

# AEROSPACE MATERIAL SPECIFICATION

**SAE**

**AMS 4534**

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Submitted for recognition as an American National Standard

COPPER-BERYLLIUM ALLOY, BARS AND RODS  
98Cu - 1.9Be  
Solution Heat Treated, Cold Worked, and  
Precipitation Heat Treated (TH04, formerly HT)

UNS C17200

## 1. SCOPE:

### 1.1 Form:

This specification covers a copper-beryllium alloy in the form of bars and rods.

### 1.2 Application:

This alloy has been used typically for parts requiring a combination of high strength, good wear resistance, and corrosion resistance, and where thermal conductivity, electrical conductivity and low magnetic susceptibility are important, but usage is not limited to such applications.

### 1.3 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

## 2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

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## 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2221 Tolerances, Copper and Copper Alloy Bars and Rods

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

AMS 2750 Pyrometry

## 2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 249 General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes

ASTM B 249M General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes (Metric)

ASTM E 8 Tension Testing of Metallic Materials

ASTM E 8M Tension Testing of Metallic Materials (Metric)

ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E 106 Chemical Analysis of Copper-Beryllium Alloys

ASTM E 112 Determining Average Grain Size

ASTM E 478 Chemical Analysis of Copper Alloys

## 2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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

### 3. TECHNICAL REQUIREMENTS:

#### 3.1 Composition:

(R)

Shall conform to percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 478, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

| Element                                       | min       | max  |
|-----------------------------------------------|-----------|------|
| Beryllium                                     | 1.80      | 2.00 |
| Cobalt + Nickel                               | 0.20      | --   |
| Cobalt + Nickel + Iron                        | --        | 0.6  |
| Aluminum                                      | --        | 0.20 |
| Silicon                                       | --        | 0.20 |
| Copper (3.1.1)                                | remainder |      |
| Copper + sum of all<br>named elements (3.1.2) | 99.5      | --   |

3.1.1 Applicable when copper is not determined by analysis. The reported (certified) value is the difference between the sum of all other specified elements and 100%; and will therefore include unnamed elements. Limits for unnamed elements may be established by agreement between purchaser and manufacturer or supplier.

3.1.2 Applicable only when copper is determined by direct analysis.

#### 3.2 Condition:

Hot reduced or hot or cold reduced, solution heat treated, cold worked, and precipitation heat treated, TH04 Temper; (See 8.2).

#### 3.3 Heat Treatment:

Product shall be heat treated as follows; pyrometry shall be in accordance with AMS 2750:

3.3.1 Solution: Heat within the range 1400° - 1475°F (760° - 802°C), hold at heat for 30 - 60 minutes, and cool as required.

3.3.2 Precipitation: Heat to 600° - 660°F (316° - 349°C), hold at heat for 2 - 3 hours, and cool as required.

## 3.4 Properties:

Product shall conform to the following requirements:

- 3.4.1 Tensile Properties: Shall be in accordance with Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2A - Tensile Properties, Inch-Pound Units

| Nominal Diameter or Least Distance Between Parallel Sides, Inches | Tensile Strength ksi, min | Yield Strength at 0.2% Offset ksi, min | Elongation in 2 Inches %, min |
|-------------------------------------------------------------------|---------------------------|----------------------------------------|-------------------------------|
| Up to 0.375, incl                                                 | 182                       | 157                                    | 3                             |
| Over 0.375 to 1.000, excl                                         | 180                       | 154                                    | 3                             |
| Over 1.000 to 2.000, excl                                         | 177                       | 150                                    | 3                             |
| Over 2.000 to 2.500, excl                                         | 175                       | 147                                    | 3                             |
| Over 2.500 to 3.000, incl                                         | 172                       | 145                                    | 3                             |

TABLE 2B - Tensile Properties, SI Units

| Nominal Diameter or Least Distance Between Parallel Sides, Millimeters | Tensile Strength MPa, min | Yield Strength at 0.2% Offset MPa, min | Elongation in 50.8 mm %, min |
|------------------------------------------------------------------------|---------------------------|----------------------------------------|------------------------------|
| Up to 9.52, incl                                                       | 1255                      | 1082                                   | 3                            |
| Over 9.52 to 25.40, excl                                               | 1241                      | 1062                                   | 3                            |
| Over 25.40 to 50.80, excl                                              | 1220                      | 1034                                   | 3                            |
| Over 50.80 to 63.50, excl                                              | 1207                      | 1014                                   | 3                            |
| Over 63.50 to 76.20, incl                                              | 1186                      | 1000                                   | 3                            |

- 3.4.1.1 Tensile property requirements for product over 3.000 inches (76.20 mm) in nominal diameter or least distance between parallel sides shall be as agreed upon by purchaser and vendor.

- 3.4.2 Hardness: Bars and rods 0.188 to 2.0 inches (4.78 to 50.8 mm), inclusive, in nominal diameter or least distance between parallel sides should have hardness of 37 - 45 HRC, or equivalent, determined in accordance with ASTM E 18, but the product shall not be rejected on the basis of hardness if the tensile properties of 3.4.1 are met. Hardness requirements for bars and rods under 0.188 inch (4.78 mm) in nominal diameter or least distance between parallel sides shall be as agreed upon by purchaser and vendor.

- 3.4.3 Grain Size: The product shall have average grain size not larger than shown in Table 3, determined in accordance with ASTM E 112.

TABLE 3 - Grain Size Requirements

| Nominal Diameter<br>or Distance Between<br>Parallel Sides<br>Inches | Nominal Diameter<br>or Distance Between<br>Parallel Sides<br>Millimeters | Average<br>Grain Size<br>mm, max |
|---------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------|
| Up to 1.000, excl                                                   | Up to 25.40, excl                                                        | 0.050                            |
| 1.000 to 1.500, excl                                                | 25.40 to 38.10, excl                                                     | 0.075                            |
| 1.500 to 2.000, excl                                                | 38.10 to 50.80, excl                                                     | 0.100                            |
| 2.000 to 3.000, excl                                                | 50.80 to 76.20, excl                                                     | 0.125                            |

- 3.4.3.1 Grain size requirements for product 3.000 inches (76.20 mm) and over in nominal diameter or least distance between parallel sides shall be as agreed upon by purchaser and vendor.

- 3.4.4 Microstructure: Shall contain not more than 6% beta phase constituent, determined at 100X magnification. Any beta phase present shall be fine and well dispersed and shall not be in the form of stringers.

### 3.5 Quality:

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.

### 3.6 Tolerances:

Shall conform to AMS 2221 or MAM 2221 as applicable to 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 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.