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Standard Specification for Aluminum-Alloy 5005 Drawing Stock for Electrical Purposes[1]

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ε[1] NOTE—7.1 was updated editorially in June 1998.

1. Scope

1.1 This specification covers aluminum-alloy 5005 Drawing stock, 0.375 in. (9.52 mm) in diameter, in the tempers shown in Table 1, for drawing into wire for electrical conductors (Explanatory Note 1 and Note 1).

1.2 The SI values for density and resistivity are regarded as the standard. For all other properties the inch-pound values are to be regarded as standard and the SI units may be approximate.

NOTE 1—The alloy and temper designations conform to ANSI H35.1. Aluminum-alloy 5005 corresponds to unified numbering system alloy A95005 in accordance with Practice E 527.

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*

B 193 Test Method for Resistivity of Electrical Conductor Materials[2]

B 354 Terminology Relating to Uninsulated Metallic Electrical Conductors[2]

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products[3]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[4]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[4]

E 101 Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[4]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[4]

TABLE 1 Tensile Requirements

Temper	Tensile Strength	
	ksi	MPa
5005-0	14–20	97–138
5005-H12 and -H22	17–23	117–159
5005-H14 and -H24	20–26	138–179
5005-H16 and -H26	24–30	165–207

E 527 Practice for Numbering Metals and Alloys (UNS)[5]

2.3 *American National Standard:*

ANSI H35.1 American National Standard Alloy and Temper Designation Systems for Aluminum[6]

2.4 *National Bureau of Standards:*

NBS *Handbook 100—Copper Wire Tables*[7]

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity of each temper,

3.1.2 Temper of stock (Table 1 and Explanatory Note 1),

3.1.3 Whether joints are permitted (Section 4),

3.1.4 Package size (see 14.2),

3.1.5 Whether wrapping is required (see 14.3),

3.1.6 Special package marking, if required (see 14.4), and

3.1.7 Place of inspection (Section 12).

4. Joints

4.1 The stock shall be furnished in continuous lengths without joints, unless otherwise agreed upon between the manufacturer and the purchaser at the time of placing the order.

4.2 When the manufacturer and the purchaser agree that the stock may be furnished with joints, the joints shall be made by electric-butt welding, by cold-pressure welding, or by electric-butt, cold-upset welding.

5. Resistivity

5.1 The electrical resistivity at 20°C (68°F) of the respective tempers of stock shall conform to the requirements prescribed

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[2] *Annual Book of ASTM Standards*, Vol 02.03.

[3] *Annual Book of ASTM Standards*, Vol 02.02.

[4] *Annual Book of ASTM Standards*, Vol 03.05.

[5] *Annual Book of ASTM Standards*, Vol 01.01.

[6] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

[7] Available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161.

in Table 2 (Explanatory Note 3).

5.2 The electrical resistivity shall be determined on representative samples of the 0.375-in. (9.52-mm) diameter stock in accordance with Test Method B 193.

6. Density

6.1 For the purpose of calculating mass per unit length, cross section, etc., the density of aluminum-alloy 5005 shall be taken as 2700 kg/cm^3(0.098 lb/in.^{3}) at 20°C.

7. Tensile Requirements

7.1 The tensile strength of the respective tempers of stock shall conform to the requirements prescribed in Table 1.

7.2 Tension tests shall be made of representative specimens. The length of the specimens shall be sufficient to have at least 10 in. (250 mm) free length between the jaws of the testing machine. Tests shall be made in accordance with Test Methods B 557 (Explanatory Note 2).

7.3 The tensile strength of joints in undrawn stock, when furnished under the conditions given in Section 10, shall be not less than 15 ksi (103 MPa), except for temper 5005-O which shall have a tensile strength of not less than 14 ksi (97 MPa).

7.4 The fracture shall occur in the free length between the jaws of the testing machine. If fracture takes place within 1 in. (25 mm) of either jaw the test may not be representative of the material and a retest shall be permitted.

8. Diameter and Permissible Variations

8.1 The diameter of the stock shall be specified as 0.375 in. (9.52 mm).

8.2 The diameter of the stock, determined as the average of the maximum and minimum diameter in the same transverse plane, shall not vary from the specified diameter by more than ±0.020 in. (0.51 mm).

9. Chemical Requirements

9.1 The stock shall conform to the requirements as to chemical composition prescribed in Table 3. Conformance shall be determined by the manufacturer by analyzing samples taken at the time the ingots or continuously cast bars are poured, or samples taken from the finished or semifinished product. If the manufacturer has determined the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product.

9.2 *Number of Samples*—The number of samples taken for determination of chemical composition shall be as follows:

9.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken to represent each group of ingots poured simultaneously from the same source of molten metal.

TABLE 2 Electrical Resistivity Requirements

Temper	Resistivity, Ω·mm^2/m, max	Equivalent Volume Conductivity, % IACS, min
5005-O	0.031752	54.3
5005-H12 and -H22	0.031928	54.0
5005-H14 and -H24	0.031988	53.9
5005-H16 and -H26	0.032047	53.8

TABLE 3 Chemical Requirements[A]

Element	Composition, %
Silicon, max	0.40
Iron, max	0.7
Copper, max	0.20
Manganese, max	0.20
Magnesium	0.50–1.1
Chromium, max	0.10
Zinc, max	0.25
Other elements, each, max	0.05
Other elements, total, max	0.15
Aluminum	remainder

[A] Analysis shall regularly be made only for the elements specified in this table. If, however, the presence of other elements is suspected or indicated in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in amounts in excess of the specified limits for other elements.

9.2.2 When samples are taken at the time continuously cast bars are poured, at least one sample shall be taken to represent the continuously cast length poured from each furnace load of molten metal.

9.2.3 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 5000 lb (2300 kg) or fraction thereof of material in the shipment, except that no more than one sample shall be required per continuous unjointed coil.

9.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

9.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a weight of prepared sample not less than 75 g. Sampling shall be in accordance with Practice E 55.

9.3.2 Samples for spectrochemical and other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.

9.4 *Methods of Analysis*—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34), spectrochemical (Test Methods E 101 or E 227), or other methods.

10. Workmanship, Finish, and Appearance

10.1 The material shall be uniform in quality and temper. It shall be suitable for drawing into wire.

10.2 The finish shall be that of commercially clean stock.

10.3 The stock shall be sound, smooth, and free of pipes, laps, cracks, kinks, twists, seams, damaged ends, and other injurious defects within the limits of good commercial practice.

11. Number of Tests

11.1 A tension test specimen and a resistivity test specimen shall be taken to represent each 5000 lb (2300 kg) or less of stock in the lot, except that no more than one sample shall be required per continuous unjointed coil. A lot shall consist of all stock of the same type offered in one shipment. Not less than two coils shall be sampled unless the lot consists of but a single coil. If desired, the same specimen may be used for both the tension and resistivity tests.

12. Inspection

12.1 Unless otherwise specified in the contract or purchase

order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

12.2 All inspections and tests shall be made at the place of manufacture unless otherwise especially agreed to between the manufacturer and the purchaser at the time of the purchase.

12.3 The manufacturer shall afford the inspector representing the purchaser all reasonable manufacturer's facilities to satisfy him that the material is being furnished in accordance with this specification.

13. Rejection

13.1 Failure of any of the test specimens to comply with the requirements of this specification shall constitute grounds for rejection of the lot represented by the specimen. The lot may be resubmitted for inspection by testing every coil for the characteristic in which the specimen failed and sorting out of the defective coils.

14. Packaging and Package Marking

14.1 The material shall be shipped in coils.

14.2 Coil size and weight shall be agreed upon between the manufacturer and the purchaser at the time of placing the order.

14.3 Coils shall be wrapped for shipment only when specified in the contract or order. The quality and application of the wrapping material should be adequate to protect stock from damage incident to normal handling and shipment.

14.4 Each coil shall bear a tag showing the manufacturer's name or trademark, size, alloy, and temper of material. If additional information is to be required on the tags, it shall be arranged with the manufacturer at the time of purchase.

15. Keywords

15.1 aluminum drawing stock; aluminum-alloy 5005 drawing stock; aluminum-alloy drawing stock; drawing stock for aluminum wire

EXPLANATORY NOTES

NOTE 1—The selection of the proper temper of stock will depend on the size of wire to be drawn, the wire properties desired, and the wire drawing practices employed.

NOTE 2—For Definitions of terms relating to conductors, reference should be made to Terminology B 354.

NOTE 3—In general, the values for tensile strength are not greatly affected by variations in speed of testing, so that a considerable range of testing speed is permissible. Care, of course, must be exercised to prevent the speed of testing from exceeding the rate at which the load-indicating equipment functions satisfactorily.

NOTE 4—Relationships that may be useful in connection with the values of electrical resistivity prescribed in Table 2 are shown in Table 4. Resistivity units are based on the International Annealed Copper Standard (IACS) adopted by IEC in 1913, which is $\frac{1}{58}$ $\Omega \cdot mm^2/m$ at 20°C (68°F) for 100 % conductivity. The value of 0.017241 $\Omega \cdot mm^2/m$ at 20°C (68°F) are respectively the international equivalent of volume resistivity of annealed copper equal to 100 % conductivity. A complete discussion of this subject is contained in *NBS Handbook 100*. The use of five significant figures in expressing resistivity does not imply the need for greater accuracy of measurement than that specified in Test Method B 193. The use of five significant figures is required for reasonably accurate reversible conversion from one set of resistivity units to another. The equivalent resistivity values in the table were derived from the fundamental IEC value ($\frac{1}{58}$ $\Omega \cdot mm^2/m$) computed to seven significant figures and then rounded to five significant figures.

TABLE 4 Equivalent Resistivity Values at 20°C

Material	Volume Conductivity, % IACS	Resistivity[A]			
		Volume			
		$\Omega \cdot mm^2/m$	$\Omega \cdot cmil/ft$	$\mu\Omega \cdot in.$	$\mu\Omega \cdot cm$
Copper, soft	100	0.017241	10.371	0.67879	1.7241
5005 aluminum alloy	54.3	0.031752	19.100	1.2501	3.1752
	54.0	0.031928	19.206	1.2570	3.1928
	53.9	0.031988	19.242	1.2594	3.1988
	53.8	0.032047	19.277	1.2617	3.2047

[A] The equivalent resistivity values for 100 % IACS conductivity were each computed from the fundamental IEC value ($\frac{1}{58}$ $\Omega \cdot mm^2/m$) using conversion factors each accurate to at least seven significant figures. Corresponding values for other conductivities (aluminum) were derived from these by multiplying by the reciprocal of the conductivity ratios accurate to at least seven significant figures.