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AEROSPACE MATERIAL SPECIFICATION

AMS 4640D
Superseding AMS 4640C

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ALUMINUM BRONZE BARS, RODS, SHAPES, TUBE, AND FORGINGS
81.5Cu - 10.0Al - 4.8Ni - 3.0Fe

UNS C63000

1. SCOPE:

1.1 Form: This specification covers one type of aluminum bronze in the form of bars, rods, shapes, tubes, forgings, and forging stock.

1.2 Application: Primarily for parts requiring strength and wear resistance at moderate temperatures.

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 2223 - Tolerances, Copper and Copper Alloy Seamless Tubing
MAM 2223 - Tolerances, Metric, Copper and Copper Alloy Seamless Tubing
AMS 2350 - Standards and Test Methods
AMS 2808 - Identification, Forgings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B154 - Mercurous Nitrate Test for Copper and Copper Alloys
ASTM B249 - General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, and Shapes
ASTM B251 - General Requirements for Wrought Seamless Copper and Copper Alloy Tubing
ASTM E8 - Tension Testing of Metallic Materials
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E478 - Chemical Analysis of Copper Alloys

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

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Specifications:

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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E478, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	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
Other Elements, total	--	0.50
Copper	remainder	

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Bars, Rods, Shapes, and Tubes: Hot rolled, drawn, extruded, cold finished Ø if necessary, and annealed by heating within the range 1100° - 1300°F (595° - 705°C) and cooling in air.

3.2.2 Forgings: Quenched in room temperature water from 1625°F ± 25 Ø (885°C ± 15), annealed by heating within the range 1100° - 1300°F (595° - 705°C), and cooling in air.

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 specified in Table I and Table II, determined in accordance with ASTM E8.

3.3.1.1 Rounds, Hexagons, and Octagons:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
Up to 1.000, incl	110,000	70,000	10
Over 1.000 to 2.000, incl	110,000	62,000	10
Over 2.000 to 3.000, incl	105,000	55,000	10
Over 3.000 to 5.000, incl	100,000	50,000	10

TABLE I(SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min
Up to 25.00, incl	760	480	10
Over 25.00 to 50.00, incl	760	425	10
Over 50.00 to 75.00, incl	725	380	10
Over 75.00 to 125.00, incl	690	345	10

3.3.1.2 Flats, Squares, Shapes, and Tubes:

TABLE II

Nominal Thickness or OD Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
Up to 1.000, incl	100,000	52,000	10
Over 1.000 to 3.000, incl	95,000	50,000	10
Over 3.000	90,000	48,000	10

TABLE II(SI)

Nominal Thickness or OD Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min
Up to 25.00, incl	690	360	10
Over 25.00 to 75.00, incl	655	345	10
Over 75.00	620	330	10

3.3.2 Hardness:

3.3.2.1 Bars, rods, shapes, and tubes should have hardness as follows, determined in accordance with ASTM E10, or equivalent hardness by other methods, but shall not be rejected on the basis of hardness if the tensile property requirements are met:

3.3.2.1.1 Rounds, Hexagons, and Octagons:

Nominal Diameter or Distance Between Parallel Sides		
Inches	Millimeters	Hardness
Up to 2.000, incl	Up to 50.00, incl	201 - 248 HB
Over 2.000 to 5.000, incl	Over 50.00 to 125.00, incl	187 - 241 HB

3.3.2.1.2 Flats, Squares, Shapes, and Tubes:

Nominal Thickness or OD		
Inches	Millimetres	Hardness
Up to 3.000, incl	Up to 75.00, incl	187 - 241 HB
Over 3.000	Over 75.00	183 - 241 HB

3.3.2.2 Forgings: Shall have hardness of 201 - 248 HB.

3.3.3 Embrittlement: Specimens as in 4.3.1.2 and 4.3.2.1 shall withstand, Ø without cracking, immersion in mercurous nitrate solution in accordance with ASTM B154, Procedure A.

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

3.5 Tolerances: Unless otherwise specified, 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 Ø 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:

4.2.1 Acceptance Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each melt or lot as applicable.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Bars, Rods, and Shapes: ASTM B249 and the following:

4.3.1.1 Specimens for tensile testing of bars, rods, and shapes over 1.500 in. (37.5 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 in. (150 mm) or twice the diameter or least distance between parallel sides, whichever is greater.

4.3.2 Tubes: ASTM B251 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 vendor's 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.

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 of each melt and for tensile properties and hardness 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, AMS 4640D, melt number, size or part number, and quantity. If forgings are supplied, part number and the size and melt source of stock used to make the forgings shall also be included.