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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4860E

Issued DEC 1939
Revised APR 2001
Reaffirmed APR 2006

Superseding AMS 4860D

Manganese Bronze, Sand and Centrifugal Castings
58Cu - 39Zn - 1.2Fe - 1.0Al - 0.80Mn
As Cast

(Composition similar to UNS C86500)

1. SCOPE:

1.1 Form:

This specification covers a manganese bronze alloy in the form of sand and centrifugal castings.

1.2 Application:

These castings have been used typically for parts requiring strength, toughness, and corrosion resistance, 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2694 Welding Repair of Aerospace Castings
AMS 2804 Identification, Castings

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 208	Preparing Tension Test Specimens for Copper-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings
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
ASTM E 1417	Liquid Penetrant Examination
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 (3.1.4)	55.0	60.0
Zinc (3.1.2)	36.0	42.0
Iron	0.40	2.0
Aluminum	0.50	1.5
Manganese	0.10	1.5
Tin	--	1.0
Nickel (plus Cobalt)	--	1.0
Lead	--	0.40
Sum of Named Elements (3.1.3)	99.0	--

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 Zinc 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 the elements in Table 1 are analyzed, the sum shall be 99.0% minimum, but such determination is not required for routine acceptance of each lot.

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

3.2 Condition:

As cast. MO_1 (as sand cast) or MO_2 (as centrifugally cast) (See 8.2).

3.3 Casting:

Castings shall be produced in lots from metal conforming to 3.1.

3.3.1 A lot shall be all castings produced from one furnace melt or crucible melt. When two or more furnace melts or crucible melts or combination thereof are used to charge a ladle for pouring, the castings therefrom shall constitute a lot. A lot shall be not more than 1000 pounds (454 kg) of castings.

3.4 Test Specimens:

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

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 in accordance with 3.4.2.1 and 3.4.2.2. Metal for the coupons shall be part of the melt which is used for 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 time as the molten metal for the castings. The temperature of the metal during pouring of the coupons shall be not lower than that during pouring of the castings.

3.4.2.1 Sand Cast: Coupons from which specimens are machined shall be standard keel blocks conforming to ASTM B 208 cast in molds made with the regular foundry mix of sand without using chills or baked sand core molds. Coupons shall be machined to standard 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.

3.4.2.2 Centrifugally Cast: Coupons from which specimens are machined shall be cylindrical bars of such size to allow machining of standard 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.

3.5 Properties:

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

3.5.1 Tensile Properties: Separately-cast specimens or specimens as in 4.3.4 cut from any area of a casting shall meet the requirements shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	65.0 ksi (448 MPa)
Yield Strength at 0.2% Offset	25.0 ksi (172 MPa)
Elongation in 4D	20%

3.5.1.1 Tensile properties of separately-cast specimens shall be used for acceptance of castings except when purchaser specifies that tensile properties of specimens cut from any area of a castings apply.

3.6 Quality:

3.6.1 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.

3.6.1.1 Castings shall have smooth surfaces and shall be cleaned sufficiently to permit nondestructive testing.

3.6.2 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.

3.6.3 When specified, castings shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417.

3.6.4 Radiographic, fluorescent penetrant, and other quality acceptance standards may be agreed upon by purchaser and vendor.

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

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

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 the 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 (3.5.1), and quality (3.6) 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 coupons are not available. Tensile properties of separately-cast coupons need not be determined when tensile 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.

4.3.3 Sufficient castings of each part number in accordance with 4.4.1 as required to satisfy dimensional, mechanical property, and quality evaluation.

4.3.4 One or more castings from each lot when properties of specimens machined from castings are required. Specimens shall conform to ASTM E 8 or ASTM E 8M and shall be either 0.500 inch (12.70 mm) in 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 3.5.1, 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.

4.4 Approval:

4.4.1 Sample castings from new or reworked master 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
Fluxing or deoxidation procedure
Gating and risering practices
Metal pouring temperature; variation of ±50 °F (±28 °C) is permissible
Mold set-up, parting agent, and rotational speed for centrifugal castings
Solidification and cooling procedures
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:

4.5.1 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 and 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, lot number, AMS 4860E, part number, and quantity.

4.6 Resampling and Retesting:

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. 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.