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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4881A

Issued 7-1-76
Revised 10-1-87

Superseding AMS 4881

NICKEL-ALUMINUM-BRONZE CASTINGS, MARTENSITIC
Sand and Centrifugal
78Cu - 11Al - 5.1Ni - 4.8Fe
Solution Heat Treated and Tempered

UNS C95520

1. SCOPE:

1.1 Form: This specification covers one type of nickel-aluminum bronze in the form of sand or centrifugal castings.

1.2 Application: Primarily for parts requiring a combination of high strength and hardness with some ductility and toughness.

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 2350 - Standards and Test Methods
AMS 2360 - Room Temperature Tensile Properties of Castings
AMS 2630 - Ultrasonic Inspection
AMS 2635 - Radiographic Inspection
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2646 - Contrast Dye Penetrant Inspection
AMS 2694 - Repair Welding of Aerospace Castings
AMS 2804 - Identification, Castings

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

ASTM B208 - Preparing Tension Test Specimens for Copper-Base Alloys for Sand Castings
ASTM E8 - Tension Testing of Metallic Materials
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E478 - Chemical Analysis of Copper-Base 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 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing 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 E478 or by spectrochemical or other analytical methods approved by purchaser:

	min	max
Copper	74.5	--
Aluminum	10.5	11.5
Nickel	4.2	6.0
Iron	4.0	5.5
Manganese	--	1.5
Zinc	--	0.30
Tin	--	0.25
Cobalt	--	0.20
Silicon	--	0.15
Chromium	--	0.05
Lead	--	0.03
Copper plus Sum of Named Elements	99.8	--

3.1.1 If composition is determined by instrumental methods such as Ø spectrochemical, x-ray, or atomic absorption, copper may be reported as remainder.

3.2 Condition: Solution heat treated and tempered.

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 lb (900 kg) or less as melted for pouring castings or, when permitted by purchaser, a melt shall be 4000 lb (1800 kg) or less of metal withdrawn from one continuous furnace in not more than eight consecutive hours.

3.3.2 Ø 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: Chemical analysis specimens and tensile specimens shall be cast as follows and, when requested, shall be supplied with the castings:

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

3.4.2 Tensile Coupons: Shall be cast with each lot of castings and as follows:

3.4.2.1 Ø Sand Cast: Coupons from which specimens are produced shall be standard keel blocks in accordance with ASTM B208 cast in molds made with the regular foundry mix of sand, without using chills, or in baked core sand molds. 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. If the metal for castings is given any treatment such as fluxing or cooling and reheating, the metal for the coupons shall be a portion of the metal so treated, and during such treatment shall be heated to the same maximum temperature and held for approximately the same length of time as the molten metal for the castings. Coupons shall be heat treated with the castings in accordance with 3.5 and machined to standard tensile specimens conforming to ASTM E8 with 0.500 in. (12.50 mm) diameter at the reduced parallel gage section.

3.4.2.2 Ø Centrifugally Cast: Coupons from which specimens are produced shall be cylindrical bars of such size to allow machining specimens conforming to ASTM E8 with 0.500 in. (12.50 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. If the metal for castings is given any treatment in the furnace as described in 3.4.2.1, the metal for the coupons shall be given the same treatment.

3.5 Heat Treatment: All castings and representative coupons for tensile specimens shall be solution heat treated by heating to a temperature within the range 1600° - 1700°F (870° - 925°C), holding at the selected temperature within ±25°F (±15°C) for not less than 2 hr, and quenching in water and tempered by heating to a temperature within the range 925° - 1000°F (495° - 540°C), holding at the selected temperature within ±15°F (±10°C) for not less than 2 hr, and cooling in air to room temperature.

3.6 Properties: Castings and representative tensile coupons produced in accordance with 3.4.2 and heat treated as in 3.5 shall conform to the following requirements:

3.6.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8; conformance to the requirements of 3.6.1.1 shall be used as the basis for acceptance of castings except when purchaser specifies that the requirements of 3.6.1.2 apply:

3.6.1.1 Separately-Cast Specimens:

3.6.1.1.1 Sand Cast:

Tensile Strength, min	125,000 psi (860 MPa)
Yield Strength at 0.2% Offset, min	95,000 psi (655 MPa)
Elongation in 4D, min	2%

3.6.1.1.2 Centrifugally Cast:

Tensile Strength, min	130,000 psi (895 MPa)
Yield Strength at 0.2% Offset, min	95,000 psi (655 MPa)
Elongation in 4D, min	3%

3.6.1.2 Specimens Cut from Any Area of a Castings: Shall meet the following requirements:

3.6.1.2.1 Castings 1.00 In. (25 mm) and Under in Nominal Section Thickness:

3.6.1.2.1.1 Sand Castings: Shall meet the requirements of 3.6.1.1.1.

3.6.1.2.1.2 Centrifugal Castings: Shall meet the requirements of 3.6.1.1.2.

3.6.1.2.2 Castings Over 1.00 In. (25 mm) in Nominal Section Thickness:

3.6.1.2.2.1 Sand Castings:

Tensile Strength, min	120,000 psi (825 MPa)
Yield Strength at 0.2% Offset, min	85,000 psi (585 MPa)
Elongation in 4D, min	1.5%

3.6.1.2.2.2 Centrifugal Castings:

Tensile Strength, min	125,000 psi (860 MPa)
Yield Strength at 0.2% Offset, min	90,000 psi (620 MPa)
Elongation in 4D, min	2%

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

3.6.2 Ø Hardness: Should be not lower than the following, determined in accordance with ASTM E18, but castings shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.6.2.1 Sand Castings: 25 HRC, or equivalent.

3.6.2.2 Centrifugal Castings: 28 HRC, or equivalent.

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 well cleaned.

3.7.2 Ø 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 accordance with AMS 2630, to fluorescent penetrant inspection in accordance with AMS 2645, to contrast dye penetrant inspection in accordance with AMS 2646, or to any combination thereof.

3.7.4 Radiographic, ultrasonic, fluorescent penetrant, contrast dye penetrant, and other quality standards shall be as agreed upon by purchaser and vendor.

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

3.7.5.1 Ø 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: The vendor of castings 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 4.5. 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.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Except as specified in 4.2.1.1, tests to determine Ø conformance to requirements for composition (3.1), tensile properties of separately-cast specimens (3.6.1.1) or, when specified, tensile properties of specimens machined from castings (3.6.1.2), hardness (3.6.2), and quality (3.7) are classified as 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 Ø only when specified by purchaser or when separately-cast specimens are not available. Tensile properties of separately-cast specimens need not be determined when properties of specimens cut from castings are determined.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical Ø requirements of this specification are classified as 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, processing, or both 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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 At least one chemical analysis specimen in accordance with 3.4.1 from each Ø melt or a casting from each lot.

4.3.2 Three separately-cast tensile specimens in accordance with 3.4.2 from each Ø lot except when purchaser requires properties of specimens cut from castings.

4.3.3 Two preproduction castings in accordance with 4.4.1 of each part number.

4.3.4 Ø One or more castings from each lot when properties of specimens machined from castings are required. Size, location, and number of specimens machined from castings shall be as specified on the drawing or as agreed upon by purchaser and vendor. When size, location, and number of specimens are not specified, not less than four tensile specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each lot.

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 process control factors which will produce acceptable castings; this shall constitute the approved casting procedure and shall be used for producing production castings. If necessary to make any change in parameters for 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 Ø Control factors for producing castings include, but are not limited to, the following:

Type of furnace
Furnace atmosphere
Fluxing or deoxidation procedure
Gating and risering practices (sand castings), mold set-up, parting agent, and rotational speed (centrifugal castings)
Metal pouring temperature; variation of ±50°F (±30°C) from the established limit is permissible
Solidification and cooling procedures
Cleaning operations
Solution heat treatment and tempering cycles
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:

4.5.1 Ø 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 specimens as in 3.4.1 cast from each melt represented and the results of tests on each lot to determine conformance to the other technical requirements of this specification. When properties of specimens cut from castings are determined, the report shall include the results of tests to determine conformance to such requirements. This report shall include the purchase order number, melt number, AMS 4881A, part number, and quantity.