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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 4640F

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Superseding AMS 4640E

ALUMINUM BRONZE, BARS, RODS, SHAPES, TUBES, AND FORGINGS

81.5Cu - 1 0 . 0 A l - 4.8Ni - 3.0Fe

Drawn and Stress Relieved (HR50) or Temper Annealed (TQ50)

UNS C63000

1. SCOPE:

1.1 Form:

This specification covers an aluminum bronze alloy in the form of bars, rods, shapes, tubes, forgings, and forging stock.

1.2 Application:

These products have been used typically for parts requiring strength and wear resistance at moderate temperatures, but usage is not limited to such applications.

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.

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 2223 Tolerances, Copper and Copper Alloy Seamless Tubing
MAM 2223 Tolerances, Metric, Copper and Copper Alloy Seamless Tubing
AMS 2808 Identification, Forgings

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 154	Mercurous Nitrate Test for Copper and Copper Alloys
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 251	General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B 251M	General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric)
ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 478	Chemical Analysis of Copper Alloys

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services 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:

Shall conform to the 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
Aluminum	9.0	11.0
Nickel	4.0	5.5
Iron	2.0	4.0
Manganese	--	1.5
Zinc	--	0.30
Tin	--	0.20
Silicon	--	0.25
Copper + Silver (3.1.2)	remainder	
Copper + Silver + Sum of Named Elements (3.1.1)	99.5	--

3.1.1 Applicable only when copper is determined by direct analysis.

3.1.2 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 vendor.

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 (R) Bars, Rods, Shapes, and Tubes: Hot rolled or extruded, drawn or otherwise cold finished if necessary, and annealed by heating within the range 1100 to 1300 °F (593 to 704 °C) and cooling in air (HR50 temper - See 8.2).

3.2.2 Forgings: Quenched in room temperature water from 1625 °F ± 25 (885 °C ± 14), annealed by heating within the range 1100 to 1300 °F (593 to 704 °C), and cooling in air (TQ50 temper - See 8.2).

3.2.3 Forging Stock: As ordered by the forging manufacturer.

3.3 Properties:

The product shall conform to the following requirements:

3.3.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E 8 or ASTM E 8M.

3.3.1.1 Rounds, Hexagons, and Octagons: Shall be as shown in Table 2.

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

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength ksi	Yield Strength at 0.5% Extension Under Load ksi	Elongation in 4D %
Up to 1.00, incl	110	68.0	10
Over 1.00 to 2.00, incl	110	60.0	10
Over 2.00 to 3.00, incl	105	55.0	10
Over 3.00 to 5.00, incl	100	50.0	10

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Diameter of Distance Between Parallel Sides Millimeters	Tensile Strength MPa	Yield Strength at 0.5% Extension Under Load MPa	Elongation in 4D %
Up to 25.4, incl	758	469	10
Over 25.4 to 50.8, incl	758	414	10
Over 50.8 to 76.2, incl	724	379	10
Over 76.2 to 127.0, incl	689	345	10

3.3.1.2 Flats, Squares, Shapes, and Tubes: Shall be as shown in Table 3.

TABLE 3A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness or OD Inches	Tensile Strength ksi	Yield Strength at 0.5% Extension Under Load ksi	Elongation in 4D %
Up to 1.00, incl	100	52.0	10
Over 1.00 to 3.00, incl	95.0	50.0	10
Over 3.00	90.0	48.0	10

TABLE 3B - Minimum Tensile Properties, SI Units

Nominal Thickness or OD Millimeters	Tensile Strength MPa	Yield Strength At 0.5% Extension Under Load MPa	Elongation in 4D %
Up to 25.4, incl	689	359	10
Over 25.4 to 76.2, incl	655	345	10
Over 76.2	621	330	10

3.3.2 Hardness: Shall be as follows or equivalent, determined in accordance with ASTM E 10: (R)

3.3.2.1 Rounds, Hexagons, and Octagons: Shall be as shown in Table 4.

TABLE 4 – Hardness

Nominal Diameter or Distance Between Parallel Sides Inches	Nominal Diameter or Distance Between Parallel Sides Millimeters	Hardness
Up to 2.00, incl	Up to 50.8, incl	201 to 248 HB
Over 2.00 to 5.00, incl	Over 50.8 to 127.0, incl	187 to 241 HB

3.3.2.2 Flats, Squares, Shapes, and Tubes: Shall be as shown in Table 5.

TABLE 5 – Hardness

Nominal Thickness or OD Inches	Nominal Thickness or OD Millimeters	Hardness
Up to 3.00, incl	Up to 76.2, incl	187 to 241 HB
Over 3.00	Over 76.2	183 to 241 HB

3.3.2.3 Forgings: Shall have hardness of 201 to 248 HB.

3.3.3 (R) Embrittlement: Specimens as in 4.3.1.2, 4.3.2.2, and 4.3.3.1 shall withstand, without cracking, immersion in mercurous nitrate solution in accordance with ASTM B 154, Procedure A, or other solution and procedure acceptable to purchaser.

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 the following as applicable to refractory alloys:

3.5.1 Bars and Rods: AMS 2221 or MAM 2221.

3.5.2 Tubes: AMS 2223 or MAM 2223.

3.5.3 Shapes: As agreed upon by purchaser and vendor.

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

All technical requirements are acceptance tests and shall be performed on each melt or lot as applicable.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 Bars, Rods, and Shapes: Shall be in accordance with ASTM B 249 or ASTM B 249M and the following:

4.3.1.1 Specimens for tensile testing of bars, rods, and shapes over 1.50 inches (38.1 mm) in nominal diameter or distance between parallel sides shall have their axes located approximately midway between center and surface.

4.3.1.2 Specimens for embrittlement test shall be full cross-section of the product and shall have length of approximately 6 inches (152 mm) or twice the diameter or least distance between parallel sides, whichever is greater.

4.3.2 Tubes: Shall be in accordance with ASTM B 251 or ASTM B 251 M and the following:

4.3.2.1 Specimens for tensile testing of tubes shall be taken with the axis of specimens located at the approximate midwall.

4.3.2.2 Specimens for embrittlement test shall be taken as in 4.3.1.2.

4.3.3 Forgings: Two samples from each lot; a lot shall be all forgings of one part number processed consecutively under the same fixed forging parameters and presented for vendors inspection at one time.

4.3.3.1 Specimens for embrittlement test shall be of any convenient size and shape agreed upon by purchaser and vendor or an entire forging may be used.

4.3.4 Forging Stock: As agreed upon by purchaser and vendor.