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Draft Indian Standard

WROUGHT ALUMINIUM WIRE FOR ELECTRICAL PURPOSES — SPECIFICATION

[*Second Revision* of IS 2067]

ICS 77.120.10

Ores and Feed Stock for Aluminium Industry, its Metals/Alloys and Products Sectional Committee, MTD 07	**Last date of comments 30 March 2024**

FOREWORD

(Formal clauses of the foreword will be added later.)

This standard was first published in 1962 and subsequently revised in 1975. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. In addition, the following significant modifications have been made:

a) Reference clause has been included;

b) Clause 3, Supply of material has been modified;

c) In Clause 5.1, all grades of IS 4026 are now permitted;

d) Units of resistivity values changed to ohm. mm^2/m

e) Method of checking resistivity at 20°C included as Annex B

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded of value should be the same as that of the specified in this standard.

Draft Indian Standard

WROUGHT ALUMINIUM WIRE FOR ELECTRICAL PURPOSES — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers the requirements of aluminium wire of size up to and including 9 mm for electrical conductors and specifies the chemical composition, mechanical properties, electrical resistivity, and other general requirements.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 504 (Part 1 to 12) : 2002	Chemical analysis of aluminium and its alloys : Parts 1 to 12 (*second revision*)
IS 504 (Part 13 to 16) : 2003	Chemical analysis of aluminium and its alloys : Parts 13 to 16 (*second revision*)
IS 1608 (Part 1) : 2022/ ISO 6892-1 : 2019	Metallic materials — Tensile testing : Part 1 Method of test at room temperature (*fifth revision*)
IS 3635 : 1966	Methods of test for resistance of metallic electrical resistance material
IS 4026 : 2023	Aluminium ingots, billets and wire bars (EC Grade) *(fifth revision)*
IS 10259 : 1982	General condition of delivery and inspection of aluminium and aluminium alloy products
IS 10810 (Part 3) : 1984	Methods of test for cables : Part 3 Wrapping test for aluminium wires

3 SUPPLY OF MATERIAL

General requirements relating to the supply of material are laid down in IS 10259.

4 TERMINOLOGY

4.1 Diameter of Wire — The diameter of wire shall be the mean of two measurements at right angles taken at the same cross section.

4.2 Wire — Solid circular section that has been reduced by cold-drawing to a diameter up to and including 9 mm.

5 CHEMICAL COMPOSITION

5.1 The chemical composition of wrought aluminium wire shall be made from the grades specified in IS 4026.

5.2 The chemical analysis as mentioned in **5.1** shall be carried out either in accordance with the methods specified in IS 504 (Part 1 to 12) and IS 504 (Part 13 to 16) or by any other established instrumental / chemical method. In case of any dispute, the method specified in IS 504 (Part 1 to 12) and IS 504 (Part 13 to 16) shall be used as referee method. However, when the method is not given in IS 504 (Part 1 to 12) and IS 504 (Part 13 to 16), the referee method shall be as agreed between the purchaser and the supplier.

6 CONDITION

The material shall be supplied in one of the following conditions as specified by the purchaser and shall have the mechanical properties as mentioned in **9**.

Annealed	O
Three-quarter hard	H3
Hard	H4

7 FREEDOM FROM DEFECTS

The wire shall be free from all types of harmful defects such as scratches, pits and ovality of cross section beyond specified limit, and it shall be clean of all greases and oils. The wire shall have a smooth finish.

8 ELECTRICAL RESISTIVITY

When determined in accordance with **13.3**, the electrical resistivity of the wire shall not exceed the values given in Table 1.

NOTE — 'Resistivity' is used in place of 'conductivity'. The international value of volume resistivity of annealed copper at 20 °C is 0.017 241 ohm-mm^2/m which equals 100 percent conductivity. This term means that a copper wire 1 mm^2 in cross section and one metre in length would have a resistance of 0.017 241 ohm. Conductivity values and their equivalent resistivity values are given in Annex A for ready reference.

Table 1 Electrical Resistivity of Wire
(*Clause* 8)

Sl No.	**Condition**	**Resistivity At 20 °C**, *Max* Ohm. mm^2/m
(1)	(2)	(3)
i)	O (Annealed)	0.028264
ii)	H3 (Three quarter hard)	0.028450
iii)	H4 (Full hard)	0.028450

9 MECHANICAL PROPERTIES

The mechanical properties obtained from test pieces selected and tested in accordance with **12** and **13** respectively shall be as given in Table 2.

Table 2 Mechanical Properties
(*Clause* 9)

Sl No.	**Condition**	**Tensile Strength (N/mm2)**	**Minimum Elongation or Wrapping Test**
(1)	(2)	(3)	(4)
i)	O	70 to 100	15 percent minimum elongation on 250 mm gauge length (all sizes)
ii)	H3	100 to 150	To pass the wrapping test (all sizes)
iii)	H4	150 to 165	To pass the wrapping test (all sizes)

10 JOINTS

Joint in the wire shall only be permitted before final drawing. No joint shall be allowed on finished wire.

11 TOLERANCES

11.1 The diameter of round wire determined by means of a suitable micrometer and by taking the mean of the two measurements at right angles, made at the same cross section of a sample, taken from any part of a coil, reel or drum shall be as ordered subject to a tolerance of ± 1 percent.

11.2 Ovality — The difference between the maximum and minimum measurements, taken at the same cross section, shall not exceed 1 percent.

12 TEST SAMPLES

12.1 The sample for various tests such as tensile test and electrical resistivity as specified in **13** shall be selected as given in **12.1.1** and **12.1.2**.

12.1.1 These test samples shall be cut from a coil selected at random from a lot of coils of wires of same diameter produced under the same conditions and technique.

12.1.2 The weight of each such lot shall not exceed the weights as given below. The test sample shall carry identification marks and shall not be annealed or mechanically worked except straightening for testing purposes:

Sl No.	*Wire Diameter*	*Maximum Weight of Lot*
(1)	(2)	(3)
i)	0.5 mm up to and including 1.25 mm	250 kg
ii)	Above 1.25 mm	1 000 kg

12.1.3 The weight of the lot for wire of standard diameter below 0.5 mm shall be as agreed to between the purchaser and the supplier.

13 TESTS

13.1 Tensile test — Tensile test shall be conducted in accordance with IS 1608 (Part 1).

13.2 Wrapping Test — Wrapping test shall be carried out in accordance with IS 10810 (Part 3).

Commented [DS1]: There are 2 reference standrads are available. IS 10820 & IS 1755. Will check and confirm the correct one.

13.3 Electrical Resistivity — The measurement of resistance shall be carried out to an accuracy of at least one in thousand. The length of sample selected for this shall be sufficient to give the accuracy required and shall be suitable for the method of testing employed.

13.3.1 Electrical resistivity at 20 ºC shall be determined on representative sample by resistance measurement as per method mentioned in Annex B.

14 RETESTS

14.1 If any test sample fails to comply with any of the test requirements for each such rejected coil, two samples from two different coils from the same lot shall be taken and one such sample shall be from the coil from which the original test sample was taken or otherwise the rejected coil shall be withdrawn by the suppliers. If both these test samples satisfy the test requirements the lot shall be deemed to comply with the requirements of this standard. If any of these two test samples fail to satisfy the requirements of this standard, the lot shall be rejected.

14.2 All such rejected lots shall carry the identification marks and be kept aside.

15 PACKING

15.1 The material shall be packed in coils.

15.2 Coil size and weight shall be agreed upon by the supplier and the purchaser at the time of placing the order.

15.3 Coils need be wrapped only when specified in the order. The quality and application of the wrapping material should be adequate to protect wire from damage incidental to normal handling and shipment.

16 MARKING

16.1 Each coil shall bear a tag showing manufacturer's name or trademark, weight and grade, size and temper condition. The supplier shall furnish a certificate that the material supplied complies with the requirements of requirements of this standard.

16.2 The coil shall carry a distinguishing tag, wrapping or the like, to indicate if the coil is in two lengths and if the material contains any joints.

16.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

ANNEX A

(*Clause* 8)

EQUIVALENT RESISTIVITY VALUES

Sl No.	**Material**	**Volume Conductivity** percent	**Resistivity At 20 °C**, *Max* Ohm. Mm^2/m
(1)	(2)	(3)	(4)
i)	Copper	100	0.017241
ii)	Aluminium	60.6	0.028450
		61.0	0.028264
		61.3	0.028126
		61.4	0.028080
		61.5	0.028035
		61.8	0.027899
		62.0	0.027809

ANNEX B
(*Clause* 10.1)

MEASUREMENT OF ELECTRICAL RESISTIVITY

B-1 SCOPE

This test method covers the determination of the electrical resistivity of aluminium and aluminium alloys in form of wire.

B-2 DEFINITIONS

a) Resistivity — Resistivity is the electrical resistance of a body of unit length, and unit cross-sectional area or unit weight; and

b) Volume Resistivity — Volume resistivity is commonly expressed in ohms for a theoretical conduct or of unit length and cross-sectional area in acceptable metric units in Ω.mm2/m. It may be calculated by the following equation:

$$\mathbf{P}v = \left(\frac{\mathbf{A}}{\mathbf{L}}\right)\mathbf{R}$$

Where,

Pv = volume resistivity, in Ω.mm2/m;

A = cross-sectional area, in mm2

L = gauge length, in mm; and

R = measured resistance, in Ω.

B-3 APPARATUS

Resistance shall be measured with a circuit configuration and instrumentation that has a resistance measurement capability of +/-0.15 percent accuracy.

B-4 TEST SPECIMEN

a) The test specimen shall be in the form of a wire. It shall be of uniform cross section throughout its length within +/- 0.75 percent of the cross-sectional area. Wherever possible it shall be the full cross section of the material it represents, if the full cross section is such that the uniformity of the cross-sectional area can be accurately determined. A test length of at least 1 ft or 300 mm;
b) Cross-sectional dimensions of the specimen may be determined by micrometer measurements with required accuracy of ± 0.10 percent, if required accuracy not possible with micrometer, determine the cross-section from weight, density, and length of the specimen (for purpose of calculation take density of aluminium: 2.705 g/cm3);

c) Resistance of at least 0.000 01 Ω (10 μΩ) in the test length between potential contacts;

d) No surface cracks or defects visible to the unaided normal eye, and substantially free from surface oxide, dirt, and grease;

e) No joints or splices; and

f) Wire rod sample may be drawn from outer side of coil.

B-5 PROCEDURE

a) Clean the specimen surface for good electrical contact and make resistance measurement to an accuracy of ± 0.15 percent using micro ohm meter. To eliminate errors due to contact potential, take two readings, one direct and one with the current reversed, in direct succession;

b) Maintain the consistent room temperature (recommended 22 ºC ± 2 ºC) and test specimen must be kept in room for least for 45 min before taking resistance measurement to maintain the temperature uniformity in a test specimen;

c) Apply the temperature correction, if measurement deviate from the temperature 20 ºC by the given formula;

$$R_T = \frac{R_t}{1+\alpha_{T(t-T)}}$$

Where;

R_T = resistance at reference temperature T;

Rt = resistance as measured at temperature t;

α_T = known or given temperature coefficient of resistance of the specimen being measured at reference temperature *T*;
T = reference temperature; and
t = temperature at which measurement is made.

For purpose of calculation: α_T (aluminium): 0.004; and

d) For measurement of resistivity, use formula

$$\boldsymbol{p_v = \left(\frac{A}{L}\right)R}$$

Where;

p_v = volume electrical resistivity, in Ω.mm2/m;
A = cross-sectional area, in mm2;
L = gauge length, in mm; and
R = measured resistance, in Ω.'