AEROSPACE MATERIAL SPECIFICATION

AMS4616™	REV. H

Issued 1956-07
Reaffirmed 2012-02
Revised 2024-02

Superseding AMS4616G

Silicon Bronze Bars, Rods, Forgings, and Tubing
92Cu - 3.2Si - 2.8Zn - 1.5Fe
Stress Relieved
(Composition similar to UNS C65620)

RATIONALE

AMS4616H results from a Five-Year Review and update of this specification with changes to update wording related to unauthorized exceptions (see 3.7, 4.4.3, and 8.4), relocate Definitions (see 2.3), update Applicable Documents (see Section 2), Composition (see 3.1), and Ordering Information (see 8.5).

1. SCOPE

1.1 Form

This specification covers one type of bronze in the form of bars, rods, forgings, tubing, and forging stock (see 8.5).

1.2 Application

These products have been used typically for antifriction bearing cages, 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2221 Tolerances, Copper and Copper Alloy Bars and Rods

AMS2223 Tolerances, Copper and Copper Alloy Seamless Tubing

AMS2808 Identification, Forgings

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS4616H

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B154 Mercurous Nitrate Test for Copper Alloys

ASTM B249/B249M General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings

ASTM B251/B251M General Requirements for Wrought Seamless Copper and Copper-Alloy Tube

ASTM B601 Classification for Temper Designations for Copper and Copper Alloys-Wrought and Cast

ASTM B858 Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys

ASTM E8/E8M Tension Testing of Metallic Materials

ASTM E10 Brinell Hardness of Metallic Materials

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E478 Chemical Analysis of Copper Alloys

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM E478 or by other analytical methods acceptable to the purchaser (see 8.5).

Table 1 - Composition

Element (3.1.1)	Min	Max
Copper (incl. Silver)	90.0	--
Silicon	2.4	4.0
Zinc	1.5	4.0
Iron	1.0	2.0
Manganese	--	1.0
Phosphorus	--	0.10
Sum of Named Elements (3.1.2)	99.5	--

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.

3.1.2 When all named elements in Table 1 are analyzed, the sum shall be 99.5% minimum, but such determination is not required for routine acceptance of each lot.

3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Bars, Rods, and Tubing

Hot rolled, drawn, or extruded, cold finished if necessary, and stress relieved.

3.2.2 Forgings

Stress relieved.

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 Bars, Rods, Forgings, and Tubing

3.3.1.1 Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E8/E8M:

Table 2 - Minimum tensile properties

Property	Value
Tensile Strength	56.0 ksi (386 MPa)
Yield Strength at 0.2% Offset	20.0 ksi (138 MPa)
Elongation in 4D	30%

3.3.1.2 Hardness

Shall be not lower than 90 HB/10/1000, or equivalent, determined in accordance with ASTM E10 on the surface, except on rounds where a flat, as necessary for accuracy, may be made; hardness also shall be not lower than 55 HRB, determined in accordance with ASTM E18, approximately midway between center and surface of the cross section.

3.3.1.3 Grain Size

Shall be as follows, determined in accordance with ASTM E112:

3.3.1.3.1 Bars, Rods, and Tubing

Average grain size shall be not larger than 0.20 mm.

3.3.1.3.2 Forgings

Maximum grain size on the outer half of the radii for antifriction bearing cages shall be 0.50 mm except that not more than 25% of the area may show grains up to 1.00 mm.

3.3.1.4 Embrittlement

Specimens as in 4.3.8.1 and 4.3.8.2 shall withstand, without cracking, immersion in mercurous nitrate solution in accordance with ASTM B154, Procedure A, or the ammonia vapor test in accordance with ASTM B858.

3.3.2 Forging Stock

As agreed upon by the purchaser and producer (see 8.5).

3.4 Quality

The product, as received by the 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 Sizes

Except when exact lengths or multiples of exact lengths are ordered, straight bars, rods, and tubing will be acceptable in mill lengths of 6 to 20 feet (2 to 6 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

3.6 Tolerances

Shall conform to the following:

3.6.1 Bars and Rods

AMS2221 as applicable to refractory alloys.

3.6.2 Tubing

AMS2223 as applicable to refractory alloys.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.3.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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

4.2.1 Acceptance Tests

Composition (see 3.1), tensile properties (see 3.3.1.1), hardness (see 3.3.1.2), and grain size (see 3.3.1.3) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Embrittlement (see 3.3.1.4) is a periodic test and shall be perform at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Shall be in accordance with the following:

4.3.1 Rods and Bars

ASTM B249/B249M.

4.3.2 Tubing

ASTM B251/B251M.

4.3.3 Forgings and Forging Stock

As agreed upon by the purchaser and producer; a lot of forgings shall be not more than 5000 pounds (2268 kg) of forgings of the same part number produced in a continuous series of operations and presented for the producer's inspection at one time (see 8.5).

4.3.4 Composition

One sample from each lot.

4.3.5 Tensile Properties

One sample from each lot.

4.3.5.1 The axis of tensile specimens from bars over 1.500 inches (38.10 mm) in nominal diameter or distance between parallel sides and from forgings over 1.500 inches (38.10 mm) in nominal cross section shall be located approximately midway between center and surface.

4.3.6 Hardness

Each piece.

4.3.7 Grain Size

One sample from each lot.

4.3.8 Embrittlement

As agreed upon by the purchaser and producer (see 8.5).

4.3.8.1 Test specimens from bars, rods, and tubing shall be full cross section of the product and shall have length of either approximately 6 inches (152 mm) or twice the nominal diameter or least distance between parallel sides, whichever is greater.

4.3.8.2 Specimens from forgings may be any convenient size or shape or an entire forging may be used.

4.4 Reports

4.4.1 The producer of bars, rods, forgings, and tubing shall furnish with each shipment a report showing the results of tests for chemical composition of each lot and the results of tests on each lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, lot number, AMS4616H, size, and quantity. If forgings are supplied, the number and the size and melt source of stock used to make the forgings shall also be included.

4.4.2 The producer of forging stock shall furnish with each shipment a report stating that the chemical composition of the stock conforms to the specified requirements. This report shall include the purchase order number, lot number, AMS4616H, size, and quantity.

4.4.3 When material produced to this specification has exceptions taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS4616H(EXC) because of the following exceptions:" and the specific exceptions shall be listed (see 5.1.4).