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Superseding AMS4602C	

Copper Bars, Rods, and Shapes  
Oxygen-Free, Hard Temper (HO4)

(Composition similar to UNS C10200)

#### RATIONALE

AMS4602D has been reaffirmed to comply with the SAE five-year review policy.

#### 1. SCOPE:

##### 1.1 Form:

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

##### 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or [www.sae.org](http://www.sae.org).

AMS 2221 Tolerances, Copper and Copper Alloy Bars and Rods

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on this Technical Report, please visit  
<http://www.sae.org/technical/standards/AMS4602D>**

## 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or [www.astm.org](http://www.astm.org).

ASTM B 193	Resistivity of Electrical Conductor Materials
ASTM B 249	General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings
ASTM B 249M	General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings (Metric)
ASTM B 577	Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 53	Standard Test Methods for Determination of Copper in Unalloyed Copper by Gravimetry
ASTM E 290	Semi-Guided Bend Test for Ductility of Metallic Materials

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Material:

Shall be oxygen-free copper conforming to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 53, by spectrochemical methods, 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 8.2).

### 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 E 8 or ASTM E 8M.

TABLE 2A – Minimum Tensile Properties, Inch/Pound Units

Nominal Diameter or Least Distance Between Parallel Sides Inch	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 Bending: Product shall withstand, without cracking, bending in accordance with ASTM E 290 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.
- 3.3.3 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 B 193.
- 3.3.4 Embrittlement: The product, after exposure to hydrogen, shall withstand, without cracking, eight bends, determined in accordance with ASTM B 577, 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 AMS 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. 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 B 249 or ASTM B 249M and the following:

4.3.1 Composition: One sample from each lot.

4.3.2 Tensile Properties: One sample from each lot.