



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AMS 4532D

Superseding 4532C

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COPPER-BERYLLIUM ALLOY SHEET AND STRIP
98Cu - 1.9Be (CDA 172)
Half Hard

1. SCOPE:

- 1.1 Form: This specification covers one type of copper-beryllium alloy in the form of sheet and strip.
- 1.2 Application: Primarily for parts requiring high strength with good electrical conductivity or lack of magnetic susceptibility. These products have higher strength and lower ductility than AMS 4530.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2222 - Tolerances, Copper and Copper Alloy Sheet, Strip, and Plate
AMS 2350 - Standards and Test Methods

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B194 - Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B248 - General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM E8 - Tension Testing of Metallic Materials
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E106 - Chemical Analysis of Copper-Beryllium Alloys

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Specifications:

MIL-C-3993 - Copper and Copper-Base Alloy Mill Products, Packaging of

REAFFIRMED

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3. TECHNICAL REQUIREMENTS:

- 3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E106, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

Ø	min	max
Beryllium	1.8	- 2.0
Cobalt	0.20	--
Nickel + Cobalt + Iron	--	0.60
Other Elements, total	--	0.50
Copper	remainder	

- 3.2 Condition: Solution heat treated and cold rolled to half-hard temper.

- 3.3 Properties: The product shall conform to the following requirements:

3.3.1 As Solution Heat Treated and Cold Rolled:

- 3.3.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8; elongation requirements apply only to product 0.004 in. (0.10 mm) and over in nominal thickness:

Ø Tensile Strength	85,000 - 100,000 psi (586 - 690 MPa)
Elongation, in 2 in. (50 mm) or 4D, min	5%

- 3.3.1.2 Hardness: Should be as follows or equivalent, determined in accordance with ASTM E18, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.1.1 are

Nominal Thickness		Hardness
Inches	(Millimetres)	
0.010 to 0.020, incl	(0.25 to 0.51, incl)	88 - 91 HR15T
Over 0.020 to 0.045, incl	(Over 0.51 to 1.14, incl)	74 - 79 HR30T
Over 0.045 to 0.188, incl	(Over 1.14 to 4.78, incl)	88 - 96 HRB

- 3.3.1.2.1 Hardness requirements for product less than 0.010 in. (0.25 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

- 3.3.1.3 Microstructure: Product shall reveal a minimum of beta phase constituent. Any beta phase present shall be fine and well dispersed and shall not be in the form of stringers. Standards for acceptance shall be as agreed upon by purchaser and vendor. Product may be precipitation heat treated as in 3.3.2 before examination.

- 3.3.1.4 Grain Count: Shall be as specified in Table I and 3.3.1.4.1, determined in accordance with ASTM B194. Product may be precipitation heat treated as in 3.3.2 before examination.

TABLE I

Nominal Thickness		Grain Count min
Inches	(Millimetres)	
Over 0.004 to 0.006, incl	(Over 0.10 to 0.15, incl)	6
Over 0.006 to 0.008, incl	(Over 0.15 to 0.20, incl)	7
Over 0.008 to 0.010, incl	(Over 0.20 to 0.25, incl)	8

3.3.1.4.1 Grain count requirements for product less than 0.004 in. (0.10 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.2 After Precipitation Heat Treatment: Product shall have the following properties after being precipitation heat treated by heating to 600° - 625°F (315° - 330°C), holding at heat for 2 hr ± 0.25, and cooling in air;

3.3.2.1 Tensile Properties: Shall be as specified in Table II, determined in accordance with ASTM E8.

Ø	TABLE II			
	Nominal Thickness Inches	Tensile Strength psi		Yield Strength at 0.2% Offset psi, min
		min	max	
	Up to 0.004, excl	185,000	--	160,000
	0.004 to 0.020, incl	185,000	--	160,000
	Over 0.020 to 0.188, incl	185,000	210,000	160,000
				Elongation in 2 in. or 4D %, min
				--
				1
				1

Ø	TABLE II (SI)			
	Nominal Thickness Millimetres	Tensile Strength MPa		Yield Strength at 0.2% Offset MPa, min
		min	max	
	Up to 0.10, excl	1276	--	1103
	0.10 to 0.51, incl	1276	--	1103
	Over 0.51 to 4.76, incl	1276	1448	1103
				Elongation in 50 mm or 4D %, min
				--
				1
				1

3.3.2.2 Hardness: Should be as specified in Table III and 3.3.2.2.1, determined in accordance with ASTM E18.

Ø	TABLE III	
	Nominal Thickness	Hardness min
	Inches (Millimetres)	
	0.010 to 0.020, incl (0.25 to 0.51, incl)	79.5 HR15N
	Over 0.020 to 0.060, incl (Over 0.51 to 1.52, incl)	59 HR30N
	Over 0.060 to 0.188, incl (Over 1.52 to 4.78, incl)	38 HRC

3.3.2.2.1 Hardness requirements for product less than 0.010 in. (0.25 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4 Quality: The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to AMS 2222 as applicable to refractory alloys.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

Ø 4.3 Sampling: Shall be in accordance with ASTM B248 and the following:

- 4.3.1 Specimens for tensile tests of widths 9 in. (229 mm) and over shall be taken with the axis of specimen perpendicular to the direction of rolling; for widths less than 9 in. (229 mm), specimens shall be taken with the axis parallel to the direction of rolling.

4.4 Reports:

- 4.4.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests for chemical composition, tensile properties, hardness, and grain count of each lot, and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, lot number, material specification number and its revision letter, size, and quantity.

- 4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

- 4.5 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

- 5.1 Identification: The product shall be identified as in 5.1.1 unless line marking as in 5.1.2 is specified by purchaser.

- 5.1.1 Each sheet and strip shall be marked near one end, coils being marked near the outside end, with AMS 4532D, lot number, manufacturer's identification, and nominal thickness, using any suitable marking fluid. As an alternate method, individual pieces or bundles shall have attached a durable tag or label marked with the above information or shall be boxed and the box marked with the same information.

- 5.1.2 When specified by purchaser, each sheet and strip shall be marked on one face, in the respective location indicated below, with AMS 4532D, lot number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be removable in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the product or its performance and shall be sufficiently stable to withstand normal handling. The specification number, manufacturer's identification, and nominal thickness shall be continuously line marked; the lot number may be included in the line marking or may be marked at one location on each piece.

- 5.1.2.1 Flat Strip 6 In. (152 mm) and Under in Width: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm).

- 5.1.2.2 Flat Sheet and Flat Strip Over 6 In. (152 mm) in Width: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm), the rows being spaced not more than 6 in. (152 mm) apart and alternately staggered.