	32	32	40	40
iv	Length of Sleeve				
a	Before compression (mm)	241	241	279	279
b	After compression (mm)	270	270	310	310
v	Material	Ex. Al.Alloy	Ex. Al.	Ex. Al.Alloy	Ex. Al.
vi	Weight of sleeve in (kg)	0.450	0.453	0.810	0.810
vii	Breaking strength as percentage of UTS of conductor	95%			
viii	Conductivity as percentage of conductivity of conductor	100% of equivalent length of conductor			
ix	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductors			
F	Vibration Damper	For AAAC & ACSR ZEBRA			
i	Total weight of the damper (Kg)	4.5 Approx			
		Left			Right
ii	Weigh of each damper mass (kgs.)	1.6			2.2
iii	Resonance frequencies				
	1. First frequency (Hz)	12+ 1			18+ 2

	2. Second frequency (Hz)	28+ 2	36+2
iv	Dimensions of each damper mass	60 $\Phi$ x 195	55 $\Phi$ x 165
v	Material of :		
	1. Damper mass	Cast iron hot dip galvanised.	
	2. Messenger cable.	High tensile galvanised steel wire.	
vi	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	
vii	Standard to which conforming	IS 2486 and IS 2633	
viii	No of strands in messenger cable strands	19	
ix	Lay ratio of messenger cable strands	9 11	
x	Min tensile strength of messenger cable ( kg /sq. mm)	135	
xi	Mass pull - off strength (KN)	5	
xii	Clamping torque (Kg.m)	7	
xiii	Slipping strength of the damper clamp		
	1.Before fatigue test (KN)	2.5	
	2. After fatigue test (KN)	2	
xiv	Magnetic power loss per vibration damper (Watts)	1 watt at 500 amps	
xv	Min. corona extinction voltage under dry conditions (KV)	154	
xvi	Radio interference voltage under conditions 1 MHZ, AT 154 KV (Microvolt)	Below 1000	
xvii	Percentage variation in reactance after fatigue test in comparison with that before the fatigue test (%)	20	
<b>G</b>	<b>Midspan compression joint For 7/3.15mm Galvanised Stranded Steel Wire</b>		
i	Material	Galvanized Steel	
ii	Size	OD 20.2 x Length 230	
iii	Suitable for groundwire	Yes (7/3.15)	
iv	Weight in kg	0.85	
v	Minimum failing load	50 KN	
vi	Galvanization		
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 dip	
vii	Standard to which conforming	IS 2633	



<b>H</b>	<b>Suspension Clamps For 7/3.15mm Galvanised Stranded Steel Wire</b>	
i	Materials	Malleable Cast Iron / Galvanised 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
<b>I</b>	<b>Compression type dead end assemblies For 7/3.15mm Galvanised Stranded Steel Wire</b>	
i	Materials	Forged steel
ii	Size	As per drawing
iii	Suitable for ground wire	Yes (7/3.15)
iv	Weight in kg	3.69
v	Minimum failing load	70 KN
vi	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
vii	Standard to which conforming	IS 2486 and IS 2633
<b>J</b>	<b>Flexible copper bond</b>	
i	Drawings enclosed	Yes
ii	Stranding	37/7/0.417
iii	Cross sectional area (Sq.mm)	75.6
iv	Minimum copper equivalent area (Sq.mm)	34 (each individual wire)
vi	Length of copper cable (mm)	500
vii	Material lugs	Tinned Copper
viii	Bolt Size	
	(i) Diameter (mm)	16
	(ii) Length (mm)	40
ix	Resistance (Ohm)	0.0004 ( as per IS:2121)
x	Total weight of flexible copper bond (kg)	0.45 (approx)

