

TECHNICAL SPECIFICATION FOR ACSR CONDUCTORS

1. SCOPE :

This specification provides for the manufacturing, testing and supply of ACSR conductors as per details given below:

2. STANDARDS :

The conductor shall conform to the following Indian Standard specifications which shall mean latest revisions with amendments / changes adopted and published unless specifically stated otherwise in the specification.

1. IS: 398 (Part-II) 1976 /1990 : Specification for Aluminium Conductors.
2. IS: 2629-1985/1990 : Hot dip Galvanizing of Iron & Steel
3. IS: 4826-1979 : Specification for Hot Dipped Galvanized coating on Round Steel Wires.
4. IS: 209-1966/1992 : Electrolytic High Grade Zinc.
5. IS: 1778:1980 : Specification for Reels and Drums for Bare Conductors
6. IS: 2633-1992 : Method of Testing uniformity of coating of Zinc coated Articles.
7. IS: 1841 : EC grade aluminium rod produced by rolling (Second Revision).
8. IS: 5484 : EC grade aluminium rod produced by continuous castnf and rolling (first revision).

2.1 CLIMATIC CONDITIONS:-

Locations	At various locations in Uttar Pradesh
Max. ambient air temperature (°C)	50
Max. ambient temperature in a closed box (°C)	60
Max. ambient ait temperature in shade (°C)	45
Min. ambient air temperature (°C)	(-) 5
Average daily ambient air temperature (°C)	40
Max. relative humidity (%)	95
Max. altitude above mean sea level (m)	2200
Average annual rainfall (mm)	1500
Isoceraunic level (days per year)	50
Seismic level (Horizontal accn.)	0.30 g.
Max. wind pressure (kg/sq. meter)	200
Moderately hot & humid tropical climate, conducive to ruse & fungus growth.	

3. MATERIAL AND WORKMANSHIP

Materials used in manufacture of the conductor shall be of the highest quality of its kinds obtainable and except where modified by the specification, shall comply in all respect with the standards laid down by Indian Standard Institution.

3.1 Physical constants for Hard Drawn Aluminium:-

The Aluminium Wire (Strands) shall be hard drawn from electrolytic Aluminium rod made from HINDALCO, NALCO, BALCO make only purity not less than 99.5%. Test certificates of Aluminium Manufacturer in respect of impurity content of Aluminium conductivity etc. shall have to be furnished in order to assess its quality.

Resistivity:-

The resistivity of aluminium depends upon its purity and its physical condition. However as per the specified value of purity in this specification the maximum value permitted is 0.028264 ohm. sq. mm /mtr at 20 Deg. C, and this value shall be used for calculation of the maximum permissible value of resistance. This value may be checked from the measured value of the resistance.

Density:-

At a temperature of 20°C the density of hard drawn aluminium shall be 2.703 g/cm³

Constant Mass Temperature Co-efficient of Resistance:-

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

3.2 Physical Constants for Galvanised Steel Wire:-

The Steel Wire (Strands) shall be drawn from High Carbon Steel Wire Rods produced by either the acid or the basic open-hearth process, or by the electric Furnace process. Steel produced by Basemer process shall not be used for drawing of wires. The steel wires shall be hot dip Galvanized conforming to IS: 2629:1985 and shall have weight to zinc coating as per IS: 4826/1979. The quality of zinc used for coating on steel wire strands shall be as per ZN98 of IS: 209:1966/1992 i.e. Electrolytic High Grade Zinc of 99.95% purity.

Density:-

At 20°C, the density of galvanised steel wire is to be taken as 7.80 g/cm³.

Zinc coating shall be reasonably smooth, continuing of reasonable uniform thickness and free from all defects not consistent with good commercial practice. The steel wire shall be of such quality and purity that when drawn to the size of wire specified and coated with zinc, the finished strands and the individual wire shall be of uniform quality and have the same properties and characteristics as prescribed in the relevant Indian Standard.

All the Aluminium as well as Steel wires strands shall be reasonable smooth, uniform and shall be free from all defects such as die marks, scratches, abrasions and kinks etc. after drawing and also after stranding.

The finished conductor shall have a smooth surface without any surface dents, abrasions, scuff marks and shall be free from dirt grit etc. Also the conductor shall be free from loose strands. The ends of the conductor shall be properly sealed to avoid unwinding of the strands.

Particular care has therefore, to be taken during the manufacture, handling, packing and transportation of the conductor, to see that the surface is not dented, cut or damaged in any way.

4.0 PRINCIPLE PARAMETERS:-

S. No.	Description	Aluminium	Steel
1	Number of strands	6	7
2	Diameter (mm)		
a)	Strands		
i)	Nominal	4.72	1.57
ii)	Maximum	4.77	1.60
iii)	Minimum	4.67	1.54
b)	Overall Conductor	14.15	-
3.	Cross Sectional Area Whole Conductor (mm ²)	118.5	
4	Weight (Kg./Km.)		
a)	Whole Conductor	288	106
b)	Each Strand (At nominal dia.)	47.8	15.1
c)	Total Weight (Al. + Steel)	394	-
5	Calculated DC resistance at 20 deg. C (Ohms/Km)		
a)	Whole Conductor	0.2792	-
b)	Strand	1.650	-
6	Ultimate Tensile Strength (KN)		
a)	Whole Conductor	32.41	
b)	Strand		
i)	Before	2.78	2.70
ii)	After Stranding	2.64	2.57

7	Modulus of Elasticity (Kg./Sq. Cm)	0.8055x10 ⁶	
8	Coefficient of linear expansion (per de. C)	19.8x 10 ⁻⁶	-
9	Chemical Composition (%)		
a)	EC grade Al.	As per IS	NA
b)	Copper (Max.)	0.04	NA
c)	Carbon	NA	0.50-0.85
d)	Manganese	NA	0.50-1.10
e)	Phosphorous	NA	Max. 0.035
f)	Sulphur	NA	Max. 0.045
g)	Silicon	NA	0.10-0.35
10	Zinc Purity (%)	NA	99.95
a)	Weight of Zinc coating (gm/sq. mtr.)	NA	190
11	Resistivity (Ohms Sq. mm/Mtr.)	0.028264	NA
12	Density (At 20 deg C) Gm/Cu Cm)	2.703	7.80
13	Constant mass Temp. Co-efficient of resistance - per C	0.004	NA
14	Lay Ratio		
a)	First Layer		
i)	Maximum	14	28
ii)	Minimum	10	13
b)	Second Layer		
i)	Maximum		-
ii)	Minimum		-

5. JOINTS :

5.1 There shall be no joint of any kind in the steel core of the conductor, Joints in the Aluminium strands, if any shall be as per IS: 398 (Part-II) 1976/1990. Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

5.2 A certificate shall be recorded by the supplier on each and every invoice / bill and challan as follows.

“Certified that there is no joints of any kind in steel core of the conductor and kind in Steel core of the conductor and joints in the Aluminium strands, if any, are as per IS: 398 (Part-II) 1976/1990.

6.0 STRANDING :

The wires used in manufacture of standard conductor shall meet all the relevant requirements of IS: 398 (Part-II) 1976/1990.

7.0 LAY RATIO OF CONDUCTOR:

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

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

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.

8.0 PACKING & MARKING

8.1 The conductor shall be supplied on strong non-returnable wooden drum so that it is not damaged during transit and can withstand all the transit and weather hazards. The supplier/manufacturer shall be responsible for any damage to the material during transit due to improper / inadequate packing. The drum shall be painted on the inside and outside with Aluminum paints and fitted with strong cast iron bushings. All drums shall have layer of a waterproof paper under the lagging. The conductor drums shall conform to IS: 1778/1980. The drums shall be strapped with steel wire. Each drum shall have the following information marked on it with indelible ink along with other essential data.

1. Property of (Name of Discom).

2. Designation of Consignee
 3. Drum No.
 4. Contract/Specification number.
 5. Size and type of conductor.
 6. Number and length of each conductor in the drum.
 7. Gross weight of the drum.
 8. Weight of the empty drum.
 9. Net weight of conductor.
 10. Position of conductor end and arrow marking for un-winding.
 11. ISI mark.
- 8.2 The Drums shall be constructed in such a way to ensure delivery of conductor in the store free from displacement and damage and should be able to withstand all stresses due to handling and the stringing operation so that conductor surface is not dented, scratched or damaged in any way during transport and erection.
- 8.3 All wooden components shall be manufactured out of seasoned wood, preferably soft wood free from defects that may materially weaken the component parts of the drum. Wood preservative of treatment for anti termite/anti fungus (Aldrime/Aldruse) shall be applied to the entire drum with preservative of such quality, which is not harmful to the conductor nor to the person using or storing the same.

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

After placement of the Letter of Award, the supplier shall submit four copies of fully dimensioned drawings of the drum, for purchaser's approval before taking up manufacturing of conductor and or drums. After getting approval from the purchaser, supplier shall submit 6 more copies of the approved drawings to purchaser for further distribution and field use at purchaser's end.

The complete drum including inner check of the flanges and drum barrel surface shall be painted with a bitumen based paint.

Before reeling, card board 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.

A minimum space of 75 mm shall be provided between the inner surface of the external protective layer and outer layer of the conductor.

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

Outside the protective layer, there shall be minimum of two binder consisting of hoop iron/galvanised steel wire. Each protective layer shall have two recess to accommodate the binders.

The conductor ends shall be properly sealed and secured with the help of U-nails on one side of the flanges. The end securing shall be done by taking out at least 500 mm. of steel core on either ends and sealing it with U-nails. The composite conductor shall be banded by use of galvanised steel wire/aluminium.

If any bidder wishes to supply the conductor in the steel drums, the same will be acceptable, however free of cost.

9. CHECKING OF CONDUCTOR LENGTH

Sufficient facilities should exist at contractor's premises to measure the conductor length by the inspecting officers. For this purpose motorized system to facilitate quick measurement should be installed at the works.

10. TOLERANCE OF QUANTITIES

The total permissible variation for the entire quantity ordered shall subject to limit of $\pm 1\%$ for orders upto 500 kms and $\pm 1/2\%$ for orders above 500 kms. However, the permissible variation in case of individual consignee may be $\pm 5\%$.

11. LENGTH AND VARIATIONS IN LENGTHS

The standard length of each type of ACSR conductor shall be as given below. Non standard length, less than, as mentioned below shall not be acceptable. Also, non standard lengths shall be acceptable subject to maximum of 10% of the ordered quantity.

Item	Standard Length	Non Standard Length
ACSR Weasel	1.5 Km.	1.0 Km
ACSR Rabbit	1.5 Km.	1.0 Km
ACSR Raccoon	1.5 Km.	1.0 Km
ACSR Dog	1.0 KM	0.750 KM
ACSR Panther	1.0 KM	0.750 KM

12. TESTING:

12.1 Type Tests (CPRI/ERDA):-

The bidder shall submit the following type tests reports alongwith Technical bid (IS:398 part 2):-

1. Measurement of Diameter (Cl. 13.2)
 - a) Aluminium Wire
 - b) Steel Wire
2. Breaking Load Test (Cl. 13.3)
 - a) Aluminium Wire (before/after)
 - b) Steel Wire (before/after)
3. Ductility Test (Cl. 13.4)
 - a) % Elongation (Steel Wire)(before/after)
 - b) Torsional test (before/after)
4. Wrapping Test (Cl. 13.5)
 - a) Aluminium Wire
 - b) Steel Wire
5. Resistance Test (Cl. 13.6)
 - a) Aluminium Wire
 - b) Conductor
6. Measurement of Lay Ratio (Cl. 13.8)
 - a) First Layer (Steel)
 - b) Outermost Layer (Alu.)
 - c) Beneath Outermost Layer (Alu.)
7. Stress Strain Test (Cl. 13.11)
 - a) On composite conductor
 - b) On steel core
8. Surface Condition Test (Cl. 13.9)
9. Ultimate Breaking Load of stranded conductor (Cl. 13.10)
10. Galvanising Test of steel wire (Cl. 13.7)
 - a) Weight of Zinc coating
 - b) Uniformity of Zinc coating

12.2 Acceptance Tests:-

The conductor shall be subjected to the following tests in accordance with IS: 398 (Part-II) 1976: -

- i) Check for diameter of individual Aluminium and Steel strands.
- ii) Check for lay ratio of various layers of Aluminium and Steel.
- iii) Breaking load tests on Aluminium and galvanized steel wires.
- iv) Wrapping test on Aluminium and galvanized steel wires.
- v) Electrical resistance test on Aluminium wires only.
- vi) Ductility test on galvanized steel wire only.
- vii) Galvanizing test on galvanized steel wires only.
 - (i) Weight of zinc coating.
 - (ii) Uniformity of zinc coating.
- viii) Checking of conductors surface declared length and weight.
- ix) Visual Examination test on conductor drums as per IS: 1778/1980.
- x) The rejection & retest procedure shall be followed as stipulated in IS: 398 (Part-II) 1976.

12.3 Acceptance Tests:-

a)	Visual & Dimensional Check	IS:398 (Part II) 1996/Relevant with latest amendments
b)	Visual check for joints, scratches etc. and lengths of conductor	do
c)	Dimensional check on steel and aluminium strands	IS:398 (Part II) 1996 or as per this specification
d)	Check for lay ratio layers	IS:398 (Part II) 1996/Relevant with latest amendments
e)	Galvanising test on steel strands	do
f)	Torsion and elongation test on steel strands	do
g)	Breaking load test on steel and aluminium strands	do
h)	Wrap test on steel and aluminium strands	do
i)	DC resistance test on aluminium strands	do
j)	UTS test on welded joints of aluminium strand	As per this specification

13. TESTING AND TEST CERTIFICATE

The conductor shall be subjected to all tests laid down in the relevant ISS at contractor's works or at approved test laboratory at contractor's cost. Certified copies of test certificate in respect of tensile test of both Aluminium and Steel strand, electrolytic quality of Aluminium and galvanized coating test of steel strand and all other tests as prescribed in the relevant ISS shall be furnished by contractor in triplicate, one copy to respective consignee officer second copy to "Engineer of Contract".

14. QUALITY ASSURANCE PLAN:-

The bidder shall invariably furnish following information along with his offer, failing which his offer shall be rejected.

- 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 supplier's representative and as routine and / or acceptance during production and on finished goods, copies of test certificates.
- ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.
- iii) List of manufacturing facilities available.
- iv) Level of automation achieved and list of areas where manual 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 equipment available with the Supplier for final testing of Conductor specified. In the case if the suppliers does not possess all the Routine and Acceptance testing facilities the tender will be rejected.
- vii) The DISCOM reserves the right for factory inspection to verify the facts quoted in the offer. If any of the facts are found to be misleading or incorrect the offer of that Bidder will be out rightly rejected and he may be black listed/debarred from business.
- viii) Special features provided to make it maintenance free.
- 14.2 The bidder shall also submit following information to the purchaser along with the technical Bid. .
 - i) List of raw materials as well as bought out accessories, and the name of suppliers of raw materials as well as bought out accessories.
 - ii) Type test certificates of the raw material and bought out accessories.
 - iii) Quality assurance plan (QAP) with hold points for purchaser's inspection.
- 14.3 The Supplier shall submit the routine test certificates of all the bought out items, accessories etc.
- 15. **INSPECTION:-**
- 15.1 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 Suppliers works raw materials and process of manufacture and conducting necessary tests as may be deemed fit, for certifying the quality of product.
- 15.2 The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.
- 15.3 No material shall be despatched from its point of manufacture before it has been satisfactorily inspected, tested, and necessary despatch instructions are issued in writing, except for the cases where waiver of inspection is granted by competent authority of the DISCOM, and even in this case also written dispatch instructions will be issued. Any dispatches before the issue of Dispatch Instructions in writing will be liable for rejection and non acceptance by the consignee.
- 15.4 The acceptance of any quantity of material shall in no way relieve the Supplier of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.
- 15.5 At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of conductor by following method:
 "At the works of the manufacturer 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."
- 15.6 The inspecting officer will carry out 100% checking of all the drums for inspection by Weight.
- 15.7 The sample cut of from any numbers of drums for carrying out any type of tests will be to the suppliers account.
- 15.8 For sealing of both ends of conductor, the position of conductor ends should be marked clearly on the body of wooden drum to avoid opening of all wooden planks of the conductor drum.
- 15.9 Necessary care should be taken by the supplier to ensure that Seals provided by the inspection officer remains intact during transportation and receipt of the drum by stores wing.
- 15.10 Each store division of Discom shall again verify the length and weight of atleast 5% or minimum two no., whichever is higher, quantity of drums supplied in the store division and payments against the supply shall be released only after issuance of the certificate by the Executive Engineer, ESD regarding the correctness of both the parameters. 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 of the lot, if the conductor is found short during verification.

Similarly, Superintending Engineer, ESC (Discom) shall also witness and verify minimum 2 no. quantity of drums supplied in each lot for length & weight. The Superintending Engineer, ESC shall also be responsible for sample testing of the each supplied lot in coordination with the quality cell of the Discom.

16. CALIBRATION OF TESTING EQUIPMENTS:

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

- a) Calibration Reports from Government approved testing laboratory of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
- b) Standard resistance for calibration of resistance bridges.
- c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with transverse layering facilities.
- d) The bidder should have all the routine and acceptance testing facilities, in house.

In case of dispute regarding calibration, the instruments shall be jointly sealed and sent to institutions, lab or deputed for calibration at the cost of supplier. The result of such checking shall be binding on the supplier.

Note:-Indian Standard (IS) guidelines issued periodically shall prevail.

GUARANTEED TECHNICAL PARTICULARS

SL. No.	Description	Discom Requirement	To be Furnished by Bidder
1	Material Description	(Name of Conductor)	
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		
4	Standard Nominal Copper area in Sq.mm		
5	Calculated Equivalent Aluminium area in Sq.mm		
6	Actual Aluminium area in Sq.mm		
7	Standard area of Cross-section in Sq.mm a. Aluminium Strand b. Steel strand. c. Conductor		
8	Diameter of complete Conductor in mm		
9	Minimum Ultimate Tensile Stress of strand in kg/ Sq.mm a) Aluminium Strand b) Steel Strand		
10	Minimum Breaking Load in KN for a) Aluminium Strand. b) Steel Strand		
11	Purity of Aluminium Rods in %		
12	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.		
13	Maximum Working Tension		
14	Weight in Kg per KM (Max/ Min) a) Aluminium b) Steel c) Conductor		
15	Maximum Resistance in Ohms per Km at 20deg.C a) Aluminium Strand b) Conductor		
16	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)		
17	LAY Ratio Steel Core : Wire Aluminium : Wire Layer Wire Layer	Max. Min.	
18	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	
19	Moulds of Elasticity of a) Aluminium Strand : Kgs/Sq.mm b) Steel Strand : Kgs/Sq.mm c) Conductor Strand : Kgs/Sq.mm		

SL. No.	Description	Discom Requirement	To be Furnished by Bidder
20	Co-efficient of Liner Expansion per °C for a) Aluminium Strand. b) Steel Strand. c) Conductor		
21	Percentage of Carbon in Steel Wire	0.50 to 0.85%	
22	Standard length of each piece in Drum (in KM)		
23	Tolerance, if any on Standard Lengths	± 5%	
24	No. of Standard Lengths in One Reel		
25	Weight of the Conductor in One Drum(in Kg)		
26	Weight of the Drum (in Kg)		
27	Gross Weight of the Drum including weight of the Conductor (kg)		
28	Standard According to Which the Conductor Will be Manufactured and Tested.	IS:398 (Part-II) 1996	
29	Type Test No., date & Testing laboratory	CPRI/ERDA/NTH/NSIC	
30	Guarantee (in Months)		
31	Other Particulars.		