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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4640E

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Superseding AMS 4640D

Submitted for recognition as an American National Standard

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

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: 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 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.

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 2808 - Identification, Forgings

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

ASTM B 154 - Mercurous Nitrate Test for Copper and Copper Alloys
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 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 10 - Brinell Hardness of Metallic Materials
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.

2.3.1 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, Ø determined by wet chemical methods in accordance with ASTM E 478, by spectrochemical methods, or by other analytical methods acceptable to 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
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 Bars, Rods, Shapes, and Tubes: Hot rolled, drawn, extruded, cold finished if necessary, and annealed by heating within the range 1100° - 1300°F (593° - 704°C) and cooling in air (030 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° - 1300°F (593° - 704°C), and cooling in air (020 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 specified in Table I and Table II, determined in accordance with ASTM E 8 or ASTM E 8M.

3.3.1.1 Rounds, Hexagons, and Octagons:
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TABLE I

Nominal Diameter of Distance Between Parallel Sides Inches	Tensile Strength ksi, min	Yield Strength at 0.5% Extension Under Load ksi, min	Elongation in 4D %, min
Up to 1.00, incl	110.0	68.0	10
Over 1.00 to 2.00, incl	110.0	60.0	10
Over 2.00 to 3.00, incl	105.0	55.0	10
Over 3.00 to 5.00, incl	100.0	50.0	10

TABLE I(SI)

Nominal Diameter of Distance Between Parallel Sides Millimeters	Tensile Strength MPa, min	Yield Strength at 0.5% Extension Under Load MPa, min	Elongation in 4D %, min
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:
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TABLE II

Nominal Thickness or OD Inches	Tensile Strength ksi, min	Yield Strength at 0.5% Extension Under Load ksi, min	Elongation in 4D %, min
Up to 1.00, incl	100.0	52.0	10
Over 1.00 to 3.00, incl	95.0	50.0	10
Over 3.00	90.0	48.0	10

TABLE II(SI)

Nominal Thickness or OD Millimeters	Tensile Strength MPa, min	Yield Strength at 0.5% Extension Under Load MPa, min	Elongation in 4D %, min
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:

3.3.2.1 Bars, rods, shapes, and tubes should have hardness as follows, determined in accordance with ASTM E 10, 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 2.00, incl	Up to 50.8, incl	201 - 248 HB
Over 2.00 to 5.00, incl	Over 50.8 to 127.0, incl	187 - 241 HB

3.3.2.1.2 Flats, Squares, Shapes, and Tubes:

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

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 Ø 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 melt or lot as applicable.

4.3 Sampling and Testing: Shall be in accordance with the following: Ø

4.3.1 Bars, Rods, and Shapes: 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: ASTM B 251 or ASTM B 251M 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.