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AEROSPACE MATERIAL SPECIFICATION

SAE**AMS 4871E**

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Submitted for recognition as an American National Standard

ALUMINUM BRONZE, CENTRIFUGAL AND CHILL CASTINGS 85Cu - 11Al - 3.6Fe Solution Heat Treated and Tempered

UNS C95420

1. SCOPE:

1.1 Form:

This specification covers an aluminum bronze alloy in the form of centrifugal and chill castings.

1.2 Application:

These castings have been used typically for parts requiring high strength 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 2360 Room Temperature Tensile Properties of Castings
AMS 2630 Ultrasonic Inspection
AMS 2635 Radiographic Inspection
AMS 2645 Fluorescent Penetrant Inspection
AMS 2694 Repair Welding of Aerospace Castings
AMS 2750 Pyrometry
AMS 2804 Identification, Castings

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2.2 ASTM Publications:

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

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.

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:**3.1 Composition:**

(R)

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
Copper (3.1.2)	83.5	--
Aluminum	10.3	11.5
Iron	3.0	4.3
Manganese	--	0.50
Nickel plus Cobalt (3.1.2)	--	0.50
Copper plus Sum of Named Elements (3.1.1)	99.5	--

3.1.1 Limits may be established and analysis required for elements not listed in 3.1 when agreed upon by purchaser and vendor.

3.1.2 In determining copper minimum, copper may be calculated as copper plus nickel.

3.2 Condition:

Solution heat treated and tempered, TF50 temper (See 8.2).

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3.3 Casting:

Castings shall be produced in lots from metal conforming to 3.1. Metal remelted from previously analyzed ingot may be poured directly into castings. Molten metal taken from alloying furnaces, with or without additions of foundry operating scrap (gates, sprues, risers, and rejected castings), shall not be poured into castings unless first converted to ingot, analyzed, and remelted or unless the composition of a sample taken after the last addition to the melt conforms to 3.1.

3.3.1 A melt shall be the metal withdrawn from a batch-furnace charge of 2000 pounds (907 kg) or less as melted for pouring castings or, when permitted by purchaser, a melt shall be 4000 pounds (1814 kg) or less of metal withdrawn from one continuous furnace in not more than eight consecutive hours.

3.3.2 A lot shall be all castings poured from a single melt in not more than eight consecutive hours and solution heat treated and tempered in the same heat treatment batch.

3.4 Test Specimens:

(R)

Chemical analysis specimens and tensile coupons shall be cast as follows:

3.4.1 Chemical Analysis Specimens: Shall be cast from each melt and shall be of any convenient size, shape, and form.

3.4.2 Tensile Coupons: Shall be cast from each melt of metal, in permanent molds, used for pouring castings. Coupons shall be of such size to allow machining tensile specimens conforming to ASTM E 8 or ASTM E 8M with 0.500 inch (12.70 mm) diameter at the reduced parallel gage section. Metal for the coupons shall be part of the melt which is used for the castings and shall be poured at a temperature not lower than the temperature of the metal during pouring of the castings.

3.5 Heat Treatment:

(R)

Castings and representative tensile coupons shall be heat treated as in 3.5.1 and 3.5.2; at least one set of tensile coupons shall, during each stage of heat treatment, be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than three hours. Pyrometry shall be in accordance with AMS 2750.

3.5.1 Solution Heat Treatment: Heat to a temperature within the range (R) 1600 to 1700 °F (871 to 927 °C), hold at the selected temperature within ± 25 °F (± 14 °C) for not less than two hours, and quench in water.

3.5.2 Tempering: Heat to a temperature within the range 1100 to 1200 °F (593 to 649 °C), hold at the selected temperature within ± 15 °F (± 8 °C) for not less than two hours, and cool in air to room temperature.

3.6 Properties:

Castings and representative tensile coupons produced in accordance with 3.4.2 shall conform to the following requirements:

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3.6.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E 8 or ASTM E 8M; conformance to the requirements of 3.6.1.1 shall be used as the basis for acceptance of castings except when purchaser specifies that requirements of 3.6.1.2 apply:

3.6.1.1 Separately-Cast Coupons: Shall be as specified in Table 2.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	90.0 ksi (621 MPa)
Yield Strength at 0.2% Offset	45.0 ksi (310 MPa)
Elongation in 4D	5%

3.6.1.2 Specimens Cut From Castings: Specimens as in 4.3.4 shall meet the (R) requirements shown in Table 3 or Table 4 as applicable.

3.6.1.2.1 Castings 1.0 Inch (25 mm) and Under in Nominal Cross-Section:

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	90.0 ksi (621 MPa)
Yield Strength at 0.2% Offset	40.0 ksi (276 MPa)
Elongation in 4D	5%

3.6.1.2.2 Castings Over 1.0 Inch (25 mm) in Nominal Cross-Section:

TABLE 4 - Minimum Tensile Properties

Property	Value
Tensile Strength	72.0 ksi (496 MPa)
Yield Strength at 0.2% Offset	36.0 ksi (248 MPa)
Elongation in 4D	5%

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3.6.1.2.3 When properties other than those specified in 3.6.1.2.1 or 3.6.1.2.2 are required, tensile specimens as in 4.3.4, machined from locations indicated on the drawing from a casting or castings chosen at random to represent each lot, shall have the properties indicated on the drawing for such specimens. Tensile property requirements may be designated in accordance with AMS 2360.

3.6.2 Hardness of Castings: Shall be 200 to 235 HB/10/3000/15, determined in (R) accordance with ASTM E 10:

3.7 Quality:

3.7.1 Castings, 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 castings.

3.7.1.1 Castings shall have smooth surfaces and shall be cleaned sufficiently to (R) permit nondestructive inspection.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of castings in accordance with AMS 2635 until proper foundry technique, which will produce castings free from harmful internal imperfections, is established for each part number and of production castings as necessary to ensure maintenance of satisfactory quality.

3.7.3 When specified, castings shall be subjected to ultrasonic inspection in (R) accordance with AMS 2630 and/or to fluorescent penetrant inspection in accordance with AMS 2645.

3.7.4 Radiographic, ultrasonic, fluorescent penetrant, and other quality (R) standards may be agreed upon by purchaser and vendor.

3.7.5 Castings shall not be reworked by peening, plugging, welding, or other methods without written permission from purchaser.

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings repaired by welding in accordance with AMS 2694.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

(R)

The vendor of castings 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 castings conform to the requirements of this specification.

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4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Except as specified in 4.2.1.1, tests for composition (R) (3.1), tensile properties of separately-cast specimens (3.6.1.1) or, when specified, tensile properties of specimens cut from castings (3.6.1.2), hardness (3.6.2), and quality (3.7) are acceptance tests and shall be performed to represent each melt or lot as applicable.
- 4.2.1.1 Tensile properties of specimens cut from castings shall be determined only when specified by purchaser or when separately-cast specimens are not available. Tensile properties of separately-cast specimens need not be determined when tensile properties of specimens cut from castings are determined.
- 4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the first-article shipment of a casting to a purchaser, when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.
- 4.3 Sampling and Testing:
(R) Shall be in accordance with the following:
- 4.3.1 One chemical analysis specimen in accordance with 3.4.1 from each melt or (R) a casting from each lot.
- 4.3.2 Two separately-cast tensile coupons in accordance with 3.4.2 representing (R) each lot except when properties of specimens cut from castings are required.
- 4.3.3 Sufficient preproduction castings of each part number in accordance with (R) 4.4.1 as required to satisfy dimensional, mechanical property, and quality evaluations:
- 4.3.4 One or more castings from each lot when properties of specimens machined from castings are required. Tensile specimens shall conform to ASTM E 8 or ASTM E 8M and shall be either 0.500 inch (12.70 mm) diameter at the reduced parallel gage section, subsize specimens proportional to the standard, or standard sheet-type specimens. For determining conformance to the requirements of 3.6.1.2, if specimen locations are not shown on the drawing, not less than two tensile specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings from each lot.
- 4.3.5 One or more castings from each lot for hardness evaluation.
(R)

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4.4 Approval:

4.4.1 Sample castings from new or reworked patterns or molds and the casting procedure shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.2 Vendor shall establish, for production of sample castings of each part number, parameters for the process control factors which will produce acceptable castings; these shall constitute the approved casting procedure and shall be used for producing production castings. If necessary to make any change in parameters for the process control factors, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, test specimens, sample castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.

4.4.2.1 Control factors for producing castings include, but are not limited to, the following:

- Type of furnace
- Furnace atmosphere
- Mold set-up, parting agent, and rotational speed for centrifugal castings
- Fluxing or deoxidation procedure
- Metal pouring temperature; variation of ± 50 °F (± 28 °C) is permissible
- Solidification and cooling procedures
- Solution and tempering heat treatment cycles
- Cleaning operations
- Methods of inspection

4.4.2.1.1 Any of the above process control factors for which parameters are considered proprietary by the vendor may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Reports: (R)

The vendor of castings shall furnish with each shipment a report showing the results of tests for chemical composition of at least one casting or of separately-cast specimens from each melt, the results of tests for tensile properties of separately-cast coupons representing each lot or of specimens cut from castings from each lot, and stating that the castings conform to the other technical requirements. This report shall include the purchase order number, melt and lot number, AMS 4871E, part number, and quantity.

4.6 Resampling and Retesting: (R)

If any specimen used in the above tests fails to meet the specified requirements, disposition of the castings may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the castings represented. Results of all tests shall be reported.