

Nickel-Aluminum-Bronze, Martensitic, Sand, Centrifugal and Continuous Castings
78Cu - 11Al - 5.1Ni - 4.8Fe
Quench Hardened and Temper Annealed
(Composition similar to UNS C95520)

RATIONALE

AMS4881D revises form to permit use of continuous castings, clarifies when use of tensile specimens machined from casting is required (3.4.2, 3.4.2.3, 3.6.1.2.3, 4.2.1, 4.2.1.1), revises hardness (3.6.2.2), and updates wording for permissible welding of castings (3.7.5.1).

1. SCOPE

1.1 Form

This specification covers a nickel-aluminum bronze alloy in the form of sand, centrifugal or continuous castings.

1.2 Application

These castings have been used typically for parts requiring a combination of high strength and hardness with some ductility and toughness, 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.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2360	Room Temperature Tensile Properties of Castings
AMS2630	Inspection, Ultrasonic, Product Over 0.5 Inch (12.7 mm) Thick
AMS2694	In-Process Welding of Castings
AMS2750	Pyrometry
AMS2804	Identification, Castings

2.2 ASTM Publications

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 B 208	Preparing Tension Test Specimens for Copper Alloy Sand, Permanent Mold, Centrifugal, and Continuous Castings
ASTM E 8/E 8M	Tension Testing of Metallic Materials
ASTM E 18	Rockwell Hardness of Metallic Materials
ASTM E 478	Chemical Analysis of Copper Alloys
ASTM E 1417	Liquid Penetrant Testing
ASTM E 1742	Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

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 (3.1.1)	min	max
Copper (3.1.2)	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
Sum of Named Elements (3.1.3)	99.8	--

- 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 Copper may be reported as "remainder" or as the difference between the sum of results for all elements and 100%, or as the result of direct analysis.
- 3.1.3 When all named elements in Table 1 are analyzed, the sum shall be 99.8 percent minimum, but such determination is not required for routine acceptance of each lot.

3.2 Condition

Quench hardened and temper annealed (TQ50) (See 8.2).

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 quench hardened and temper annealed in the same heat treatment batch.

3.4 Test Specimens

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 sand cast or centrifugal cast castings and as follows:

3.4.2.1 Sand Cast

Coupons from which specimens are produced shall be standard keel blocks in accordance with ASTM B 208 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 E 8/E 8M with 0.500 inch (12.70 mm) diameter at the reduced parallel gage section.

3.4.2.2 Centrifugally Cast

Coupons from which specimens are produced shall be cylindrical bars of such size to allow machining specimens conforming to ASTM E 8/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. 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.

3.4.2.3 For continuous castings, the coupons shall be taken longitudinally from the cast product.

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 to 1700 °F (871 to 927 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for not less than 2 hours, and quenching in water and tempered by heating to a temperature within the range 925 to 1000 °F (496 to 538 °C), holding at the selected temperature within ± 15 °F (± 8 °C) for not less than 2 hours, and cooling in air to room temperature. Pyrometry shall be in accordance with AMS2750.

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 E 8/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 Specimens

3.6.1.1.1 Sand Cast

Shall conform to Table 2.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value	
Tensile Strength	125 ksi	(862 MPa)
Yield Strength at 0.2% Offset	95.0 ksi	(655 MPa)
Elongation in 4D	2%	

3.6.1.1.2 Centrifugally Cast

Shall conform to Table 3.

TABLE 3 - MINIMUM TENSILE PROPERTIES

Property	Value	
Tensile Strength	130 ksi	(896 MPa)
Yield Strength at 0.2% Offset	95.0 ksi	(655 MPa)
Elongation in 4D	3%	

3.6.1.2 Specimens Cut From Any Area of a Casting

3.6.1.2.1 Castings 1.00 Inch (25.4 mm) and Under in Nominal Section Thickness

3.6.1.2.1.1 Sand Cast

Shall meet the requirements of Table 2.

3.6.1.2.1.2 Centrifugal Cast

Shall meet the requirements of Table 3.

3.6.1.2.2 Castings Over 1.00 Inch (25.4 mm) in Nominal Section Thickness

3.6.1.2.2.1 Sand Cast

Shall conform to Table 4.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value	
Tensile Strength	120 ksi	(827 MPa)
Yield Strength at 0.2% Offset	85.0 ksi	(586 MPa)
Elongation in 4D	1.5%	

3.6.1.2.2.2 Centrifugal Cast

Shall conform to Table 5.

3.6.1.2.3 Continuous Cast 2.00 inch (50.8 mm) and Under in Nominal Section Thickness

Shall conform to Table 5.

TABLE 5 - MINIMUM LONGITUDINAL TENSILE PROPERTIES

Property	Value	
Tensile Strength	125 ksi	(860 MPa)
Yield Strength at 0.2% Offset	90.0 ksi	(621 MPa)
Elongation in 4D	2%	

3.6.1.2.4 When properties other than those of 3.6.1.2.1, 3.6.1.2.2, or 3.6.1.2.3 are required, tensile specimens as in 4.3.4 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 AMS2360.

3.6.2 Hardness

Shall be not lower than the following, determined in accordance with ASTM E 18.

3.6.2.1 Sand Castings

25 HRC, or equivalent.

3.6.2.2 Centrifugal and Continuous Castings

28 HRC, or equivalent.

3.7 Quality

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 Castings shall have smooth surfaces and shall be sufficiently cleaned to permit fluorescent penetrant inspection.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of castings in accordance with ASTM E 1742 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 AMS2630, to fluorescent penetrant inspection in accordance with ASTM E 1417, or to both.

3.7.4 Radiographic, ultrasonic, fluorescent penetrant, and other quality acceptance 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, welding in accordance with AMS2694 may be performed.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of castings shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Except as specified in 4.2.1.1, composition (3.1), tensile properties of separately-cast specimens (3.6.1.1, for sand and centrifugal castings) and for continuous castings, or when otherwise specified for sand and centrifugal castings, tensile properties of specimens machined 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 For sand and centrifugal castings, 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 properties of specimens cut from castings are determined.

4.2.2 Preproduction Tests

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.

4.3 Sampling and Testing

Shall be in accordance with the following:

4.3.1 One chemical analysis specimen in accordance with 3.4.1 from each melt or a casting from each lot.

4.3.2 Two separately-cast tensile specimens in accordance with 3.4.2 from each lot except when properties of specimens cut from castings are required (See 3.6.1.2, 4.2.1).

4.3.3 Sufficient castings of each part number in accordance with 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. 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 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 testing.