

**AEROSPACE
MATERIAL
SPECIFICATION**

Submitted for recognition as an American National Standard

SAE AMS 4602B

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Superseding AMS 4602A

**COPPER BARS, RODS, AND SHAPES
Oxygen-Free, Hard Temper**

UNS C10200

1. SCOPE:

1.1 Form: This specification covers one type of copper in the form of bars, rods, and shapes.

1.2 Application: Primarily for parts requiring high electrical or thermal conductivity.

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

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2221 - Tolerances, Copper and Copper Alloy Bars and Rods

MAM 2221 - Tolerances, Metric, Copper and Copper Alloy Bars and Rods

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 B193 - Resistivity of Electrical Conductor Materials

ASTM B249 - General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, and Shapes

ASTM B577 - Hydrogen Embrittlement of Copper

ASTM E8 - Tension Testing of Metallic Materials

ASTM E53 - Chemical Analysis of Copper (Electrolytic Determination of Copper)

ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

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

2.3.1 Military Specifications:

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

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be oxygen-free copper conforming to the following
 Ø percentages by weight, determined by wet chemical methods in accordance with ASTM E53 or by spectrographic or other analytical methods approved by purchaser:

| | min | max |
|----------------------|-------|--------|
| Copper (incl Silver) | 99.95 | -- |
| Oxygen | -- | 0.0010 |

3.2 Condition: Cold drawn or cold rolled, hard temper.

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

3.3.1 Tensile Properties: Shall be as specified in Table I and 3.3.1.2, determined in accordance with ASTM E8.

TABLE I

| Nominal Diameter or Distance Between Parallel Sides Inches | Tensile Strength psi, min | Elongation in 4D or 4T (See 3.3.1.1) %, min |
|--|------------------------------|---|
| Round, Hexagons, Octagons | | |
| Up to 0.250, incl | 50,000 | -- |
| Over 0.250 to 0.375, incl | 45,000 | 10 |
| Over 0.375 to 1.000, incl | 40,000 | 12 |
| Over 1.000 to 2.000, incl | 35,000 | 15 |
| Over 2.000 to 3.000, incl | 33,000 | 15 |
| Squares, Rectangles | | |
| Over 0.188 to 0.375, incl | 42,000 | 12 |
| Over 0.375 to 0.500, incl | 40,000 | 12 |
| Over 0.500 to 2.000, incl | 33,000 | 15 |
| Over 2.000 to 4.000, incl | 32,000 | 15 |
| Shapes | | |
| All sizes | 32,000 | 15 |

TABLE I (SI)

| Nominal Diameter or Distance Between Parallel Sides Millimetres | Tensile Strength MPa, min | Elongation in 4D or 4T (See 3.3.1.1) %, min |
|---|------------------------------|---|
| Round, Hexagons, Octagons | | |
| Up to 6.25, incl | 345 | -- |
| Over 6.25 to 9.50, incl | 310 | 10 |
| Over 9.50 to 25.00, incl | 275 | 12 |
| Over 25.00 to 50.00, incl | 240 | 15 |
| Over 50.00 to 75.00, incl | 230 | 15 |
| Squares, Rectangles | | |
| Over 4.75 to 9.50, incl | 290 | 12 |
| Over 9.50 to 12.50, incl | 275 | 12 |
| Over 12.50 to 50.00, incl | 230 | 15 |
| Over 50.00 to 100.00, incl | 220 | 15 |
| Shapes | | |
| All sizes | 220 | 15 |

- 3.3.1.1 Elongation shall be measured over a gage length of 4D, where D is the diameter of a machined test specimen or the full diameter of a round rod and over a gage length of 4T where T is the distance between parallel sides of a hexagon, octagon, or square or the thickness of a rectangle when such forms are tested in full section. In no case, shall a gage length less than 1 in. (25 mm) be used.
- 3.3.1.2 Tensile property requirements for rounds, hexagons, and octagons over 3.000 in. (75.00 mm) in nominal diameter or distance between parallel sides and for squares and rectangles over 4.000 in. (100.00 mm) in nominal least distance between parallel sides shall be as agreed upon by purchaser and vendor.
- 3.3.2 Bending: Product shall withstand, without cracking, bending in accordance with ASTM E290 through an angle of 120 deg around a radius equal to the minimum cross-sectional dimension of the specimen and this dimension shall be radial to the bend.
- 3.3.3 Electrical Resistivity: Shall be not greater than $0.15775 \Omega \cdot \text{g}/\text{m}^2$ at 20°C (68°F), determined in accordance with ASTM B193.
- 3.3.4 Embrittlement: The product, after exposure to hydrogen, shall withstand, without cracking, eight bends, determined in accordance with ASTM B577, Procedure D.

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

3.5 Tolerances: Shall conform to AMS 2221 or MAM 2221 as applicable to non-refractory alloys.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests 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 sample and to perform any confirmatory testing deemed 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.

4.3 Sampling: Shall be in accordance with ASTM B249 and the following:

4.3.1 Composition: One sample from each lot.

4.3.2 Tensile Properties: One sample from each lot.

4.3.2.1 The axis of tensile specimens shall be located approximately midway between center and surface of product over 1.500 in. (37.50 mm) in nominal diameter or distance between parallel sides.

4.3.3 Bending: One sample from each lot.

4.3.3.1 Specimens for bending test shall be the full section of the product or shall be rectangular specimens nominally 1 in. (25 mm) wide and 0.5 in. (12 mm) in thickness.

4.3.4 Electrical Resistivity: One sample from each lot.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, tensile properties, bending, and electrical resistivity 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, AMS 4602B, size, and quantity.