

**SECTION – IV**

**TECHNICAL SPECIFICATIONS  
FOR  
POWER CONDUCTOR**

## SECTION – IV

# TECHNICAL SPECIFICATIONS FOR POWER CONDUCTORS

### I. “AAAC MOOSE” CONDUCTOR: (if applicable only)

**1.0 SCOPE:** This specification covers the manufacture testing at manufacturer’s works and supply of AAAC MOOSE as per technical details enclosed. These conductors are to be used as Power conductors and Ground wire respectively on 220 KV Double circuit Transmission lines.

### 2.0 STANDARD:

Except as modified by this specification, these AAAC conductors to be supplied shall conform to the latest edition with revision of the following Bureau of Indian Standards (IS) and British Standards (BS).

IS-1778-1980 conductors	Reels and drums for bare  (First Revision)
IS-398 Part IV-1982	Aluminium conductors galvanized steel-reinforced for Extra high voltage (400 KV and above) (Amendment No.1)
IS-1841-1978	EC grade Aluminium rod produced by rolling (Second Revision)
IS-5484-1978	EC grade Aluminium rod produced by continuous casting and rolling (First Revision)
IS-7623-1985	Lithium base Grease for Industrial purposes (First Revision)

IS-398(Part-4)-1994      All Aluminium alloy stranded  
conductors for overhead  
Transmission purpose.

However in an event where the Bidder offers AAAC conductor conforming to standards other than the above, then the salient points of comparison between the standards quoted herein shall be detailed in the Schedule enclosed to the Bid proposal sheets.

**2.1** The materials shall conform to clause No.4 of IS 398 (part-IV) 1979.

- a) The conductor shall conform to type tests and shall also be subjected to acceptance and routine tests as specified in the specification.
- b) The resistance of the individual aluminium alloy wires shall be determined separately before stranding by means of tests on samples of wires to an accuracy of one part in a thousand. The test samples shall be of sufficient length to give the required accuracy.

**c) PHYSICAL CONSTANTS OF MATERIALS:**

**d) PHYSICAL CONSTANTS OF HARD DRAWN ALUMINIUM ALLOY WIRES:**

This shall conform to clause No.3 of IS 398 (Part-IV) – 1979.

**2.1.2 SURFACE CONDITIONS:**

The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp edges, abrasions or other departure from smoothness on uniformity of surface contour that would increase radio interferences and corona losses. When subjected to tension up to 50% of the ultimate strength of the conductor, the surface shall not depart from the cylindrical form on any part of the component, parts or strands, more relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

### **2.1.3 JOINTS IN WIRE AND CONDUCTORS:**

**Aluminum Alloy wires:** No joint shall be permitted in the Aluminium alloy wires in the outer most layer of the AAAC conductor. Joints in the individual aluminium alloy wires 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 M apart in the complete stranded conductor. Such joints shall be made by the cold pressure butt welding. They are not required to fulfill the mechanical requirements for the un-jointed wires.

### **2.1.4 STRANDING:**

The wires used in construction of stranded conductor shall before stranding, satisfy all requirements of IS 398 with latest amendments.

For Aluminium Alloy conductors, the lay ratio of the different layers shall be within the limits given under appendix-I. 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 underlying wire or wires. The final layer of wires shall have a right hand lay.

### **2.1.5 PACKING AND MARKING:** The conductor shall be wound on non-returnable reels or drums conforming to Indian Standard 1778 and its latest amendments with the following.

- a) Trade name if any.
- b) Name of the manufacture
- c) Size of conductor
- d) Length of conductor
- e) Gross weight of drum with protective lagging including conductor.
- f) Weight of empty drum with protective lagging.
- g) Net weight of conductor
- h) Arrow marking for unwinding
- i) Position of conductor end.

Only one conductor length shall be packed on each drum.

### **2.1.6 LENGTHS:**

The conductor shall be supplied in the standard lengths of 1.0 to 1.5 KM for AAAC MOOSE conductor. Not less than 95% of the total quantity of the conductor shall be supplied in standard

lengths. None of the pieces of the remaining 5% shall be less than half of the nominal lengths.

### **3.0 TESTS AND INSTRUCTIONS:**

Within two weeks of the receipt of each consignment of raw materials viz., aluminium rods etc., at the manufacturer's work, the contractor shall furnish for approval of the owner raw material test certificate in triplicate. No manufacturer shall commence manufacturing the conductor ordered prior to the owner's approval of the test certificates for raw materials.

**3.1** Test certificates shall cover all tests stipulated in the relevant ISS.

**3.2** Test certificates in triplicate for tests on hard drawn aluminium wire employed in the manufacture of AAAC conductor shall be submitted. No dispatch shall be affected prior to the owner's written approval of the test certificates.

### **3.3 TYPE TESTS:**

Following tests shall constitute the Type tests. The Bidders shall furnish the type test certificates of recent origin from a reputed laboratory for having conducted these tests for the purchaser's scrutiny along with the Bids.

- a) Visual Examination
- b) Measurements of diameters of individual Aluminium and Steel wires.
- c) Measurement of lay ratio of each layer.
- d) Breaking load test.
- e) Elongation Test.
- f) Resistance test.
- g) Load test on composite conductor.

In addition to the above all the type tests shall be repeated for every 1000 KM of the AAAC MOOSE of the same type and make ordered after the award of the contract which will be witnessed by the purchaser's representative. The extra cost if any shall be clearly indicated in the price schedules attached to the Section-III, Bid proposal sheets BPS.

**3.4 ACCEPTANCE TESTS:** The following shall constitute the Acceptance tests.

- a) Visual Examination
- b) Measurements of diameters of individual Aluminium and Steel wires.

- c) Measurement of lay ratio
- d) Breaking load test on individual wires
- e) Elongation Test
- f) Resistance test
- g) Verification of length and weight of conductor.

The above acceptance tests shall be conducted in the presence of the owner's representative.

Schedule of various type and routine tests to be carried out on conductors shall be submitted by the contractor for owner's approval. No change in the schedule of tests, unless desired by the owner shall be subsequently made by the contractor or his sub-contractor or the manufacturer without prior consent of the owner.

The owner may at any time call for any tests that are laid in the specification as optional tests. The contractor shall arrange to carry out such tests expeditiously and at his own cost. Test certificate for each optional test shall be submitted to the owner for approval.

The contractor shall notify the owner at least six weeks in advance, the time of manufacture, so that inspection of material manufacture and/or witnessing of tests can be arranged. Inspection shall also include method of packing and stacking of finished materials in the work.

### **3.6 ROUTINE TESTS:**

These shall be same as Acceptance tests and shall be conducted by the manufacturer on all the coils to check the requirements, which are likely to vary during the manufacturer.

- 3.7** The contractor shall supply six copies of sag tension charts per consignee for the conductor supplied. The contractor shall also prepare and supply a sag template on celluloid, which shall be subject to approval by the owner at no extra cost to the owner.

**APPENDIX-I**  
**(A) CONDUCTOR DETAILS AAAC MOOSE:**

Stranding and wire diameter Aluminium (mm)	:	61/3.55
Overall diameter (mm)	:	31.95
Calculated equivalent area of aluminium (Sq.mm)	:	520
Sectional area of cross section (Sq.mm)	:	603.30
Approximate total weight (kg/KM)	:	1666
Guaranteed ultimate tensile strength of conductor (Kg)	:	16295
Calculated DC resistance at 20° C (ohm/KM)	:	0.05502

**CHEMICAL COMPOSITION AAAC CONDUCTOR**

The conductor shall be constructed of heat-treated aluminium-magnesium-silicon alloy wires containing approximately 0.5% magnesium and approximately 0.5% silicon and having the mechanical and electrical properties specified in Table-1 of ISS 398 (Part-IV)-1979.

**DETAILS OF SOLID AND ALUMINIUM ALLOY WIRES USED IN  
THE AAAC CONDUCTOR:**

<b><u>Diameter</u></b>	<b><u>AAAC MOOSE</u></b>
a) Standard	3.55 mm
b) Maximum	3.585 mm
c) Minimum	3.51 mm
Sectional area	9.898 mm
Weight	26.72 Kgs/Km
Breaking load	2.91 KN

Resistance at 20 C :- When corrected to standard weight.

a) Maximum	:	3.388 ohm/Km
b) Standard	:	3.283 ohm/Km

<b><u>LAY RATIOS</u></b>	<b><u>Max.</u></b>	<b><u>Min.</u></b>
6 Wire Layer	17	10
12 Wire Layer	16	10
18 Wire Layer	15	10
24 Wire Layer	14	10

Modulus of Elasticity of conductor in kg/sq.mm	0.55x10 <sup>6</sup>
Co-efficient of linear Expansion in /Deg.C	23.0x 10 <sup>-6</sup>



## **II. “MOOSE ACSR” CONDUCTOR: (if applicable only)**

**1.0 SCOPE:** This specification covers the manufacture testing at manufacturer’s works and supply of MOOSE ACSR as per technical details enclosed. These conductors are to be used as Power conductors on 400 KV Multi-circuit and Double circuit Transmission lines.

### **2.0 STANDARD:**

Except as modified by this specification, the ACSR conductor to be supplied shall conform to the latest edition with revision of the following Bureau of Indian Standards (IS) and British standards (BS).

IS-209-1979	Zinc (Third Revision)
BS-215-1970	Aluminium conductors, steel reinforced
IS-398-Part-II-1976	Aluminium conductors, galvanised steel-reinforced (Second Revision) (Amendments 1 to 3)
IS-398 Part V-1982	Aluminium conductors galvanized steel-reinforced for Extra high voltage (400 KV and above) (Amendment No.1)
IS-1778-1980	Reels and drums for bare conductors (First Revision)
IS-1841-1978	EC grade Aluminium rod produced by rolling (Second Revision)
IS 2629-1985	Recommended practice for hot dip galvanizing of Iron and steel.
IS-2633-1972	Methods of testing uniformity of coating on Zinc coated articles.
IS-4826-1979	Hot dipped Galvanized coating on round steel wires (Amendment No.1)
IS-5484-1978	EC grade Aluminium rod produced by continuous casting and rolling (first revision)

IS-7623-1985                      Lithium base Grease for Industrial purposes. (First Revision)

IS-8263-1976                      Method of Radio Interference tests on high voltage insulators

However in an event where the Bidder offers ACSR conductor conforming to standards other than the above, then the salient points of comparison between the standards quoted herein shall be detailed in the Schedule enclosed to the Bid proposal sheets.

The material offered shall be of best quality and workmanship. The conductor shall be suitable for being installed directly in air supports on suspension installed directly in air supports on suspension insulator strings or anchored through tension insulators strings at Tower cross arms. They shall be suitable for climatic conditions listed in the specification. The steel cored aluminium conductor strands shall consist of hard drawn aluminium wire, manufactured from 99.95% pure electrolytic aluminium rods of E.C. grade. They shall be free from scratches, die marks and other surface imperfections. The aluminium rods used shall comply with IS 1841-1978 and IS 5484. The mechanical and Electrical properties of Aluminium wire shall comply with the requirements as in Appendix-II enclosed. They shall be reinforced with galvanized high tensile strength steel wire made from materials produced either by acidic or basic open heart process or by electric process. No steel wire drawn from Bessemer process shall be used. The steel wire shall not contain sulphur and phosphorus exceeding 0.05% and the total sulphur and phosphorus shall not exceed 0.085%. The steel wire shall not be subject to any heat treatment after being galvanized. The zinc coating of the steel wires shall be smooth and of uniform thickness and shall conform to IS-209 and satisfy tests as per IS-2633. There shall be no bare spots owing to adherence of scales or other causes. The zinc used for galvanizing shall be electrolytic high grade zinc not less than 99.95% shall conform to and satisfy all the requirements of IS 209-1966. Neutral grease may be applied between the layer of wire. Lithium soap grease corresponding to Grade-II of IS 7623-1974 (specification for Lithium soap grease) is suitable for such application.

The conductor shall conform to type tests and shall also be subjected to acceptance and routine tests as specified in the specification.

The resistance of the individual aluminium wires shall be determined separately before stranding by means of tests on samples of wires to an accuracy of one part in a thousand. The test samples shall be of sufficient length to give the required accuracy.

## **2.1 Physical constants of Materials**

### **2.1.1 Physical constants of Hard drawn Aluminium**

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

Density: At temperature of 20 deg.C, the density of hard drawn Aluminium has been taken as 2.703 g/cu.cm.

Constant-Mass

Temperature Co-efficient

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

Coefficient of Linear

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

### **2.1.2 Physical constants of Galvanized ground wire**

Density: At temperature of 20 deg.C the density of galvanized steel wire is to be taken as 7.80 g/cu.cm

Coefficient of linear expansion : In order to obtain uniformity in calculations a value of  $11.5 \times 10^{-6}$

deg.C may be taken as the value for the co-efficient of Linear expansion of galvanized steel wires used for the cores of steel reinforced aluminium conductors.

- a. The following tolerance shall be permitted on standard diameter and on the resistance of aluminium wires.

Tolerance on standard Diameter of Aluminium wire	+/- 0.5% on the nominal dia specified in Annexure-II when corrected to standard weight and temperature.
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Negative tolerance on standard Wt./Km. of conductor is not permitted.

Galvanized Steel Wire	+2% on the nominal dia. specified in Annexure-II.
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**NOTE** : The cross section of any wire shall not depart from circularity by more than an amount corresponding to tolerance of 2% on the standard dia meter.

**2.1.3 SURFACE CONDITIONS:** The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp edges, abrasions or other departure from smoothness on uniformity of surface contour that would increase radio interferences and corona losses. When subjected to tension upto 50% of the ultimate strength of the conductor, the surface shall not depart from the cylindrical form on any part of the component, parts or strands, more relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

#### **2.1.4 JOINTS IN WIRE AND CONDUCTORS :**

Aluminium wires: No joint shall be permitted in the Aluminium wires in the outermost layer of the ACSR conductor. Joints in the individual aluminium wires 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 M apart in the complete stranded conductor. Such joints shall be made by the

cold pressure butt welding. They are not required to fulfill the mechanical requirements for the un joined wires.

Galvanized steel wires: There shall be no joints except those in the base rod or wire before final drawings, in steel wires forming the core of the steel-reinforced aluminium conductor.

**2.1.5 STRANDING:** The wires used in construction of stranded conductor shall before stranding, satisfy all requirements of IS 398 with latest amendments.

For steel cored aluminium conductors, the lay ratio of the different layers shall be within the limits given under appendix-I. For all constructions each alternate layer shall be stranded in opposite directions. The wires in each layers shall be evenly and closely stranded round the underlying wire or wires. The final layer of wires shall have a right hand lay.

**2.1.6 PACKING AND MARKING:** The conductor shall be wound on non-returnable reels or drums conforming to Indian Standard 1778 and its latest amendments with the following.

1. Trade name if any.
  2. Name of the manufacture.
  3. Size of conductor.
  4. Length of conductor.
  5. Gross weight of drum with protective lagging including conductor
  6. Weight of empty drum with protective lagging.
  7. Net weight of conductor.
  8. Arrow marking for unwinding.
  9. Position of conductor end.
- Only one conductor length shall be packed on each drum.

**2.1.7 LENGTHS:** The conductor shall be supplied in the standard lengths of 1.2 to 1.5 KM. Not less than 95% of the total quantity of the conductor shall be supplied in standard lengths. None of the pieces of the remaining 5% shall be less than half of the nominal lengths.

**2.1.8 TESTS AND INSTRUCTIONS:** Within two weeks of the receipt of each consignment of raw materials viz. Steel, electrolytic aluminium rods etc. at the manufacturer's work. The contractor shall furnish for approval of the owner raw material test certificate in triplicate. No manufacture shall commence manufacturing the

conductor ordered prior to the owner's approval of the test certificates for raw materials.

Test certificates shall cover all tests stipulated in the relevant ISS.

Test certificates in triplicate for tests on hard drawn aluminium wire employed in the manufacture of ACSR conductor shall be submitted. No despatch shall be affected prior to the owner's written approval of the test certificates.

### **3.0 Type tests:**

The validity period of the type tests on various equipments related to transmission lines shall be as per the guidelines mentioned in "Guidelines for the Validity period of type test(s) conducted on major electrical equipment in power transmission- May 2020" by Central Electricity Authority, GOI.

Following tests shall constitute the Type tests. The Bidders shall furnish the type test certificates within 10 years old as on date of opening of Bid from a NABL accredited laboratory for having conducted these tests for the purchaser's scrutiny along with the Bids.

- i) Visual Examinations
- ii) Measurements of diameters of individual Aluminium and Steel wires.
- iii) Measurements of lay ratio of each layer.
- iv) Breaking load test
- v) Ductility test
- vi) Wrapping test
- vii) Resistance test
- viii) Galvanizing test
- ix) Load test on composite conductor.
- x) Surface condition test
- xi) Corona test
- xii) Radio interference voltage test

In addition to the above all the type tests shall be repeated for every 1000 KMs of MOOSE ACSR of the same type and make ordered after the award of the Contract if required by the Owner which will be witnessed by the purchaser's representative. The extra cost if any shall be clearly indicated in the price schedules attached to the Section BPS.

### **3.1 Acceptance tests:** The following shall constitute the Acceptance tests.

- i) Visual examination
- ii) Measurements of diameters of individual aluminium and steel wires.
- iii) Measurements of lay ratio
- iv) Breaking load test on individual wires
- v) Ductility test
- vi) Wrapping test.
- vii) Resistance test
- viii) Galvanizing test
- ix) Load test on composite conductor.
- x) Verification of length and weight of conductor

The above acceptance tests shall be conducted in the presence of the owner's representative.

Schedule of various type and routine tests to be carried out on conductors shall be submitted by the contractor for owner's approval. No change in the schedule of tests, unless desired by the owner shall be subsequently made by the contractor or his sub-contractor or the manufacturer without prior consent of the owner.

The owner may at any time call for any tests that are laid in the specification as optional tests. The contractor shall arrange to carry out such tests expeditiously and at his own cost. Test certificate for each optional tests shall be submitted to the owner for approval.

The contractor shall notify the owner at least six weeks in advance, the time of manufacture, so that inspection of materials manufacture and/or witnessing of tests can be arranged. Inspection shall also include method of packing and stacking of finished materials in the works.

**3.2 Routine tests:** These shall be same as Acceptance tests and shall be conducted by the manufacturer on all the coils to check the requirements which are likely to vary during the manufacture.

**4.0 Sag Tension Charts:** The contractor shall supply six copies of sag tension charts per consignee for the conductor supplied. The contractor shall also prepare and supply a sag template on celluloid which shall be subject to approval by the owner at no extra cost to the owner.

APPENDIX – I  
CONDUCTOR DETAILS ACSR “ MOOSE “

Stranding and wire diameter Aluminium	: 54/3.53 mm.
Steel	: 7/3.53 mm.
Overall diameter	: 31.77 mm
Calculated equivalent area of Aluminium	: 515.7 Sq.mm.
Actual area of cross section	: 528.5 Sq.mm
Standard area and cross section in Sq.mm	
a) Aluminium strand	: 9.787
b) Steel strand	: 9.787
c) Conductor	: 597
Approximate total weight	: 2004 Kgs./Km.
Guaranteed ultimate tensile Strength of Conductor	:161.2 KN
Calculated DC resistance at 20o C	:0.0552 Ohm/Km.
Lay-Ratios	:Max. Min.
Steel core	:18 16
Aluminium layers	:Max. Min.
12 wire layers	:14 12
18 wire layers.	:13 11
24 wire layer	:12 10
Modules of elasticity of conductor	:69 GN/Sq.m
Co-efficient of linear expansion per degree C.	:19.3 x 10 <sup>-6</sup>



## CHEMICAL COMPOSITION OF HIGH CARBON STEEL

The chemical composition of high carbon steel used in the manufacture of steel wire of ACSR conductor is given below for guidance.

Element	Percentage composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorus	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

### (B) DESIGN PARTICULARS

Span a)	Normal span	:	400 Meter.
b)	Wind span	}	As mentioned in
c)	Wt. span	}	tower designs

Wind pressure on full projected area: 107 Kgs., Sq.mm.

Temperature : Min: 0° C , Max: 75°C, Every day:32°C

Factor of safety – The minimum factor of safety for conductor may be assumed as 2.0 based on their ultimate tensile strength at 32 Deg.C and maximum wind pressure expected in the region. In addition the conductor tension at 32 Deg.C without external load should not exceed the following percentages of the ultimate strength of the conductor.

Initial unloaded tension	:	35 %
Final unloaded tension	:	25 %

## **APPENDIX – II**

### **DETAILS OF SOLID AND ALUMINIUM WIRES USED IN THE MOOSE ACSR CONDUCTOR:**

<u>Diameter</u>	<u>Steel</u>	<u>Aluminium</u>
a) Standard	3.53 mm	3.53 mm
b) Maximum	3.60 mm	3.55 mm
c) Minimum	3.46 mm	3.51 mm
Sectional area	9.787 mm	9.787 mm
Weight	76.34 Kgs/Km.	26.45 Kgs/Km.
Breaking load	12.22 KN (after stranding)	1.49 KN
	12.86 KN (before stranding)	1.57 KN
Minimum ultimate tensile strength	134.0 Kg/Sq.mm	16.38 Kgs/Sq.mm

#### **ZINC COATING :**

No. and duration of dips 3 ( 1 min. dip)

Minimum weight of coating 259 Gm/Sq. Meter.

Resistance at 20 °C: When corrected to standard weight.

a) Maximum : 2.921 ohm/Km

### **APPENDIX – III**

#### **TESTING FOR GALVANISING**

##### **SAMPLING AND PREPARATION OF TEST PIECES:**

Sampling: The degree of sampling shall be as agreed to between the galvanizer and the owner.

Preparation of test pieces: The test sample length of the wire shall be cut from one of both ends of coil under test portion of wire which are obviously damaged shall be not used for sample. In case of stranded or armour wire or wire which has undergone any other similar process, care should be taken to avoid in preparing the sample. A sample of suitable length usually not less than 150 mm shall be from one or both of the selected coils.

NOTE: The test pieces shall be selected from the material galvanized but if the material is of inconvenient lengths, shorter pieces of the same section and of the same steel composition may be introduced as test pieces. All test pieces shall be treated in the same manner in the same bath and at the same line as the materials.

Cleaning of sample: The test piece can be cleaned with a volatile organic solvent such as ether, trichloroethylene, carbon tetra-chloride etc. then rinsed with alcohol and finally washed thoroughly with a suitable clean, volatile organic solvent which will not attack the zinc coating or leave a greasy or waxy deposit. Test pieces shall be brought to a temperature from 15 to 20 Deg.C prior to the beginning of the test.

Abnormal cases may arise by reason of unusual surface conditions the copper sulphate solution will not act normally on the zinc coating; for example, the solution may have no apparent attachment on all or part of the surface or false deposits of copper may appear on the zinc coating. If there is any abnormality of performance of test pieces, they shall be discarded and new one selected. The new test pieces shall be cleaned in alcohol rinsed and wiped dry and then immersed for three minutes in a solution consisting of one part by volume of ammonium hydroxide (Sp.Gr.0.90) and nine parts of distilled water. The test piece may be so rubbed with cotton cloth during this immersion. After cleaning the test pieces shall be washed and wiped dry.

## COPPER SULPHATE SOLUTION:

### PREPARATION:

- a) Dissolve about 36 g of commercial copper sulphate crystal in 100 Ml. Of distilled water (See note). Heat the water to aid solution but if heated, the solution should be cooled before neutralizing.
- b) Neutralize the free sulphuric acid with solution by shaking with excess of copper carbonate (Chemically pure) or copper hydroxide (Chemically pure) (about one gram/liter of solution) and allow to stand for at least 24 hours before filtering or decanting the solution.
- c) The specific gravity of the test solution during the test shall be 1.186 at  $18 \pm 2$  Deg.C. Adjustment may be made by adding distilled water or solution of higher specific gravity.

NOTE: Chemically pure copper sulphate crystals are preferably of commercial grade although not necessary for this test.

Test pieces of wire shall be tested in a glass container of at least 50 mm inside diameter for 2.00 mm wire and smaller and at least 75 mm inside diameter for wire larger in diameter than 2.00 mm. The container shall be filled with fresh test solution to a depth of at least 100 mm. This quantity of solution shall be used for the simultaneous testing of one to seven test pieces. The solution shall be discharged after completion of the test and fresh solution used for any additional test.

TEMPERATURE OF THE SOLUTION: The temperature of the solution shall not vary outside the limits of  $18 \pm 2$  Deg.C either at the commencement of the test or through the duration of the test.

PROCEDURE: The cleaned test piece or pieces shall be subjected to as many one minute or half minute successive dips as prescribed in Appendix-II in the copper sulphate solution kept at a temperature of  $18 \pm 2$  Deg.C. Half minute dips shall be carried after the completion of all the one minute dips. If possible, immerse the test pieces completely taking care that they do not touch each other. During the test neither the test pieces nor the solution shall be agitated. After each dip withdraw the test pieces, rinse immediately in clean running water (see note) and remove any black deposit by a fiber brush, taking care that all the holes and pockets are removed, wipe and dry the test pieces with a clean soft cloth and return immediately to solution.

Successive dips of one minute each shall be continued with washing and wiping of the test pieces after each dip, until the test pieces have

withstood the required number of dips or until the end point has been reached.

NOTE: The rinse water shall be changed often enough preferably after each dip to ensure that it is reasonably free from copper sulphate, the temperature of the rinse water should be 15 Deg.C to 20 Deg.C.

#### INTERPRETATION OF THE TEST

The material passes this test if at the end of the specified number of dips, when the test piece is finally rinsed and wiped dry, it does not show any red deposit of copper upon the base metal. In case of wire any red deposit of copper within 25 mm of the cut end of the sample shall not be interpreted as a failure of the sample.

A fine line appearance of copper on the top of screw threads or on sharp edges of articles or within 25 mm. of a cut portion of specimen, shall not be judged as failure. Likewise, the failure of a coating at or adjacent to any cut or abrasion present on the original test shall not be considered as failure.

Direction of false end point if it is possible to remove the bright copper deposit with an ink eraser on top speed the copper deposit with the edge of blunt tool as the back of a knife, blade and zinc appears underneath the copper such an appearance of deposited copper shall be construed as false end point.

SUPPLEMENTARY TESTS: If at any time during the test there is any doubt as to the presence of exposed base metal as determined by visual inspection, test given under 5.20 may be used.

#### SUPPLEMENTARY TEST FOR ALL TYPES OF ZINC COATINGS:

MICROSCOPIC TEST: Section the test piece through the copper deposit mount and polish it metallagraphically. Etch the polished surface using an etching solution composed of 20 g of chromic acid, 1.5 g of sodium sulphate and 100 ml. Of distilled water. After etching wash the test piece under a microscope, using a magnification 100 diameters or greater if necessary look for the exposed base metal.

### **III. “ACSR DRAKE/COYOTE/LYNX” CONDUCTOR:**

#### **1.0 Scope:**

- 1.1 This specification provides for design, manufacture, engineering, inspection and testing before despatch, packing and delivery F.O.R. (destination) of aluminium conductors steel reinforced (ACSR) for overhead transmission purposes specified herein.
- 1.2 The conductor 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 they shall conform to the following Indian Standards, which shall mean latest revisions, amendments thereof. Equivalent International and Internationally recognized standard to which some of these standards generally correspond are also listed below:

Sl.No.	Indian Standards	Title	International Standards
1	IS: 209	Specification for zinc	<b>BS: 3436</b>
2	IS: 398 Part-I to Part-V (As relevant)	Specification for aluminium conductors for overhead transmission purpose	<b>IEC: 209</b> <b>BS: 215</b> (Part-II)
3	IS: 1778	Reels and Drums for Bare Conductors	<b>BS: 1559</b>
4	IS: 1521	Method of Tensile Testing of steel wire	<b>ISO/R89</b>
5	IS: 2629	Recommended practice for Hot Dip Galvanizing of Iron and Steel	
6	IS: 2633	Method of Testing Uniformity of coating of zinc coated Articles	
7	IS: 4826	Galvanised coating on round steel wire	<b>ASTM A-472</b> <b>729</b>

8	IS: 6745	Method of Determination of weight of zinc coating of zinc coated Iron and Steel Articles	<b>BS: 443</b>
9	IS: 1841	EC grade Aluminium rod produced by rolling (second Revision)	
10	IS: 5484	EC grade Aluminium rod produced by continuous casting and rolling (first revision)	
11	IS: 6754	Methods of determination of weight of zinc coating of zinc coated Iron and steel Articles.	
12	C-49 CSA	Specification for Drake ACSR	

2.2 The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution, 101, Pentonville Road, N-19-ND – UK
IEC/CISPR	International Electro-technical Commission, Bureau Central de la Commission, Electro Technique International, 1 Rue de verembe, Geneva, SWITZERLAND
BIS	Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi-110 001 INDIA
ISO	International Organization for Standardization, Danish Board of Standardization, Danish Standardizing Sraat, Aurehoegvej-12, DK-2900, Heelprup, DENMARK
NEMA	National Electric Manufacture Associate, 115, East 44 <sup>th</sup> Street, New York NY 10017 U.S.A
CSA	Canadian Standards Assn.

However, in an event where the Bidder offers ACSR conductor conforming to standards equivalent to or better than the above, the salient points of comparison between the standards adopted and the standards quoted herein shall be detailed in relevant schedule. Two copies of authenticated English version of such standards shall be furnished along with the offer.

### 3.0 **Principal Parameters:**

3.1 The details of conductor are tabulated below:

Stranding and wire diameter	26/4.442 mm Aluminium 7/3.45 mm Steel (Drake)	30/2.79 mm Aluminium 7/2.79 mm Steel (Lynx)	26/2.5 mm Aluminium 7/1.9 mm Steel (Coyote)
a) Number of Strands Steel Centre.  I Steel Layer I Al. Layer II Al. Layer	1 6 10 16	(Not applicable) 1 6 12 18	(Not applicable) 1 6 10 16
b) Sectional area of aluminium (Sq.mm)	402.8	183.4	131.7
c) Total sectional area (Sq.mm)	468.40	226.2	151.6
d) Overall diameter (mm)	28.13	19.53	15.86
e) Approximate weight (kg/km)	1623.5	844	521
f) Calculated D.C resistance at 20°C (ohm/km)	0.0715	0.1589	0.2214
g) Minimum UTS (Kg)	14175	7950	4625
h) Modulus of Elasticity (Kgs/Sq.cm x 10 <sup>6</sup> )	0.773	0.787	0.773



The details of aluminium strand are as follows:

a) Minimum breaking load of strand before stranding (Kg)	262	105	88
b) Minimum breaking load of strand after stranding (Kg)	249	100	84
c) Maximum DC resistance of strand at 20°C (ohm/km)	1.842	4.700	5.671

The details of steel strand are as follows:

i. Minimum breaking load of strand before stranding (Kg)	1251	819	403
ii. Minimum breaking load of strand after stranding (Kg)	1188	778	383
iii. Minimum weight of zinc coating (gm/sq.m)	259	230	210

#### 4.0 **General Technical Requirement:**

4.1 The conductor shall be suitable for satisfactory operation under the tropical climatic conditions given in the project synopsis.

#### 4.2 **Physical constants of materials:**

4.2.1 Physical constants for Hard-drawn Aluminium.

4.2.2 Resistivity: The resistivity of aluminium depends upon its purity and its physical condition. For the purpose of this specification the maximum value permitted is 0.028264 Ohm.sq.mm/mt 20°C, and this value has been used for calculation of the maximum permissible value of resistance.

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

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

4.2.4 Constant-Mass Temperature Co-efficient of Resistance: At a temperature of 20°C the constant-mass temperature co-efficient of resistance of hard drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely.

4.2.5 Co-efficient of linear expansion: The coefficient of linear expansion for hard drawn aluminium at 0°C has been taken as 0.004/°C has been taken as  $23.0 \times 10^{-6}/^{\circ}\text{C}$ . This value holds good for all practical purposes over the range of temperature from 0°C to highest safe operating temperature.

#### 4.3 **Physical constant for Galvanised steel wires:**

4.3.1 Density: At a temperature 20°C, the density of galvanised steel wire is to be taken as 7.80 g/cm<sup>3</sup>.

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

#### 4.4 **Materials:**

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

4.4.2 Galvanised steel wire shall be drawn from high carbon steel rods produced by either acidic or basic open-hearth process, electric furnace process or basic oxygen process. The mechanical and electrical properties of wire shall comply with the requirements given in relevant standard. The chemical composition of high carbon steel wire is given below for guidance only.

<b><u>Element</u></b>	<b><u>Percentage Composition</u></b>
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

- 4.4.3 The zinc used for galvanising shall be electrolytic high-grade zinc not less than 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209 Galvanizing may be done by hot process. Natural grease may be applied between the layers of wires.

NOTE: Lithium soap grease corresponding to Grade-II of IS: 7623 (Specification for lithium soap greases) is suitable for such application.

#### 4.5 **Freedom from Defects:**

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

#### 4.6 **Wire sizes:**

##### 4.6.1 Nominal size:

The aluminium and galvanised steel wires for the stranded conductor covered by this standard shall have diameters specified in clause 3.1. The diameter of the steel wires shall be measured over the zinc coating.

##### 4.6.2 **Tolerances on normal size:**

- 4.6.2.1 Aluminium Wires: A tolerance of  $\pm 1\%$  is permitted on the nominal diameter of conductor respectively.
- 4.6.2.2 Galvanized steel earthwire: A tolerance of  $\pm 2\%$  is permitted on the nominal diameter.

NOTE: In order to maintain the circularity of the wires the tolerance allowed in 4.6.2.1 and 4.6.2.2 shall apply to both the measurements at right angles taken at the same cross-section as per Clause 2.2 of IS:398 (Part-II) (Second Revision with Amendments 1 to 30).

#### 4.7 **Joints in Wires:**

- 4.7.1 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.

NOTE: 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.

- 4.7.2 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 aluminium conductor.

NOTE: Joints are not 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.

#### 4.8 **Stranding:**

- 4.8.1 The wires used in the construction of galvanised steel reinforced aluminium conductor shall before stranding, satisfy all the relevant requirements of this specification.
- 4.8.2 The lay ratio of the different layers shall be within the limits given in the following tables:

LAY RATIO OF ALUMINIUM CONDUCTORS,  
GALVANISED STEEL-REINFORCED  
(Drake, Lynx and Coyote)

	Maximum	Minimum
1. ACSR DRAKE		
a) Steel Wire	28	18
b) Aluminium	14	10
i. 10 Wire layer	16	10
ii. 16 Wire layer		
2. ACSR LYNX		
a) Steel Wire	30	20
b) Aluminium	21	14
i. 12 Wire layer	14	11.25
ii. 18 Wire layer		
3. COYOTE ACSR		
a) Steel Wire	30	20
b) Aluminium	21	14
i. 10 Wire layer	14	11.25
ii. 16 Wire layer		

Note: The details of ACSR Coyote and Lynx may be ignored as they are not in the scope.

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

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

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

**Standard Length:**

- 4.8.5 The standard length of the Conductor shall be in Standard length of 1500 meters for Drake. However, the bidder is at to offer a higher standard length. A tolerance of  $\pm 5\%$  on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.
- 4.8.6 Random lengths will be accepted provided no length is less than 70% of the standard length specified and the total quantity of such random lengths shall not be more than 5% of the total quantity ordered.
- 4.8.7 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars. This is required for special stretches like river crossing etc. The purchaser reserves the right to place orders for the above length on to the extent of 10% of the total ordered quantity the same terms and conditions applicable for the standard lengths during the pendency of the contract.

**5.0 Tests:**

- 5.1 The type, acceptance, routine tests and tests during manufacture shall be carried out on the conductor. For the purposes of this clause:
- 5.1.1 Type tests shall mean those tests, as per IS, which are to be carried out to prove the design, process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the offer.
- 5.1.2 Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for predespatch inspection, for the purposes of acceptance of that lot.

- 5.1.3 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the conductor to check requirements, which are likely to vary during production.
- 5.1.4 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture by the supplier to ensure the desired quality of the end product to be supplied by him.
- 5.1.5 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the supplier and the purchaser as per relevant clause of General Conditions of Contract.
- 5.1.6 The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be as specified in Annexure-II or as mutually agreed to between the supplier and the purchaser in the Quality Assurance Programme.
- 5.1.7 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the “Guaranteed Technical Particulars”, **Volume-III** of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

## 5.2 **Type tests:**

The following type tests shall be conducted once on each sample/samples of conductor for every 500 KM of production from each manufacturing facility.

- a) UTS test on Stranded Conductor: Ref. Test Procedure
- b) Corona extinction voltage test (dry): - do-
- c) Radio interference voltage test (dry): - do-
- d) DC resistance test on stranded

- Conductor : - do-
- e) Stress-strain Test : - do-

## 5.3 **Acceptance Tests:**

b) Visual and dimensional check on: Ref. Test Procedure

Drum

c) Visual check for joints, scratches :

Etc. and lengths of conductor - do -

d) Dimensional check on steel and :

Aluminium strands - do -

e) Check for lay ratios of various :

Layers - do -

f) Galvanizing test on steel strands : - do -

g) Torsion and Elongation test on : - do -

Steel strands

h) Breaking load test on steel and :

Aluminium strands - do -

i) Wrap test on steel and aluminium:

Strands - do -

j) DC resistance test on aluminium :

Strands - do -

k) UTS test on welded joints of :

Aluminium strand - do -

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

#### 5.4 **Routine Tests:**

b) Check to ensure that the joints are as per specification.

c) Check that there are no cuts etc on the strands.

d) All acceptance tests as mentioned in Clause 5.3 above shall be carried out on each coil.

#### 5.5 **Tests during Manufacture:**

b) Chemical analysis of zinc used : Ref. Test Procedures

For making galvanising



c) Chemical analysis of aluminium : - do -

Used for making aluminium strands

d) Chemical analysis of steel used : - do -

For making steel strands

**5.6 Testing Expenses:**

5.6.1 The testing charges for the type tests specified shall be indicated separately in the prescribed schedule.

5.6.2 The Bidder shall indicate the type test charges for each type test separately. In case the same are not mentioned then the charges are deemed to have been included in the quoted rates of materials.

5.6.3 In case of failure in any type test, the Bidder is either required to modify the design of the material or repeat the particular type test three times successfully at his own expenses. The decision of the purchaser in this regard shall be final and binding. The type tests are to be conducted irrespective of whether the same have been conducted earlier or not.

5.6.4 Bidder shall indicate the laboratories in which he proposes to conduct the type tests. He shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by him in the appropriate schedule.

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

5.6.6 The prices quoted by the bidder towards conductance of type tests shall **not** be taken into consideration for bid evaluation.

**NOTE:** The Type Test / Special Tests, if repeated at the insistence of owner, the applicable testing charges shall be paid by the successful Bidder upfront to the laboratory and the same shall be reimbursable by KPTCL as per actuals on submission of Bills along with proof of payment and on successful completion of all the Type Tests, specified and on approval of the same by the owner.

In case equipment/material fails in the type tests during testing then the testing charges paid by the Bidder to the laboratory will not be reimbursed by KPTCL.

The above clause is applicable for all the equipments /materials, in case, the Type Test/Special Tests, are repeated at the insistence of owner (KPTCL).

**5.7 Additional Tests:**

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

**5.8 Sample Batch for type testing:**

5.8.1 The supplier shall offer at least three (3) drums for selection of samples required for conducting all the type tests.

5.8.2 The supplier is required to carry out all the acceptance tests successfully in the presence of purchaser's representative before despatch.

**5.9 Test Reports:**

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

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

5.9.3 All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

5.9.4 All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.

**5.10 Test Facilities:**

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

- h) Calibration of various testing and measuring equipment including tensile testing machine resistance measurement facilities, burette, thermometer, barometer etc.
- i) Standard resistance for calibration of resistance bridges.
- j) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 metres per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc with transverse layering facilities.

**6.0 Inspection:**

6.1 The Purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the supplier's works raw materials and process of manufacture for conducting necessary tests as detailed herein.

- a. The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.
- b. No material shall be despatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the purchaser in writing. In the later case also, the conductor shall be despatched only after satisfactory testing for all tests specified herein has been completed.

- c. The acceptance of any quantity of material shall in no way relieve the supplier of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.
- d. At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by following method:

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

#### 7.0 **Quality Assurance Plan:**

- 7.1 The Bidder shall invariably furnish following information along with his offer, failing which his 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 materials are tested, list of tests normally carried out on raw materials in presence of Bidder’s representative, copies of test certificates.
  - ii) Information and copies of test certificates as in (i) above in respect of bought out material.
  - iii) List of manufacturing facilities available.
  - iv) Level of automation achieved and list of areas where manual processing exists.
  - v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
  - vi) List of testing equipments 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 deviation from specified test requirements.

7.2 The supplier shall within 30 days of placement of order submit following information to the purchaser.

- i. List of raw materials sub-suppliers selected from those furnished along with offer.
- ii. Type test certificates of the raw material.
- iii. Quality Assurance Plan (QAP) withhold points for Purchaser's inspection. The quality assurance plan and Purchaser's hold points shall be discussed between the Purchaser and supplier, before the QAP is finalized.

**4.1** The supplier shall submit the routine test certificates of raw material at the time of routine testing on the conductor.

#### **8.0 Packing & Forwarding:**

8.1 The Conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength, and displacement during transit, storage and subsequent handling and stringing operations in the field. The drums shall generally conform to IS: 1778-except otherwise specified hereinafter.

8.1.1 The drums shall be suitable for wheel mounting and for jetting off the conductor under a minimum controlled tension of the order of 5 KN.

8.2 The Bidder should submit the proposed drum drawings along with the bid. However, the same shall be in line with the requirements as stated herein. After placement of the Letter of Award, the supplier shall submit four copies of fully dimensioned drawing of the drum he wished to supply, for Purchaser's approval before taking up manufacturing of Conductor. After getting approval from the purchaser, supplier shall submit 30 more copies of the approved drawing to Purchaser for further distribution and field use at Purchaser's end.

- 8.3 All wooden components shall be manufactured out of seasoned softwood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti-fungus (Aldrime/Aldruse) shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.
- 8.4 The flanges shall be of two/three ply construction with each ply at right angles to the other and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The tolerance in thickness of each ply shall be + 3 mm only. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in the line with the periphery of the barrel.
- 8.5 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 8.6 Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing. Barrel studs should be tack welded with the nuts after tightening.
- 8.7 Normally, the nuts on the studs shall stand protrude of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 8.8 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen-based paint.
- 8.9 Before reeling, cardboard or double corrugated or thick bituminised waterproof bamboo paper shall be secured to the drum barrel and inside of flanges or the drum by means of a

suitable commercial adhesive material. The paper should be dried before use. Medium grade Kraft paper shall be used in between the layers of the conductor. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.

8.10 A minimum space of 125 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor.

8.11 Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.

8.12 Outside the protective layer, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective layer shall have two recesses to accommodate the binders.

8.13 The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm of steel core on either end by U-nails. The composite conductor shall be hinged by use of galvanized steel wire/ aluminium wire at three locations at least 75 mm apart or more covered with PVC adhesive tape so as to avoid loosening of conductor layers in transit and handling.

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

8.15 **Marking:**

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

a) Contract/Award letter number.

- b) Name and address of consignee.
- c) Manufacturer's name and address.
- d) Drum Number.
- e) Size of conductor.
- f) Length of conductor in meters.
- g) Gross weight of drum with conductor.
- h) Weight of empty drum with lagging.
- i) Arrow marking for unwinding.



## **TEST PROCEDURES**

### **1.0 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 aluminium and steel strands.

### **2.0 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-meter 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 clause 3.1 (h) and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

### **3.0 Corona Extinction Voltage Test:**

One sample of conductor of 5-meter 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 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.

### **4.0 Radio Interference Voltage test:**

Under the conditions as specified in (2) above, the conductor samples shall have a radio interference voltage level below 1500

micro volts at one MHz when subjected to 50 Hz 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.

**5.0 D.C. Resistance test on Stranded Conductor:**

On a conductor sample of minimum 5-meter 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°C as per Clause No.12.8 of IS: 398 (Part-V). The resistance corrected at 20°C shall conform to the requirements of this specification.

**6.0 Stress-Strain Test:**

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

**6.2 Test set-up:**

6.2.1 The test sample shall be supported in a trough over its full length and the trough adjustment so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.

6.2.2 The distance between the clamp and the sleeve mouth shall be monitored with calipers during the test to ensure that, after the test, it does not change by more than  $1 \text{ mm} \pm 0.1 \text{ mm}$  from the value before the test.

6.2.3 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 aluminium 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 0.3 mm error in the reading.

### 6.3 Test Loads for complete conductor.

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

- 6.3.1 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.
- 6.3.2 For non-continuous stress-strain data, the strain readings at 1 KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.
- 6.3.3 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.
- 6.3.4 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. The load shall then be released.
- 6.3.5 Reloading up to 85% 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 then be released.
- 6.3.6 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 6.3.5.

### 6.4 **Test Loads for Steel Core only:**

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

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

### 6.5 **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 aluminium 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°C.

**7.0 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.

**8.0 Chemical Analysis of Aluminium and Steel:**

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

**9.0 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.

**10.0 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.

**11.0 Dimensional check of steel and aluminium strands:**

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

**12.0 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 and clause No.9.4 & 9.5 of IS-398 (Part-V).

**13.0 Galvanizing Test:**

The test procedure shall be as specified in IS: 4826. The material shall conform to the requirement of this specification.

**14.0 Torsion and Elongation Tests on Steel Strands.**

The test procedures shall be as per clause No.12.6.1 and 12.6 of IS:398 (Part-V). In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

**15.0 Breaking load test on welded Aluminium strand:**

Two Aluminium 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.

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## **“ACSR Panther” CONDUCTOR:**

### **9.0 Scope:**

- 1.1 This specification provides for design, manufacture, engineering, inspection and testing before despatch, packing and delivery F.O.R. (destination) of aluminium conductors steel reinforced (ACSR) for overhead transmission purposes specified herein.
- 1.3 The conductor 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.

### **10.0 Standards:**

- 2.1 Except as modified in this specification they shall conform to the following Indian Standards, which shall mean latest revisions, amendments thereof. Equivalent International and Internationally recognized standard to which some of these standards generally correspond are also listed below:

Sl.N o.	Indian Standards	Title	International Standards
1	IS: 209	Specification for zinc	<b>BS: 3436</b>
2	IS: 398 Part-I to Part-V (As relevant)	Specification for aluminium conductors for overhead transmission purpose	<b>IEC: 209</b> <b>BS: 215</b> (Part-II)
3	IS: 1778	Reels and Drums for Bare Conductors	<b>BS: 1559</b>
4	IS: 1521	Method of Tensile Testing of steel wire	<b>ISO/R89</b>
5	IS: 2629	Recommended practice for Hot Dip Galvanizing of Iron and Steel	
6	IS: 2633	Method of Testing Uniformity of coating of zinc coated Articles	
7	IS: 4826	Galvanised coating on round steel wire	<b>ASTM A-472</b> <b>729</b>

8	IS: 6745	Method of Determination of weight of zinc coating of zinc coated Iron and Steel Articles	<b>BS: 443</b>
9	IS: 1841	EC grade Aluminium rod produced by rolling (second Revision)	
10	IS: 5484	EC grade Aluminium rod produced by continuous casting and rolling (first revision)	
11	IS: 6754	Methods of determination of weight of zinc coating of zinc coated Iron and steel Articles.	
12	C-49 CSA	Specification for ACSR	

2.3 The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution, 101, Pentonville Road, N-19-ND – UK
IEC/CISPR	International Electro-technical Commission, Bureau Central de la Commission, Electro Technique International, 1 Rue de verembe, Geneva, SWITZERLAND
BIS	Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi-110 001 INDIA
ISO	International Organization for Standardization, Danish Board of Standardization, Danish Standardizing Sraat, Aurehoegvej-12, DK-2900, Heelstrup, DENMARK
NEMA	National Electric Manufacture Associate, 115, East 44 <sup>th</sup> Street, New York NY 10017 U.S.A
CSA	Canadian Standards Assn.

However, in an event where the Bidder offers ACSR conductor conforming to standards equivalent to or better than the above, the salient points of comparison between the standards adopted and the standards quoted herein shall be detailed in relevant schedule. Two copies of authenticated English version of such standards shall be furnished along with the offer.

#### 11.0 **Principal Parameters:**

3.1 The details of conductor are tabulated below:

Stranding and wire diameter	30/3.0 mm Aluminium 7/3.0 mm Steel (Panther)
j) Number of Strands Steel Centre.	
I Steel Layer	1
I Al. Layer	6
II Al. Layer	12
	18
k) Sectional area of aluminium (Sq.mm)	212.10
l) Total sectional area (Sq.mm)	261.50
m) Overall diameter (mm)	21.0
n) Approximate weight (kg/km)	974
o) Calculated D.C resistance at 20°C (ohm/km)	0.139
p) Minimum UTS (KN)	89.67
q) Modulus of Elasticity (Kgs/Sq.cm x 10 <sup>6</sup> )	0.80

The details of aluminium strand are as follows:

d) Minimum breaking load of strand before stranding (KN)	1.17
e) Minimum breaking load of strand after stranding (KN)	1.11
f) Maximum DC resistance of strand at	4.79



20°C (ohm/km)	
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The details of steel strand are as follows:

iv. Minimum breaking load of strand before stranding (KN)	9.29
v. Minimum breaking load of strand after stranding (KN)	8.83
vi. Minimum weight of zinc coating (Gm/Sq.m)	250
vii. Zinc coating Testing	3 / dips of 1mm each
viii. Mass of Steel at Normal Diameter (Kg/KM)	55.13

## 12.0 **General Technical Requirement:**

4.1 The conductor shall be suitable for satisfactory operation under the tropical climatic conditions given in the project synopsis.

### 4.9 **Physical constants of materials:**

4.9.1 Physical constants for Hard-drawn Aluminium.

4.9.2 Resistivity: The resistivity of aluminium depends upon its purity and its physical condition. For the purpose of this specification the maximum value permitted is 0.028264 Ohm.sq.mm/mt 20°C, and this value has been used for calculation of the maximum permissible value of resistance.

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

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

4.9.4 Constant-Mass Temperature Co-efficient of Resistance: At a temperature of 20°C the constant-mass temperature co-efficient of resistance of hard drawn aluminium measured between two

potential points rigidly fixed to the wire, the metal being allowed to expand freely.

- 4.9.5 Co-efficient of linear expansion: The coefficient of linear expansion for hard drawn aluminium at 0°C has been taken as 0.004/°C has been taken as  $23.0 \times 10^{-6}/^{\circ}\text{C}$ . This value holds good for all practical purposes over the range of temperature from 0°C to highest safe operating temperature.

**4.10 Physical constant for Galvanised steel wires:**

- 4.10.1 Density: At a temperature 20°C, the density of galvanised steel wire is to be taken as 7.80 g/cm<sup>3</sup>.

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

**4.11 Materials:**

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

- 4.11.2 Galvanised steel wire shall be drawn from high carbon steel rods produced by either acidic or basic open-hearth process, electric furnace process or basic oxygen process. The mechanical and electrical properties of wire shall comply with the requirements given in relevant standard. The chemical composition of high carbon steel wire is given below for guidance only.

<b><u>Element</u></b>	<b><u>Percentage Composition</u></b>
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

- 4.11.3 The zinc used for galvanising shall be electrolytic high-grade zinc not less than 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209 Galvanizing may be done by hot process. Natural grease may be applied between the layers of wires.

NOTE: Lithium soap grease corresponding to Grade-II of IS: 7623 (Specification for lithium soap greases) is suitable for such application.

#### 4.12 **Freedom from Defects:**

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

#### 4.13 **Wire sizes:**

##### 4.13.1 Nominal size:

The aluminium and galvanised steel wires for the stranded conductor covered by this standard shall have diameters specified in clause 3.1. The diameter of the steel wires shall be measured over the zinc coating.

##### 4.13.2 **Tolerances on normal size:**

- 4.13.2.1 Aluminium Wires: A tolerance of  $\pm 1\%$  is permitted on the nominal diameter of conductor respectively.
- 4.13.2.2 Galvanized steel earthwire: A tolerance of  $\pm 2\%$  is permitted on the nominal diameter.

NOTE: In order to maintain the circularity of the wires the tolerance allowed in 4.6.2.1 and 4.6.2.2 shall apply to both the measurements at right angles taken at the same cross-section as per Clause 2.2 of IS:398 (Part-II) (Second Revision with Amendments 1 to 30).

#### 4.14 **Joints in Wires:**

- 4.14.1 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.

NOTE: 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.

- 4.14.2 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 aluminium conductor.

NOTE: Joints are not 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.

#### 4.15 **Stranding:**

- 4.15.1 The wires used in the construction of galvanised steel reinforced aluminium conductor shall before stranding, satisfy all the relevant requirements of this specification.
- 4.15.2 The lay ratio of the different layers shall be within the limits given in the following tables:

LAY RATIO OF ALUMINIUM CONDUCTORS,  
GALVANISED STEEL-REINFORCED  
(PANTHER)

	Maximum	Minimum
4. ACSR PANTHER		
c) Steel Wire	28	13
d) Aluminium		
iii. 12 Wire layer	16	10
iv. 18 Wire layer	14	10

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

- 4.15.3 In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right-handed. The wires in each layer shall be evenly and closely stranded.
- 4.15.4 In conductors having multiple layers of aluminium wires, the lay ratio of any aluminium layer shall not be greater than the lay ratio of the aluminium layer immediately beneath it.

**Standard Length:**

- 4.15.5 The standard length of the Conductor shall be in Standard length of 1500 meters. However, the bidder may offer a higher standard length. A tolerance of  $\pm 5\%$  on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.
- 4.15.6 Random lengths will be accepted provided no length is less than 70% of the standard length specified and the total quantity of such random lengths shall not be more than 5% of the total quantity ordered.
- 4.15.7 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars. This is required for special stretches like

river crossing etc. The purchaser reserves the right to place orders for the above length on to the extent of 10% of the total ordered quantity the same terms and conditions applicable for the standard lengths during the pendency of the contract.

**13.0 Tests:**

5.1 The type, acceptance, routine tests and tests during manufacture shall be carried out on the conductor. For the purposes of this clause:

5.1.1 Type tests shall mean those tests, as per IS, which are to be carried out to prove the design, process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests in the offer.

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

5.8.3 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the conductor to check requirements, which are likely to vary during production.

5.8.4 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture by the supplier to ensure the desired quality of the end product to be supplied by him.

5.8.5 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the supplier and the purchaser as per relevant clause of General Conditions of Contract.

5.8.6 The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be as specified in Annexure-II or as mutually agreed to between the supplier and the purchaser in the Quality Assurance Programme.

5.8.7 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the bidder in the “Guaranteed Technical Particulars”, **Volume-III** of his proposal or the acceptance value specified in this specification, whichever is more stringent for that particular test.

5.9 **Type tests:**

The following type tests shall be conducted once on each sample/samples of conductor for every 500 KM of production from each manufacturing facility.

f) UTS test on Stranded Conductor: Ref. Test Procedure

g) Corona extinction voltage test (dry): - do-

h) Radio interference voltage test (dry): - do-

i) DC resistance test on stranded

Conductor : - do-

j) Stress-strain Test : - do-

5.10 **Acceptance Tests:**

l) Visual and dimensional check on: Ref. Test Procedure

Drum

m) Visual check for joints, scratches :

Etc. and lengths of conductor - do -

n) Dimensional check on steel and :

Aluminium strands - do -

o) Check for lay ratios of various :

Layers - do -

p) Galvanizing test on steel strands : - do -

q) Torsion and Elongation test on : - do -

Steel strands

r) Breaking load test on steel and :

Aluminium strands - do -

s) Wrap test on steel and aluminium:

Strands - do -  
t) DC resistance test on aluminium :

Strands - do -  
u) UTS test on welded joints of :

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

5.11 **Routine Tests:**

- e) Check to ensure that the joints are as per specification.
- f) Check that there are no cuts etc on the strands.
- g) All acceptance tests as mentioned in Clause 5.3 above shall be carried out on each coil.

5.12 **Tests during Manufacture:**

e) Chemical analysis of zinc used : Ref. Test Procedures

For making galvanising

f) Chemical analysis of aluminium : - do -

Used for making aluminium strands

g) Chemical analysis of steel used : - do -

For making steel strands

5.13 **Testing Expenses:**

5.6.7 The testing charges for the type tests specified shall be indicated separately in the prescribed schedule.

5.6.8 The Bidder shall indicate the type test charges for each type test separately. In case the same are not mentioned then the charges are deemed to have been included in the quoted rates of materials.

5.6.9 In case of failure in any type test, the Bidder is either required to modify the design of the material or repeat the particular type test three times successfully at his own expenses. The decision of the purchaser in this regard shall be final and binding. The



type tests are to be conducted irrespective of whether the same have been conducted earlier or not.

- 5.6.10 Bidder shall indicate the laboratories in which he proposes to conduct the type tests. He shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by him in the appropriate schedule.
- 5.6.11 The entire cost of testing for the acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/ purchaser's representative.
- 5.6.12 The prices quoted by the bidder towards conductance of type tests shall **not** be taken into consideration for bid evaluation.

NOTE: The Type Test / Special Tests, if repeated at the insistence of owner, the applicable testing charges shall be paid by the successful Bidder upfront to the laboratory and the same shall be reimbursable by KPTCL as per actuals on submission of Bills along with proof of payment and on successful completion of all the Type Tests, specified and on approval of the same by the owner.

In case equipment/material fails in the type tests during testing then the testing charges paid by the Bidder to the laboratory will not be reimbursed by KPTCL.

The above clause is applicable for all the equipments /materials, in case, the Type Test/Special Tests, are repeated at the insistence of owner (KPTCL).

**5.14 Additional Tests:**

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

**5.15 Sample Batch for type testing:**

- 5.10.1 The supplier shall offer at least three (3) drums for selection of samples required for conducting all the type tests.

5.10.2 The supplier is required to carry out all the acceptance tests successfully in the presence of purchaser's representative before dispatch.

**5.11 Test Reports:**

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

5.11.2 Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the conductor be dispatched.

5.11.3 All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

5.11.4 All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.

**5.12 Test Facilities:**

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

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

l) Standard resistance for calibration of resistance bridges.

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

**14.0 Inspection:**

6.1 The Purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture where conductor shall be manufactured and the representative shall have full facilities for unrestricted inspection of the supplier's works raw materials and process of manufacture for conducting necessary tests as detailed herein.

e. The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

f. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the purchaser in writing. In the later case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein has been completed.

g. The acceptance of any quantity of material shall in no way relieve the supplier of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

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

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

#### 15.0 **Quality Assurance Plan:**

7.1 The Bidder shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection.

- r) Statement giving list of important raw materials names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.
  - ii) Information and copies of test certificates as in (i) above in respect of bought out material.
  - iii) List of manufacturing facilities available.
  - iv) Level of automation achieved and list of areas where manual processing exists.
  - v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
  - vi) List of testing equipments 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 deviation from specified test requirements.
- 7.2 The supplier shall within 30 days of placement of order submit following information to the purchaser.
- iv. List of raw materials sub-suppliers selected from those furnished along with offer.
  - v. Type test certificates of the raw material.
  - vi. Quality Assurance Plan (QAP) withholds points for Purchaser's inspection. The quality assurance plan and Purchaser's hold points shall be discussed between the Purchaser and supplier, before the QAP is finalized.
- 4.2** The supplier shall submit the routine test certificates of raw material at the time of routine testing on the conductor.

#### 16.0 **Packing & Forwarding:**

- 8.1 The Conductor shall be supplied in non-returnable strong wooden drums provided with lagging of adequate strength, and displacement during transit, storage and subsequent handling

and stringing operations in the field. The drums shall generally conform to IS: 1778-except otherwise specified hereinafter.

- 16.1.1 The drums shall be suitable for wheel mounting and for jetting off the conductor under a minimum controlled tension of the order of 5 KN.
- 16.2 The Bidder should submit the proposed drum drawings along with the bid. However, the same shall be in line with the requirements as stated herein. After placement of the Letter of Award, the supplier shall submit four copies of fully dimensioned drawing of the drum he wished to supply, for Purchaser's approval before taking up manufacturing of Conductor. After getting approval from the purchaser, supplier shall submit 30 more copies of the approved drawing to Purchaser for further distribution and field use at Purchaser's end.
- 16.3 All wooden components shall be manufactured out of seasoned softwood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti-fungus (Aldrime/Aldruse) shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.
- 16.4 The flanges shall be of two/three ply construction with each ply at right angles to the other and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The tolerance in thickness of each ply shall be + 3 mm only. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75 mm. Where a slot is cut in the flange to receive the inner end of the conductor, the entrance shall be in the line with the periphery of the barrel.
- 16.5 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

- 16.6 Barrel studs shall be used for construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing. Barrel studs should be tack welded with the nuts after tightening.
- 16.7 Normally, the nuts on the studs shall stand protrude of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be countersunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 16.8 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen-based paint.
- 16.9 Before reeling, cardboard or double corrugated or thick bituminised waterproof bamboo paper shall be secured to the drum barrel and inside of flanges or the drum by means of a suitable commercial adhesive material. The paper should be dried before use. Medium grade Kraft paper shall be used in between the layers of the conductor. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thin polythene sheet across the flanges to preserve the conductor from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage/transport.
- 16.10 A minimum space of 125 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor.
- 16.11 Each batten shall be securely nailed across grains as far as possible to the flange edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.
- 16.12 Outside the protective layer, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective layer shall have two recesses to accommodate the binders.

16.13 The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm of steel core on either end by U-nails. The composite conductor shall be hinged by use of galvanized steel wire/ aluminium wire at three locations at least 75 mm apart or more covered with PVC adhesive tape so as to avoid loosening of conductor layers in transit and handling.

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

16.15 **Marking:**

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

- j) Contract/Award letter number.
- k) Name and address of consignee.
- l) Manufacturer's name and address.
- m) Drum Number.
- n) Size of conductor.
- o) Length of conductor in meters.
- p) Gross weight of drum with conductor.
- q) Weight of empty drum with lagging.
- r) Arrow marking for unwinding.

## **TEST PROCEDURES**

### **16.0 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 aluminium and steel strands.

### **17.0 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-meter 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 clause 3.1 (h) and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

### **18.0 Corona Extinction Voltage Test:**

One sample of conductor of 5-meter 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 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.

### **19.0 Radio Interference Voltage test:**

Under the conditions as specified in (2) above, the conductor samples shall have a radio interference voltage level below 1500



micro volts at one MHz when subjected to 50 Hz 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.

**20.0 D.C. Resistance test on Stranded Conductor:**

On a conductor sample of minimum 5-meter 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°C as per Clause No.12.8 of IS: 398 (Part-V). The resistance corrected at 20°C shall conform to the requirements of this specification.

**21.0 Stress-Strain Test:**

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

**6.6 Test set-up:**

6.6.1 The test sample shall be supported in a trough over its full length and the trough adjustment so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.

6.6.2 The distance between the clamp and the sleeve mouth shall be monitored with calipers during the test to ensure that, after the test, it does not change by more than  $1 \text{ mm} \pm 0.1 \text{ mm}$  from the value before the test.

6.6.3 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 aluminium 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 0.3 mm error in the reading.

## 6.7 Test Loads for complete conductor.

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

- 6.7.1 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.
- 6.7.2 For non-continuous stress-strain data, the strain readings at 1 KN intervals at lower tensions and 5 KN intervals above 30% of UTS shall be recorded.
- 6.7.3 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.
- 6.7.4 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. The load shall then be released.
- 6.7.5 Reloading up to 85% 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 then be released.
- 6.7.6 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 6.3.5.

## 6.8 **Test Loads for Steel Core only:**

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

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

## 6.9 **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 aluminium 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°C.

**22.0 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.

**23.0 Chemical Analysis of Aluminium and Steel:**

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

**24.0 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.

**25.0 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.

**26.0 Dimensional check of steel and aluminium strands:**

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

**27.0 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 and clause No.9.4 & 9.5 of IS-398 (Part-V).

**28.0 Galvanizing Test:**

The test procedure shall be as specified in IS: 4826. The material shall conform to the requirement of this specification.

**29.0 Torsion and Elongation Tests on Steel Strands.**

The test procedures shall be as per clause No.12.6.1 and 12.6 of IS:398 (Part-V). In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 200 mm.

**30.0 Breaking load test on welded Aluminium strand:**

Two Aluminium 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.

**GUARANTEED TECHNICAL  
PARTICULARS PANTHER ACSR  
CONDUCTOR (30 + 7/3.00 mm)**

<b>Sl. No.</b>	<b>Particulars</b>	<b>Details</b>
1.	Material Description	Panther
2.	Maker's Name and Address a). Aluminium wire b). Steel Wire. c). Complete conductor.	
3.	Stranding and Wire Diameter Standard/ Maximum/Minimum)mm a). Aluminium b). Steel	3.00/3.03/2.97 3.00/3.06/2.94
4.	Standard Nominal Copper area in Sq.mm	129
5.	Calculated Equivalent Aluminium area in Sq.mm	200
6.	Actual Aluminium area in Sq.mm	212.1
7	Standard area of Cross-section in Sq.mm a. Aluminium Strand b. Steel strand. c. Conductor.	7.069 7.069 261.553
8	Diameter of complete Conductor in mm	21.00
9.	Minimum Ultimate Tensile Stress of strand in kg/ Sq.mm a) Aluminium Strand b) Steel Strand	16.80 134.04
10.	Guaranteed Ultimate Tensile Strength of Conductor in Kg	9127.00
11.	Minimum Breaking Load in KN for a) Aluminium Strand. b) Steel Strand	1.11 8.83
12.	Purity of Aluminium Rods in %	99.6%

13.	Zinc Coating of Steel Strand a) Thickness of coating number and duration of dips (precede test) b) Minimum weight of coating in gms/ Sq. mm.	3 dips of 1 min. each 240
14.	Maximum Working Tension	2286
15	Weight in Kg per KM (Max/ Min) a) Aluminium b) Steel c) Conductor	586 388 974(Normal), 947(Minimum), 1002(Maximum)
16	Maximum Resistance in Ohms per Km at 20 deg.C a) Aluminium Stand b) Conductor	4.079 0.1390
17.	a) Continuous Maximum Current Rating of Conductor in Still Air at 45 deg. C ambient temperature (Amps) b) Temperature rise for the above current (deg. C)	486  30°C
18	LAV Ratio Steel Core : 6 Wire Aluminium : 12 Wire Layer 18 Wire Layer	<b><u>Max.</u></b> <b><u>Min.</u></b> 28      13  16      10 14      10
19	Whether the Drum on which the conductor is wound conforms to the specification and whether the detailed dimensioned drawing submitted with the tender.	IS 1778:1980 Yes
20	Moulds of Elasticity of a) Aluminium Strand : Kgs/ Sq.mm b) Steel Strand : Kgs/ Sq.mm c) Conductor Strand : Kgs/ Sq.mm	0.7031 x 10 <sup>6</sup> 1.969 x 10 <sup>6</sup> 8.0x 10 <sup>6</sup>
21	Co-efficient of Liner Expansion per Degree Centigrade for a) Aluminium Stand. b) Steel Stand. c) Conductor	23.00 x 10 <sup>-6</sup> 11.50 x 10 <sup>-6</sup> 17.80 x 10 <sup>-6</sup>
22	Percentage of Carbon in Steel Wire	0.50 to 0.85%
23	Standard length of each piece in KM	1.300

24	Maximum Single Length of Conductor which can be manufactured (km)	2.000
25	Tolerance, if any on Standard Lengths.	$\pm 5\%$
26	No. of Standard Lengths in One Reel	1
27	Dimension of the Reel in Cm.	137 x 60 x 71
28	Weight of the Conductor in One Reel in Kg	1266
29	Weight of the Reel in Kg	225
30	Gross Weight of the Reel including weight of the Conductor (kg)	1500
31	Standard According to Which the Conductor Will be Manufactured and Tested.	IS:398 (Part-II) 1996
32	Other Particulars.	----

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**PART II**  
**SECTION – V**

**TECHNICAL SPECIFICATIONS**  
**FOR**  
**GSS GROUND WIRE (7/3.15mm)**



## **PART II**

### **SECTION – V**

#### **TECHNICAL SPECIFICATIONS FOR GROUNDWIRE (7/3.15mm)**

##### **1 SCOPE:**

This Specification provides for the manufacture, testing before dispatch supply and delivery of 7/3.15mm ground wire 1100 NEWTON/Sq.mm quality (grade 3 as per IS 12776 of 1989 for the purpose of earthing and protection of power transmission lines as per the particulars given in Appendix – I attached. The ground wire shall consist of standard galvanized steel wires and shall conform to the latest edition with revision of the following Bureau of Indian Standards (IS). The other applicable standards are IS-209/2979,

IS-1521/1972, IS-1755/1961, IS-1778/1961,  
IS-2633/1972, IS-4826/1979, IS-6745/1972,  
IS-5714/1979, IS-6594/1977, IS-1766/1983,  
IS-182/1972.

##### **2 STANDARDS:**

The ground wire shall comply in all respects with the latest edition of IS 12776/1989 (with latest amendments).

##### **3 MATERIALS:**

The materials offered shall be of best quality and workmanship. The steel wire (strands) shall be manufactured from steel produced by the suitable process. The steel wire shall not contain sulphur and phosphorous exceeding 0.05% each.

The steel wire shall be evenly and uniformly coated with Zinc complying with IS-209/1979 specification for Zinc (revised)-

99.99% grade and zinc coating shall conform to heavy type coating as per IS-4826/1979 including latest amendments, IS-2633/1972 and IS-6745/1972. The individual wires after galvanizing shall be smooth, free of inequalities, spills or splits before stranding.

#### **4 SIZES AND CONSTRUCTION:**

The sizes and physical properties of the ground wire shall be as given in Appendix-I. The lay of the strands shall be of lengths given in the appendix and the wires shall be so stranded together that when an evenly distributed pull is applied at the end of completed strands, each wire will take an equal share of the pull.

#### **5 LENGTHS AND JOINTINGS:**

The ground wire may be supplied in the standard length of 2 Kms. However, random lengths of ground wire upto a minimum of 10 (ten) percent may be allowed.

The length of strand which may be supplied without joints. In the individual wires comprising it, depends on the lengths of wire which may be carried by the bobbin in a normal stranding machine. The normal lengths of strands which shall be supplied without joints in individual wires, excluding welds made in the rod before drawing shall be as given in Appendix-I. The lengths may be exceeded by agreement between the manufacturer and Owner. Joints are not permitted either in the individual strand wires or in completed strand.

Each coil shall be warranted to contain no weld joints or splice. The wire shall be free from scale, irregularities,

imperfections, flaws, splits and other defects. The zinc coating shall be smooth even and bright.

## **6 TEST AND TEST CERTIFICATE:**

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 lengths of the lay 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 now be drawn from every selected coil and subjected to tensile test, ductility test and coating test. One test specimen of the completed strand shall now be drawn from every selected coil and subjected to tensile strength. The lot shall be declared conforming to the requirements of these characteristics if all the test specimen satisfy the relevant requirement.

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

### **6.01 CHEMICAL ANALYSIS:**

One sample shall be drawn from the lot for chemical analysis. Unless otherwise agreed to between the owner and the supplier, the chemical analysis shall be carried out.

### **6.02 TENSILE TEST:**

The wire when tested in accordance with the IS-1521 or any one-gauge length of 100 mm, shall have the minimum-breaking load of strand as specified in Appendix-I, shall be as follows. The tensile strength of the finished strand shall not be less than 95% of the aggregate of the single wires.

**6.03      DUCTILITY TEST:**

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

**6.04      COATING TEST:**

The uniformity of zinc coating shall be tested as per IS-2633. The wire shall withstand the number of dips specified in Appendix-I or as per latest edition of IS-4826 and IS-6745/1972.

**6.05      TOLERANCE ON WIRE DIAMETER:**

The tolerance shall be +0.06 and -0.03 in millimeter as per clause 6.1 of IS-12776/1989.

**6.06      CHEMICAL ANALYSIS:**

Shall be conducted on a sample drawn from each lot as per clause 8.1.4 of IS-2141/1979.

**6.07      ACCEPTANCE TEST:**

The acceptance tests shall be conducted as per the scale of sampling specified in standard IS-12776/1989.

Samples from each lot shall be tested for ascertaining the conformity to the requirements of this specification. The number of coils to be selected shall be in accordance with Clause-10 of the of IS 12776/1989. The lot shall be declared in conformity with the requirements of the following tests are satisfied. The length of the test sample shall be not less than 5 (five) metres.

- c) Length and lay of joints.
- d) Ductility Test.
- e) Tolerance on wire diameter.
- f) Tensile and Elongation test.
- g) Galvanizing test.
- h) Electrical resistance as per BS 182 – 1972 and BS 5714 – 1979.

The above acceptance tests should be conducted in the presence of the Purchasers representative. Three copies of manufacturer's tests certificate shall be submitted by the contractor to the owner for approval immediately after such tests have been conducted on the G.S. strands and the wire. No separate charge shall be payable for these type and acceptance tests.

The owner reserves the right to inspect the material at manufacturer's works before dispatch.

## **1      PACKING AND MARKING:**

The ground wire shall be supplied in non-returnable reels or drums of non-perishable or treated wood conforming to IS-1778/1961 Specification for reels and drums for the same wires. Each coil shall be provided with a label fixed firmly on the inner part of the coil bearing the following information.

- iii. Trade mark, name if any.
- iv. Name of the manufacturer.
- v. Type of wire-size and length of wire.
- vi. Net weight of the wire.
- vii. Tare weight and
- viii. No. of lengths on the reel or drum.

## **2      SAG AND TENSION CHARTS:**

The successful tenderer shall submit seven copies of stringing charts for earth wire showing initial and final sags and

tensions for various temperatures and spans. One set of chart shall be in ink or tracing.

### **APPENDIX – I**

Details of ground wire (1100 Newton/Sq.mm quality) grade 3 as per IS-12776/1989.

- e) Stranding and wire diameter : 7/3.15mm
- f) Single wire before stranding
  - v. Diameter Nominal : 3.15mm
    - Maximum : +3.23mm
    - Minimum : - 3.07mm
  - vi. Minimum breaking load : 8.57 KNf
- g) Lay length
- c) Maximum : 265 mm
- d) Minimum : 123 mm
- h) Minimum breaking load of stranded wire : 58.45 KNf
- i) Percentage elongation at break on complete strand : Min.4%
- j) Minimum ultimate tensile strength of individual strand : 1100 N/Sq.mm
- k) Nominal overall diameter of stranded wire : 9.45mm
- l) Zinc coating
  - iii. Duration and No. of dips : 1. Min dip 3.
  - iv. Weight of coating : 260 Gms/Sq.m
- m) Normal length without joint or weld in the same wire : 1000 Metres