SECTION-V

GALVANISED STEEL EARTHWIRE

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

SECTION-V

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TECHNICAL SPECIFICATIONS

SECTION- V

GALVANISED STEEL EARTHWIRE

1.0 Technical Description

1.1 Details of Earth wire

1.1.1 The galvanised steel earth wire shall generally conform to IS12776 except where otherwise specified herein.

1.1.2 Standard Technical Particulars

The standard Technical Particulars (STP) of Earthwire is enclosed at Annexure-B of this section. The values indicated in the STP are the minimum and/or maximum values required to be met by the supplier.

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 galvanized and shall have minimum Zinc coating after stranding, as stipulated in Standard Technical Particulars attached with. 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 STP.

1.2.4 The steel strands shall be pre-formed and post-formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanization during performing 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 Standard Technical Particulars attached with this specification shall only 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 Standard Technical Particulars attached with.

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 Standard Technical Particulars attached with, 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 Tests and Standards

2.1 Type Tests

The following tests shall be conducted on sample/ sample(s) of the earthwire required under the package from manufacturing works from which the earthwire is to be manufactured & supplied: -

a)	DC resistance test	Annexure-A
b)	UTS test on stranded earthwire	

2.1.1 Type tests specified under Clause 2.1 shall not be required to be carried out if supplier has conducted these tests earlier on the same type of earthwire and valid type test certificates are available. The test certificate shall be considered valid if,

i. Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/ 17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and

ii. Type test reports contain validity details of Calibration reports of the relevant testing equipment and information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any),

photos, acceptance criteria/values specified in Technical Specification/relevant standards (IS/ IEC) and compliance to the same and

iii. The Equipment (i.e. Earthwire) shall be supplied from the same manufacturing works, where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint Venture (JV) for the initial period of 03 years from the date of establishment of manufacturing plant.

In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:

a) the relevant standard does not bar the same,
b) the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
c) the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/ practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
d) Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).

iv. The Type test report(s) of the equipment shall not be older than 10 (ten) years as on the originally scheduled last date of bid submission (Soft Copy).

v. While submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is:

a) No change in the Design
b) No change in the material,
c) No change in manufacturing process, and
d) No amendment/ revision in the relevant standard as regard to type test conditions, since the type test.

Further, test certificates shall also be considered valid, if the same has already been approved/ accepted by POWERGRID & tests have been conducted within the above-mentioned validity period.

In case the tests have been conducted earlier than the above stipulated period or in case of revision/ amendment in the provisions/ test procedure of the IS/IEC as

referred in the TS or in the event of any discrepancy in the test report (i.e. due to non-inclusion of validity details of calibration certificate, desired information etc. or any test not applicable due to any design/ material/ manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the supplier at no extra cost to the purchaser.

2.2 Acceptance Tests

a)	Visual and dimensional check on drum	Annexure-A
b)	Visual check for joints, scratches etc. and lengths measurement of earthwire by rewinding	
c)	Measurement of diameter of individual steel strands	
d)	Check for lay-length	
e)	Galvanising test	
f)	Torsion and elongation test	
g)	Breaking load test	
h)	Wrap test	
i)	DC resistance test	
j)	Barrel strength test on wooden drum	
k)	Chemical Analysis of steel	

2.3. Routine Tests

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

2.4. Tests During Manufacture Earthwire

a)	Chemical analysis of zinc used for galvanising	Annexure-B
b)	Chemical analysis of steel	Annexure-B

2.5 Testing Expenses

2.5.1 In the event of type testing, 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.

2.5.2 In case of failure in any type test the Contractor is either required to manufacture fresh sample lot and repeat the entire 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 Employer in this regard shall be final and binding on Contractor.

2.5.3 The entire cost of testing for the type**,** 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/ Employer's representative.

2.5.4 In case of failure in any type test, repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/ Employer representative shall be to the supplier's account. Also, if on receipt of the Contract's notice of testing the Employer's representative/ Inspector does not find the test samples or testing facilities/ equipment ready for testing, the expenses incurred by the Employer for re-deputation shall be to the supplier's account.

2.6 Additional Tests

2.6.1 The Employer 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.

2.6.2 The Employer 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 Employer.

2.7 Sample Batch For Type Testing

2.7.1 In case the type tests are required to be carried out, the samples for type testing shall be manufactured in accordance with the Standard Manufacturing Quality Plan.

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

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

2.8 Test Reports

2.8.1 In case type tests have been carried out earlier by the supplier and valid type test reports are available as specified in clause 2.1.1 above, the supplier shall submit one copy of the test report along with approval letter issued by Employer or utility.

2.8.2 In case fresh type tests have been carried out under the package, type test reports shall be furnished in original alongwith two copies. One copy will be returned duly certified by the Employer.

2.8.3 The commercial production of the earthwire can be taken up by the supplier after clearance from the purchaser.

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

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

2.9 Inspection

2.9.1 The Employer '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.

2.9.2 The Contractor shall keep the Employer 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.

2.9.3 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 Employer 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.

2.9.4 The acceptance of any quantity of material shall in no way absolve 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.

2.10 Test Facilities

2.10.1 The following test facilities shall be available at the Contractor’s works:

a) Various testing and measuring equipment for carrying out specified acceptance tests, routine tests and tests during manufacture inter alia including tensile testing machine, resistance measurement facilities, torsion & wrap testing machine, dimension checking instruments viz. digital vernier and micrometer etc., galvanizing test instruments viz. digital

elcometer and standard preece test etc., burette, digital thermometer, barometer etc.

b) Digital milli/micro ohm meter along with 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.

2.11 Packing for Earth wire

2.11.1 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.

2.11.2 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

2.11.3 The standard drawing of the drum for earthwire is enclosed with the specification. The Bidder shall supply the earthwire in the drum conforming to the standard drawing only.

2.11.4 For Earth wire, two standard lengths shall be wound on each drum.

2.11.5 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.

2.11.6 All wooden components shall be 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.

2.11.7 As an alternative to non-returnable wooden drums, bidder may supply the earthwire in returnable steel drum. However, for bid evaluation purpose, both types of drums shall be treated at par and bidder may quote accordingly.

2.11.8 The empty steel drums shall be taken back by the contractor/ supplier as & when these are available after usage of earthwire. However, 2% of the total

drums shall not be returned to the contractor/ supplier as these may be used for storage of spare earthwire by the purchaser.

2.11.9 The steel drums may get damaged and/or wear & tear during transportation, normal handling & operation at site, which shall be rectified by the supplier before re-use.

2.11.10 Solid Polypropylene sheet of minimum 5mm thickness shall be used for outer covering of earthwire in steel drum. Outside the covering, there shall be minimum two binders consisting of hoop iron/ galvanised steel wire. Two numbers of additional binders per drum shall also be supplied for re-wrapping the polypropylene sheet with each lot of earthwire and 5 nos. crimping machines with the first lot of earthwire for crimping the binders at site. As an alternative, supplier may use wooden lagging of minimum 50 mm thickness for outer covering of earthwire without any extra financial implication to the purchaser.

2.11.11 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 over which HDPE sheet to be provided. After reeling the earth wire, the exposed surface of the outer layer of earth wire shall be wrapped with self-adhesive plastic sheet to preserve the earth wire from ingress of water dirt, grit and damage during storage transport and handling.

2.11.12 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.

2.12 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) Barrel diameter at three locations and an arrow marking at the location of measurement
m) CIP/MICC No.

2.13 Verification of Earth wire Length

The Employer reserves the right to verify the length of earth wire after unreeling. The quantity for verification shall be between a minimum of five percent (5%) to a maximum of ten percent (10%) in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the supplier & purchaser.

2.14 Standards

The earth wire shall conform to the following Indian 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 these documents will be provided by the Contractor to establish their equivalence.

Sl. No.	Indian Standard	Title
1	IS 209	Specification for zinc
2	IS 12776	Galvanized Strand for Earthing-Specification
3	IS 1778	Reels and Drums for Bare Conductors
4	IS 2629	Recommended Practice for Hot Dip Galvanizing of Iron and Steel
5	IS 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
6	IS 4826	Galvanized Coating on Round Steel Wires
7	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi 110001 India

3.0 Manufacturing Quality Plan

Earthwire manufacturing shall be carried out in accordance with Standardized Manufacturing Quality plan as given in the Appendix -I of this section.

Annexure-A

1.0 Tests on Earth wire

1.1 DC Resistance Test

An 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 20°C. The test results shall conform to the requirement specified in the STP.

1.2 UTS Test on stranded earthwire

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.

1.3 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.

1.4 Visual Check for Joints, Scratches etc. and Length measurement of Earth wire by rewinding

Ten percent drums from each lot shall be rewound in the presence of the Employer. The Employer 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.

1.5 Measurement of diameter of individual steel strands

The diameter of the individual strands shall be checked to ensure that they conform to the requirement specified in the STP.

1.6 Check for Lay Length

The lay length shall be checked to ensure that they conform to the requirements specified in the STP.

1.7 Galvanising Test

The test procedure shall be as specified in IS 4826. 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.

1.8 Torsion and Elongation 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. In elongation test, the elongation of the strand after breakage, for a gauge length of 200 mm after stranding, shall not be less than the value specified in STP.

1.9 Wrap Test

The test procedure shall be as specified in IS 12776 except the test shall be carried after stranding.

1.10 Breaking load test

The breaking load of individual strands of earthwire (after stranding) shall be determined by means of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm/min and not greater than 100 mm/min. The ultimate breaking load of the specimens shall be not less than the value specified in in the STP.

1.11 Barrel strength test on Wooden Drum

The barrel strength test shall be conducted as per IS 1778 on one drum of each lot offered for inspection. Barrel batten strength shall not be less than 300 kg.

1.12 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.

1.13 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.

Annexure-B

Standard Technical Particulars for Galvanised Steel Earth wire

Sl. no.	Description	Unit	Standard Technical Particular of GS Earthwire			
			7/3.15 mm GS Earthwire	7/3.66 mm GS Earthwire	7/4.5 mm GS Earthwire	19/ 3.00 mm GS Earthwire
1.0	**Raw Materials**					
1.1	**Steel wires / rods**					
a)	Carbon	%	0.55 (Max)			
b)	Manganese	%	0.40 to 0.90			
c)	Phosphorous	%	0.04 (Max)			
d)	Sulphur	%	0.04 (Max)			
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	3.15	3.66	4.5	3.00
b)	Maximum	mm	3.20	3.74	4.58	3.05
c)	Minimum	mm	3.10	3.58	4.42	2.95
2.2.	**Minimum breaking load of strand after stranding**	KN	8.55	10.58	16.49	7.84
2.3	**Galvanising**					
a)	Minimum weight of zinc coating per sq.m. after stranding	gm	275	275	290	230
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			2 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			
d)	Min. elongation of the strand (after stranding) for a gauge length of 200 mm (after break)	%	3.5			
3.0	**Stranded Earth wire**					
3.1	Minimum UTS of Earth wire	KN	56	68	106.2	139.3
3.2	Lay length of outer steel layer					
a)	Standard	mm	160	181	230	270
b)	Maximum	mm	175	198	243	330
c)	Minimum	mm	145	165	216	210
3.3	Maximum DC resistance of earth wire at 20^0 C	Ohm/ km	3.375	2.5	1.66	1.50
3.4	Standard length of earth wire	m	2300	2000	2000	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	428	583	882	1062
b)	Maximum	kg/km	441	600	913	1100
c)	Minimum	kg/km	414	552	851	1020
3.8	Overall diameter	mm	9.45	10.98	13.5	15
3.9	Cross sectional area	sq. mm	54.55	73.65	111.33	134
3.10	Modulus of Elasticity	Kg/mm2	18993	19361	19361	19000
3.11	Coefficient of linear expansion	Per deg C	0.0000115	0.0000115	0.0000115	0.0000115