



AEROSPACE MATERIAL SPECIFICATION

AMS4602™**REV. E**

Issued 1967-11
Reaffirmed 2017-09
Revised 2022-10

Superseding AMS4602D

Copper Bars, Rods, and Shapes
Oxygen-Free, Hard Temper (H04)
(Composition similar to UNS C10200)

RATIONALE

AMS4602E results from a Five-Year Review and update of this specification with changes to correct temper designation in title, prohibit unauthorized exceptions (3.3.2, 3.6, 4.4.1, 5.1.1, 8.4), update form (1.1), applicable documents (Section 2, 3.1), composition (3.1), terminology for hydrogen embrittlement susceptibility (3.3.5), sampling and testing (4.3.2.1), ordering information (8.5), and allow the use of the immediate prior specification revision (8.3).

1. SCOPE

1.1 Form

This specification covers one type of copper in the form of bars, rods, and shapes. Requirements are provided for bar and rods up to 3.000 inches (mm) in nominal diameter, squares and rectangles with up to 4.000 inches (mm) least distance between parallel sides and shapes of any size (see 8.6).

1.2 Application

These products have been used typically for parts requiring high strength and high electrical or thermal conductivity, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2221 Tolerances, Copper and Copper Alloy Bars and Rods

AS7766 Terms Used in Aerospace Metals Specifications

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<https://www.sae.org/standards/content/AMS4602E/>

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B193	Resistivity of Electrical Conductor Materials
ASTM B249/B249M	General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings
ASTM B577	Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
ASTM B601	Temper Designation for Copper and Copper Alloys - Wrought and Cast
ASTM E8/E8M	Tension Testing of Metallic Materials
ASTM E290	Bend Testing of Material for Ductility
ASTM E478	Chemical Analysis of Copper Alloys

2.3 Definitions

Terms used in AMS are defined in AS7766.

2.3.1 Copper temper designations are defined in ASTM B601.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM E478, or by other analytical methods acceptable to purchaser:

Table 1 - Composition

Element (3.1.1)	Min	Max
Copper including Silver	99.95	--
Oxygen	--	0.0010 (10 ppm)

3.1.1 These composition limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer or supplier and purchaser.

3.2 Condition

Cold drawn or cold rolled, hard (H04) temper (see 2.3.1).

3.3 Properties

The product shall conform to the following requirements:

3.3.1 Tensile Properties

Shall be as specified in Table 2, determined in accordance with ASTM E8/E8M.

Table 2A - Minimum tensile properties, inch/pound units

Nominal Diameter or Least Distance Between Parallel Sides Inches			Tensile Strength ksi	Elongation in 4D or 4T (See 3.3.1.1) %
Rounds, Hexagons, Octagons				
	Up to	0.250, incl	50.0	--
Over	0.250 to	0.375, incl	45.0	10
Over	0.375 to	1.000, incl	40.0	12
Over	1.000 to	2.000, incl	35.0	15
Over	2.000 to	3.000, incl	33.0	15
Squares, Rectangles				
Over	0.188 to	0.375, incl	42.0	12
Over	0.375 to	0.500, incl	40.0	12
Over	0.500 to	2.000, incl	33.0	15
Over	2.000 to	4.000, incl	32.0	15
Shapes				
All sizes			32.0	15

Table 2B - Minimum tensile properties, SI units

Nominal Diameter or Least Distance Between Parallel Sides Millimeters			Tensile Strength MPa	Elongation in 4D or 4T (See 3.3.1.1) %
Rounds, Hexagons, Octagons				
	Up to	6.35, incl	345	--
Over	6.35 to	9.52, incl	310	10
Over	9.52 to	25.40, incl	276	12
Over	25.40 to	50.80, incl	241	15
Over	50.80 to	76.20, incl	228	15
Squares, Rectangles				
Over	4.78 to	9.52, incl	290	12
Over	9.52 to	12.70, incl	276	12
Over	12.70 to	50.80, incl	228	15
Over	50.80 to	101.60, incl	221	15
Shapes				
All sizes			221	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 inch (25.4 mm) be used.

3.3.2 Mechanical property requirements for rod and bar product outside of the range covered by Table 2, as applicable, shall be agreed upon between purchaser and producer and reported per 4.4.1 (see 8.6).

3.3.3 Bending

Product shall withstand, without cracking, bending in accordance with ASTM E290 through an angle of 120 degrees around a radius equal to the minimum cross-sectional dimension of the specimen and this dimension shall be radial to the bend.

3.3.4 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.

3.3.5 Hydrogen Embrittlement Susceptibility

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, free from foreign materials, and from imperfections detrimental to usage of the product.

3.5 Tolerances

Shall conform to AMS2221 as applicable to non-refractory alloys.

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer's tests and shall be responsible for performing all required tests. 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 Acceptance Tests

All technical requirements are acceptance tests and shall be performed on each lot.

4.3 Sampling and Testing

Shall be in accordance with ASTM B249/ASTM B249M 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 Tensile specimens shall be prepared in accordance with ASTM E8/E8M.

4.3.3 Bending

One sample from each lot.

4.3.3.1 Specimens for bend testing shall be the full section of the product or shall be rectangular specimens nominally 1 inch (25.4 mm) wide by 0.5 inch (12.7 mm) thick.