Designation: B 396 – 00

Standard Specification for Aluminum-Alloy 5005-H19 Wire for Electrical Purposes[1]

This standard is issued under the fixed designation B 396; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers aluminum alloy 5005-H19 (extra hard) round wire for electrical purposes.

1.2 The SI values of density and resistivity are to be regarded as 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 531 Specification for Aluminum-Alloy 5005 Drawing Stock for Electrical Purposes[2]

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

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

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

2.3 *Other Documents:*

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

NBS Handbook 100—Copper Wire Tables of the National Bureau of Standards [7]

3. Ordering Information

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

3.1.1 Quantity of each size,

3.1.2 Wire diameter (see 9.1),

3.1.3 When tension tests of wires containing joints shall be made (see 5.2 and 5.3),

3.1.4 Frequency of bending test, when required (see 6.2),

3.1.5 Special jointing procedures, if permitted, (see 10.2),

3.1.6 Package size and type (see 15.1),

3.1.7 Special package marking, if required (see 16.1), and

3.1.8 Place of inspection (Section 14).

4. Material

4.1 The wire shall be made from rod meeting the requirements of Specification B 531.

5. Tensile Requirements

5.1 The wire shall be sampled in accordance with Section 12 and tested in accordance with Test Methods B 557. The wire shall conform to the requirements as to tensile properties prescribed in Table 1 (Explanatory Note 1). The elongation of wire shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between gage marks placed originally 10 in. (250 mm) apart upon the test specimen.

5.2 When requested by the purchaser, tension tests shall be made on specimens of finished wire containing joints made in the wire prior to final drawing or in the rod. Such tests shall show not less than 90 % of the minimum strength specified in Table 1 for individual tests.

5.3 When requested by the purchaser, tension tests of finished wire specimens containing joints made in the finished wire or during final drawing, as permitted in 10.2, shall be made. Such tests shall show the tensile strength to be not less

[1] This specification is under the jurisdiction of ASTM Committee B-1 on Electrical Conductors, and is the direct responsibility of Subcommittee B01.07 on Conductors of Light Metals.

Current edition approved April 10, 2000. Published June 2000. Originally published as B 396 – 63 T. Last previous edition B 396 – 87 (1994).

[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 14.02.

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

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

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

TABLE 1 Tensile Requirements

Diameter, in. (mm)	Tensile Strength, min				Elongation in 10 in. or 250 mm for individual tests, min, %
	Average for a Lot		Individual Tests		
	ksi	MPa	ksi	MPa	
0.2600 to 0.2101 (6.604 to 5.336)	33.0	228	31.5	217	2.2
0.2100 to 0.1601 (5.334 to 4.066)	34.0	234	32.5	224	2.0
0.1600 to 0.1501 (4.064 to 3.812)	36.0	248	34.5	238	1.9
0.1500 to 0.1401 (3.810 to 3.558)	36.5	252	35.0	241	1.8
0.1400 to 0.1201 (3.556 to 3.050)	37.0	255	35.0	241	1.7
0.1200 to 0.1101 (3.048 to 2.796)	37.5	259	35.5	245	1.6
0.1100 to 0.1001 (2.794 to 2.542)	38.0	262	36.0	248	1.5
0.1000 to 0.0901 (2.540 to 2.288)	38.5	265	36.5	252	1.5
0.0900 to 0.0801 (2.286 to 2.034)	39.0	269	37.0	255	1.5
0.0800 to 0.0701 (2.032 to 1.780)	39.5	272	37.5	259	1.4
0.0700 to 0.0601 (1.778 to 1.526)	40.0	276	38.0	262	1.3

than 15 ksi (103 MPa) for electric-butt welds, and not less than 90 % of the minimum strength specified in Table 1 for individual tests for cold-pressure welds and for electric-butt, cold-upset welds.

6. Bending Requirements

6.1 The wire shall be free from brittleness as evidenced by its ability to be coiled or looped around its own diameter either with or without a mandrel. No fracture shall occur. Slight surface checks shall not constitute cause for rejection.

6.2 Unless otherwise agreed upon between the manufacturer and the purchaser at the time of placing an order, the frequency of production sampling and testing to ensure conformance with 6.1 shall be at the manufacturer's option.

7. Resistivity

7.1 Electrical resistivity, determined on samples selected in accordance with Section 5 and tested in accordance with Test Method B 193, shall not exceed 0.032227 $\Omega \cdot mm^2/m$ at 20°C (Explanatory Note 2 and Table 2).

8. Density

8.1 For the purpose of calculating mass, cross sections, etc., the density of 5005 aluminum alloy shall be taken as 2700 kg/m^3(0.098 lb/in^3) at 20°C.

9. Diameter and Permissible Variations

9.1 The diameter of the wire shall be specified in decimal fractions of an inch using four places of decimals or in millimetres using three places of decimals.

9.2 The diameter of the wire shall be determined on one coil or bobbin to represent each lot of ten (or less, if the order consists of less than ten) coils or bobbins of the same specified diameter. The diameter shall not vary from that specified by more than the permissible variations in Table 3.

9.3 If a selected coil or bobbin does not conform to Table 3, all coils or bobbins represented by it shall be gaged, and the coils or bobbins failing to conform shall be rejected.

10. Joints

10.1 Unless otherwise specified at the time of placing the order, wire shall be supplied in one continuous length of reel, coil, or bobbin. Joints may be made in the rod or in the wire prior to final drawing by electric-butt welding, by cold-pressure welding or by electric-butt, cold-upset welding in accordance with good commercial practice. Unless otherwise specified, no joints shall be made during final drawing or in the finished wire.

10.2 If agreed upon between the manufacturer and the purchaser, joints may be made during final drawing or in the finished wire by electric-butt welding, by cold-pressure welding, or by electric-butt, cold-upset welding. Not more than 10 % of the reels, coils, or bobbins shall contain such joints and no joint shall be closer than 50 ft (15 m) to another or to either end of the wire, and not more than two such joints shall be present in any reel, coil, or bobbin of the nominal specified weight.

11. Finish

11.1 The wire shall be free from all imperfections not consistent with good commercial practice.

12. Sampling

12.1 Unless otherwise agreed upon between the manufacturer and the purchaser, samples for test shall be taken from

TABLE 2 Equivalent Resistivity Values at 20°C[A]

Material	Volume Conductivity % IACS	Resistivity Constants, Volume			
		Ω·cmil/ft	$\Omega \cdot mm^2/m$	μΩ·in.	μΩ·cm
Copper	100	10.371	0.017241	0.67879	1.7241
Aluminum	61.0	17.002	0.028265	1.1128	2.8265
	53.5	19.385	0.032227	1.2688	3.2227
	52.5	19.755	0.032841	1.2929	3.2841

[A] The equivalent resistivity values for 100 % IACS conductivity were each computed from the fundamental IEC value (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 and where applicable also by the density ratios, both accurate to at least seven significant figures.

TABLE 3 Wire Diameter Variations

Specified Diameter, in. (mm)	Permissible Variations of Mean Diameter from Specified Diameter, plus and minus[A]
0.2600 to 0.1000 (6.604 to 2.540), incl	1 %
Under 0.1000 to 0.0601 (2.540 to 1.526), incl	0.0010 in. (0.025 mm)

[A] Mean diameter is the average of two diameter measurements taken at right angles to each other at any point along the length.

20 % of the reels, coils, or bobbins to determine conformance with the requirements of Sections 5 and 7.

13. Retests

13.1 If, upon testing a sample from any reel, coil, or bobbin of wire, the results do not conform to the tensile requirements specified in Table 1 for individual tests, two additional samples shall be tested and the average of the three tests shall determine the acceptance or rejection of the reel, coil, or bobbin. If a test specimen contains a joint made either in the wire or rod prior to final drawing, the results shall be discarded and a new specimen shall be tested. If, however, the specimen containing the joint fails to meet the requirements of 5.2 or 5.3 as applicable, further tests of joints shall be made and no further reels, coils, or bobbins containing joints shall be accepted until the tests show that the joining practice has been corrected.

13.2 If on testing a specimen from any reel, coil, or bobbin of wire, the results do not conform to the bending requirements of Section 6, two additional specimens shall be tested and the reel, coil, or bobbin shall be accepted if both specimens conform to the requirements of Section 6.

14. Inspection

14.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

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

14.3 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.

15. Packaging and Shipping

15.1 Package sizes and types shall be agreed upon between the manufacturer and the purchaser in the placing of individual orders.

15.2 The wire shall be protected against damage in ordinary handling and shipping.

16. Marking

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

EXPLANATORY NOTES

NOTE 1—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 2—Relationships that may be useful in connection with the values of electrical resistivity prescribed in Section 7 are shown in Table 3. 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 for 100 % conductivity. The value of 0.017241 $\Omega \cdot mm^2/m$ and the value of 0.15328 $\Omega \cdot g/m^2$ at 20°C are respectively the international equivalent of volume and mass resistivity of annealed copper equal to 100 % conductivity. The latter term means that a copper wire 1 m in length and with a mass of 1 g would have a resistance of 0.15328 Ω. This is equivalent to a resistivity value of 875.20 $\Omega \cdot$ lb/mile^2, which signifies the resistance of a copper wire 1 mile in length with a mass of 1 lb. It is also equivalent, for example, to 1.7241 μΩ per centimetre of length of a copper bar 1 cm^2 in cross section. 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.