

SECTION-V

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**TECHNICAL SPECIFICATION
(SECTION-V)**

1.0 Galvanised Steel Earth wire

1.1 Details of Earth wire

1.11 The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IS:398 (Part-II)-1976 except where otherwise specified herein.

1.1.2 The basic details of the earth wire for 400 kV line are tabulated below:

Sl.No.	Description	Unit	Value
1.	Stranding & Wire diameter	mm	7/3.66 (steel)
2.	Strands		
	a) Steel Core	No.	1 (one)
	b) Outer layer	No.	6 (six)
3.	Total sectional area	Sq.mm.	73.65

Other technical details are furnished in the section-I of this Specification.

1.2 Workmanship

1.2.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

1.2.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

1.2.3 The steel strands shall be hot dip galvanised and shall have minimum Zinc coating after stranding, as stipulated in Cl. 2.0, Table 1 of this section of the Specification. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-M.

1.2.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken

to avoid damage to galvanisation during pre-forming and post-forming operation.

1.2.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

1.3 Joints in Wires

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

1.4 Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in Clause 2.0, Table 1 of this section of the Specification only shall be permitted in the diameter of the individual steel strands and lay length of the earth wire:

1.5 Materials

1.5.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Clause 2.0, Table 1 of this section of the Specification.

1.5.2 Zinc

The zinc used for galvanising shall be electrolytic High Grade Zinc and shall conform to the requirements of IS:209.

1.6 Standard Length

1.6.1 The standard length of the earth wire shall be as stipulated in Clause 2.0, Table 1 with the specified tolerance on standard length.

1.6.2 Random length will be accepted provided no length is less than 70% of standard length and the total quantity of random lengths is not more than ten (10) percent of the total quantity in each shipment.

2.0 Standard technical particulars

2.1 The standard technical particulars to be adhered by the contractor/ manufacturer are furnished in below:

TABLE – 1 (7/3.66 mm Galvanised Steel Earth wire)

Sl. no.	Description	Unit	Standard Values
1.0	Raw Materials		
1.1	Steel wires / rods		
a)	Carbon	%	Not more than 0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	Zinc		
a)	Minimum purity of Zinc	%	99.95
2.0	Steel strands		
2.1	Diameter		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.74
c)	Minimum	mm	3.58
2.2.	Minimum breaking load of strand		
a)	After stranding	KN	10.58
2.3	Galvanising		
a)	Minimum weight of zinc coating per sq.m. after stranding	Gms.	275
b)	Minimum number of dips that the galvanized strand can withstand in the standard preece test	Nos.	3 dips of 1 minute and one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18

3.0	Stranded Earth wire		
3.1	UTS of Earth wire	KN	68 (min.)
3.2	Lay length of outer steel layer		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	Maximum DC resistance of earth wire at 20⁰ C	Ohm/ km	2.5
3.4	Standard length of earth wire	Mtrs	2000
3.5	Tolerance on standard length	%	±5
3.6	Direction of lay for outside layer		Right hand
3.7	Linear mass		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	600
c)	Minimum	Kg/km	552

3.0 Tests and Standards

3.1 Type Tests on Earthwire

The following tests shall be conducted once on a sample / samples of earthwire for every 500 Kms of production from each manufacturing facility:

- a) UTS test : As per Annexure - A
- b) DC resistance test : As per Annexure - A

3.2. Acceptance Tests on Earthwire

- a) Visual and dimensional check on drum : As per Annexure - A
- b) Visual check for joints scratches etc. and lengths of earthwire : As per Annexure - A
- c) Dimensional check : As per Annexure - A
- d) Lay length check : As per Annexure - A
- e) Galvanising test : As per Annexure - A
- f) Torsion test : As per Annexure - A

- g) Elongation test : As per IS:398 (Part-II)
- h) Wrap test : As per IS:398 (Part-II)
- i) DC resistance test : As per IS:398 (Part-II)
- j) Breaking load test : As per IS:398 (Part-II)
- k) Chemical Analysis of steel : As per Annexure - A

3.3 Routine Tests on Earthwire

- a) Check for correctness of stranding : As per Annexure - A
- b) Check that there are no cuts, fins etc. on the strands. : As per Annexure - A
- c) Check that drums are as per Specification. : As per Annexure - A

3.4 Tests During Manufacture Earthwire

- a) Chemical analysis of zinc used for galvanising : As per Annexure - A
- b) Chemical analysis of steel : As per Annexure - A

3.5 Testing Expenses

3.5.1 The break-up of the testing charges for the type tests specified shall be indicated separately.

3.5.2 Bidders shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by them.

3.5.3 In case of failure in any type test the Contractor is either required to manufacture fresh sample lot and repeat all the test successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case fresh lot is manufactured for testing then the lot already manufactured shall be rejected. The decision of the Owner in this regard shall be final and binding on Contractor.

3.5.4 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 except for the expenses of the inspector/ Owner's representative.

3.5.5 In case of failure in any type test, repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/ Owner's representative shall be deducted from the contract price. Also if on receipt of the Contract's notice of testing the Owner's representative/Inspector does not find 'materials and facilities' to be ready for testing, the expenses incurred by the Owner for re-deputation shall be deducted from the contract price.

3.6 Additional Tests

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

3.6.2 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test center. In case of evidence of non compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective item all without any extra cost to the Owner.

3.7 Sample Batch For Type Testing

3.7.1 The Contractor shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Owner's Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Owner.

3.7.2 The Contractor shall offer at least three drums for selection of sample required for conducting type test.

3.7.3 The Contractor is required to carry out all the Acceptance tests successfully in presence of Owner's representative before sample selection.

3.8 Test Reports

3.8.1 Copies of type test reports shall be furnished in at least six copies along with one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.

3.8.2 Record of routine test reports shall be maintained by the Contractor at his works for periodic inspection by the Owner's representative.

3.8.3 Test Certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

3.9 Inspection

3.9.1 The Owner 's representative shall at all times be entitled to have access to the works and all places of manufacture, where earth wire shall be manufactured and representative shall have full facilities for unrestricted inspection of the Contractor's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

3.9.2 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of earth wire in its various stages so that arrangements can be made for inspection.

3.9.3 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 Owner in writing. In the latter case also the earth wire shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

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

3.10 Test Facilities

3.10.1 The following additional test facilities shall be available at the Contractor's works :

- a) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
- b) Standard resistance for calibration of resistance bridges.
- c) Finished Earth wire 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 traverse laying facilities.

3.11 Packing for Earth wire

3.11.1 The Earth wire shall be supplied in non-returnable, strong, wooden drums and provided with lagging of adequate strength, constructed to protect the

Earth wire against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Contractor shall be responsible for any loss or damage during transportation handling and storage due to improper packing. The drums shall generally conform to IS: 1778-1980, except as otherwise specified hereinafter.

- 3.11.2 The drums shall be suitable for wheel mounting and for letting off the earth wire under a minimum controlled tension of the order of 5 kN
- 3.11.3 The general outline of the drum for Earth wire shall be as per annexed drawing. The Contractor should submit their proposed drum drawings along with the bid.
- 3.11.4 For Earth wire, two standard lengths shall be wound on each drum.
- 3.11.5 For Earth wire, each strand shall be individually welded to prevent parting of two lengths at a tension less than 15 kN. The two ends where the first length finishes and the second length starts, shall be clearly marked with adhesive tape and no weld should be present outside these marks. The length between the two marks shall be treated as scrap and will not be taken into account for measurement purposes.
- 3.11.6 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 shall be applied to the entire drum with preservatives of a quality which is not harmful to the earth wire.
- 3.11.7 The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not vary by more than 3 mm from that indicated in the figure. 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 earth wire the entrance shall be in line with the periphery of the barrel.
- 3.11.8 The wooden battens used for making the barrel of the earth wire shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the earth wire.
- 3.11.9 Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel studs shaft be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

- 3.11.10 Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 3.11.11 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.
- 3.11.12 Before reeling, cardboard or double corrugated or thick bituminous waterproof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the earth wire, the exposed surface of the outer layer of earth wire shall be wrapped with water proof thick bituminous bamboo paper to preserve the earth wire from dirt, grit and damage during transport and handling.
- Medium grade craft/crepe/polythene paper shall be used in between the layers.
- 3.11.13 A minimum space of 50 mm for earth wire shall be provided between the inner surface of the external protective lagging and outer layer of the earth wire.
- 3.11.14 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.
- 3.11.15 The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.
- 3.11.16 Outside the protective lagging there shall be minimum of two binder consisting of hoop iron/galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 3.11.17 The earth wire ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the earth wire layers during transit and handling.

3.12 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 earth wire
- (f) Length of earth wire in meters
- (g) Gross weight of drum with earth wire & lagging
- (h) Weight of empty drum with lagging
- (i) Arrow marking for unwinding
- (j) Position of the earth wire ends
- (k) Number of turns in the outer most layer
- (l) Distance between outer most layer of Earth wire and the inner surface of lagging
- (n) Barrel diameter at three locations and an arrow marking at the location of measurement

3.13 Verification of Earth wire Length

The Owner reserves the right to verify the length of earth wire after unreeling atleast ten (10) percent of the drums in a lot offered for inspection.

3.14 Standards

The earth wire shall conform to the following Indian/ International Standards, which shall mean latest revisions, amendments/changes adopted and published, unless otherwise in the Specification.

In the event of the supply of earth wire conforming to standards other than specified, the Contractor shall confirm in his bid that these standards are equivalent to those specified. In case of award salient features of comparison between the standards proposed by the Contractor and those specified in this documents will be provided by the Contractor to establish their equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS: 398-1990	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398-1998 Part-II	Aluminum Conductor Galvanised Steel Reinforced	BS;215-1970 IEC:1089-1991
4.	IS :398-1996 Part-IV	Aluminum Alloy stranded conductor	BS-3242-1970 ASTM-8399 M86 IEC:1089-1991
5.	IS:398-1992 Part-V	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
6.	IS : 1778-1997	Reels and Drums for Bare Conductors	BS:1559-1949
7.	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
8.	IS : 2629-1990	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
9.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
10.	IS : 4826-1992	Galvanised Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969
11.	IS : 6745-1991	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973
12.	IS : 8263-1991	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
13.	IS : 9997-1991	Aluminium Alloy Redraw Rods	IEC 104 - 1987
14.		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
15.		Hard drawn Aluminium wire for overhead line conductors	IEC : 889-1987

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND UK
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique internationale, 1 Rue de verembe, Geneva SWITZERLAND
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017 U.S.A.

1.0 Tests on Earth wire**1.1 UTS Test**

Circles perpendicular to the axis of the earth wire shall be marked at two places on a sample of earth wire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 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 steady rate to 100% of UTS and held for one minute. The earth wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 D.C. Resistance Test

On a earth wire sample of minimum 5m length two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially at 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 20⁰C. The resistance corrected at 20⁰C shall conform to the requirements of this Specification.

1.3 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in the Specification.

1.4 Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically,/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

1.5 Visual and Dimensional Check on Drums and its barrel strength test.

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification. The details regarding barrel strength test will be discussed and mutually agreed to by Contractor and Owner in the quality assurance programme.

1.6 Visual Check for Joints, Scratches etc. and Length of Earth wire

Ten percent drums from each lot shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and see that

the earth wire generally conforms to the requirements of this Specification. The length of earth wire wound on the drum shall be measured with the help of counter meter during rewinding.

1.7 Dimensional Check

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

1.8 Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this Specification.

1.9 Galvanising Test

The test procedure shall be as specified in IS:4826- 1979. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.10 Torsion Test

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for 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 stranded diameter of the strand the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number.