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Standard Specification for General Requirements for Copper Alloy Castings¹

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This standard has been approved for use by agencies of the Department of Defense.

¹ This specification is under the jurisdiction of ASTM Committee ~~B-5~~ B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.05 on Castings and Ingots for Remelting.

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1. Scope *

1.1 This specification establishes a ~~group of~~ general requirements common to ASTM copper alloy casting specifications B 22, B 61, B 62, B 66, B 67, B 148, B 176, B 271, B 369, B 427, B 505, B 584, B 763, B 770, and B 806. These requirements apply to the casting specifications to the extent referenced therein.

1.1.1 In the event of conflict between this specification and a casting specification, the requirements of the casting specification shall take precedence.

1.2 The chemical composition and other requirements not included in this specification shall be prescribed in the casting product specifications.

1.3 ~~Units—~~The values stated in inch-pound units are the standard. ~~SI~~ The values given in parentheses are mathematical conversions to SI units, which are provided for information only and not considered standard.

1.4 No precise quantitative relationship can be stated between the properties of the metal in various locations of the same casting or between the properties of castings and those of a test bar casting from the same metal. (See Appendix X1.)²

2. Referenced Documents

2.1 The following documents, of the issue in effect on date of casting purchase, form, part of this specification to the extent referenced herein:

2.2 ASTM Standards:

B 22 Specification for Bronze Castings for Bridges and Turntables³

B 61 Specification for Steam or Valve Bronze Castings⁴

B 62 Specification for Composition Bronze or Ounce Metal Castings⁴

B 66 Specification for Bronze Castings for Steam Locomotive Wearing Parts³

B 67 Specification for Car and Tender Journal Bearings, Lined⁴

B 148 Specification for Aluminum-Bronze Sand Castings³

B 176 Specification for Copper-Alloy Die Castings³

B 194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar³

B 208 Practice for Preparing Tension Test Specimens for Copper-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings³

B 271 Specification for Copper-Base Alloy Centrifugal Castings³

B 369 Specification for Copper-Nickel Alloy Castings³

B 427 Specification for Gear Bronze Alloy Castings⁴

B 505 Specification for ~~Copper-Base~~ Copper Alloy Continuous Castings³

B 584 Specification for Copper Alloy Sand Castings for General Applications³

B 763 Specification for Copper Alloy Sand Castings for Valve Application³

B 770 Specification for Copper-Beryllium Alloy Sand Castings for General Applications³

B 806 Specification for Copper Alloy Permanent Mold Castings for General Applications⁴

B 846 Terminology for Copper and Copper Alloys³

² For ASME Boiler and Pressure Vessel Code application see related specification in Section II of that code.

³ Annual Book of ASTM Standards, Vol 02.01.

⁴ Discontinued. See 2001 Annual Book of ASTM Standards, Vol 03 ϵ 2.01.

*A Summary of Changes section appears at the end of this standard.

E 8 Test Methods for Tension Testing of Metallic Materials

~~E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵~~

~~E 44 Definitions of Terms Relating to Practice for Using Significant Digits in Test Data to Heat Treatment of Metals Determine Conformance with Specifications⁶~~

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes⁷

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Method)⁸

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys⁹

~~E 478 Test Methods 255 Practice for Chemical Analysis of Sampling Copper and Copper Alloys for the Determination of Chemical Composition⁸~~

E 5478† Test Methods for Chemical Analysis of Copper Alloys⁸

E 581 Test Methods for Chemical Analysis of Manganese-Copper Alloys⁸

3. Terminology

3.1 Definitions:

3.1.1 *casting, n*—a general term for a metal object produced at or near finished shape by pouring or otherwise introducing molten metal into a mold and allowing it to solidify.

3.1.2 *casting, centrifugal, n*—a casting produced in a cylindrical mold rotating on its axis with the major axis

3.1 For definitions of the product coinciding with the axis of rotation. The axis of rotation may be horizontal, vertical, or any angle in between.

3.1.3 *casting, centrifuged, n*—a casting produced in a mold, a number of which may be mounted around a central sprue. The molds are rotated, in a vertical position, about a central axis concentric with the central sprue.

3.1.4 *casting, continuous, n*—a casting produced by the continuous pouring and solidification of molten metal through a water-cooled mold that determines the cross-sectional shape. The length of the product is not restricted by mold dimensions.

3.1.5 *casting, die, n*—a casting produced in a reusable metal mold (die) characterized by a high degree of fidelity terms related to the mold cavity with the molten metal being introduced under high pressure.

3.1.6 *casting, lost wax, n*—a casting produced in a sacrificial mold made of various layers copper and grades of refractory powders and washes having been invested about a wax pattern. The casting is characterized by a high degree of fidelity copper alloys, refer to the original pattern.

3.1.7 *casting, plaster mold, n*—a casting produced in a sacrificial mold made of various grades of fine plaster-like material and having a high degree of fidelity to the original pattern.

3.1.8 *casting, permanent mold, n*—a product produced in a reusable mold constructed of a durable material, usually iron or steel, with the molten metal being introduced by gravity, low pressure, or vacuum.

3.1.9 *casting, sand, n*—a casting produced in a sacrificial sand mold. The sand may be bonded by various mechanical or chemical means.

3.1.10 *casting, semicentrifugal, n*—a casting produced in a manner similar to the centrifugal casting except that a central core is used to allow the formation of other than a cylindrical inside surface. The axis of rotation is always vertical. Terminology B 846.

4. Materials and Manufacture

4.1 Manufacture:

4.1.1 ~~Mechanical—Mechanical~~ properties of Copper Alloy UNS Nos. C94700, C95300, C95400, C95410, C95500, C95520, and C96800 can be changed by heat treatment. Suggested heat treatments are given in the casting specifications containing these alloys.

4.1.2 Definitions of terms relating to heat treating are given in Definitions E 44.

5. Chemical Composition

5.1 The casting material shall conform to the chemical requirements of the casting ~~specification.~~

~~5.2 These product specification involved.~~

5.2 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 and the purchaser.

6. Mechanical Property Requirements

6.1 When tension testing is required by the casting product specification, the results shall conform to the requirements of that specification, when tested in accordance with Test Methods E 8.

⁵ Annual Book of ASTM Standards, Vol T4.02, 03.01.

⁶ Annual Book of ASTM Standards, Vol 0 14.02.

⁷ Discontinued. See 2001 Annual Book of ASTM Standards, Vol 03.05.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁸ Annual Book of ASTM Standards, Vol 03.06.

⁹ Annual Book of ASTM Standards, Vol 03.05.

7. Other Requirements

7.1 *Hydrostatic Test*—When specified in the purchase order, ~~castings a hydrostatic test shall be hydrostatically tested.~~ performed on the castings. The details of the test and acceptance criteria shall be ~~agreed upon~~ established by agreement between the manufacturer and the purchaser.

7.2 *Soundness*—When specified in the purchase order, castings shall meet soundness ~~standards~~ requirements furnished or referenced by the purchaser. In the absence of standards for soundness, the requirement shall be as agreed upon between the manufacturer and the purchaser.

8. Dimensions, Mass, and Permissible Variations

8.1 The manufacturer shall be responsible for conforming to the dimensional-accuracy requirements of the castings as related to the drawing when the pattern equipment is produced by the manufacturer.

8.2 When the pattern equipment is provided by the purchaser, the manufacturer shall be responsible for conforming to the dimensional-accuracy requirements of the casting ~~as-req.~~, but with any mutually agreed to exceptions relating to the provided pattern equipment.

8.3 Where thick and thin sections of the casting adjoin, the manufacturer shall be permitted to add fillets of adequate size, where not previously provided, subject to approval of the purchaser.

9. Workmanship, Finish, and Appearance

9.1 The surface of the casting shall be free of adhering sand, cracks, and hot tears. Other surface discontinuities shall meet visual acceptance standards agreed upon between the manufacturer and the purchaser.

10. Sampling

10.1 Lot:

~~10.1.1 A~~ lot shall consist of: (1) all of the metal poured from a single furnace or crucible melt, or (2) all the metal poured from two or more furnaces into a single ladle, or (3) all of the metal poured from a continuous melting furnace between charges, or (4) all of the metal poured from an individual melting furnace or group of melting furnaces having a uniform melting stock, operating during the course of one-half shift, not to exceed 5 h.

10.2 Chemical Analysis:

10.2.1 The sample for chemical analysis shall be ~~obtained during~~ taken in accordance with Practice E 255 for product in the pouring final form from the pieces selected in 10.1 and combined into one composite sample. The minimum weight of the composite sample shall be 150 g.

10.2.2 Instead of sampling as directed in 10.2.1, the manufacturer shall have the option of sampling at the time castings are poured or from the semifinished product. When samples are taken during the course of manufacture, sampling of the finished product by the manufacturer is not required. The number of samples taken for the determination of composition shall be as follows:

10.2.2.1 When samples are taken at the time the castings are poured, at least one sample shall be representative taken for each group of castings poured from the same source of molten metal.

10.2.3 Tension-test bars used in meeting the requirements of 6.1 may be either separately cast or removed from the casting. When tension-test bars are separately cast, they shall be poured from the same lot as the castings represented to the form and dimensions specified in the casting specification and Practice B 208.

10.2.3.1 When the requirements of 6.1 have been complied with using separately cast test bars, additional tests may be performed using test bars removed from the casting with test bar location and mechanical properties agreed upon between the manufacturer and the purchaser.

11. Number of Tests and Retests

11.1 Tests:

11.1.1 A chemical analysis of each element with a specified limiting value shall be made on each lot. Chemical analysis for residual elements is not required unless specified in the purchase order.

11.1.2 One tension test shall be performed on each lot.

11.1.3 Should the percent elongation of any tensile-test specimen be less than that specified and any part of the fracture is outside the middle two-thirds of the gage length or in a punched or scribed mark within the reduced section, the specimen may be discarded and replaced by another from the same lot.

11.1.4 If the result of any test fails to conform to the specified requirements, two retests shall be performed. If either retest fails to meet the specified requirements, the lot shall be rejected.

11.2 Retests:

11.2.1 When requested by the manufacturer, a retest shall be permitted when test results obtained by the purchaser fail to conform to the casting specification requirements.

11.2.2 Retesting shall be as prescribed in the casting specification for the initial test, ~~except for~~ the number of test specimens ~~which~~ shall be twice that normally required for the test. Test results for all specimens shall comply with the casting specification requirements. Failure to comply shall be cause for rejection.

11.2.3 Chemical Analysis—If one or more of the elements with specified limits fail to meet the compositional requirement of the product specification when determined from the sample prepared in accordance with Practice E 255, one retest cycle shall be permitted with a second composite sample prepared in accordance with Practice E 255.

12. Specimen Preparation

12.1 The specimen for chemical analysis shall be taken from the lot in such a manner as to avoid contamination and be representative of the molten metal. Sample preparation shall be in accordance with Practice E 255. Analytical specimen preparation shall be the responsibility of the reporting laboratory.

12.2 Tension test specimens shall be prepared in accordance with Practice B 208.

~~12.2.1 Should~~

~~12.2.1 If any specimen~~ is machined improperly or ~~should if~~ are flaws ~~be~~ are revealed by machining or during testing, the specimen ~~may~~ shall be discarded and replaced by another from the same lot.

13. Test Methods

13.1 *Chemical Composition:*

13.1.1 The chemical analysis methods used for the routine determination of specification compliance and preparation of test reports shall be at the discretion of the laboratory performing the analysis.

13.1.2 In case of disagreement on chemical composition, referee analytical methods for copper alloys other than copper-beryllium alloys (Specification B 770) are given in Table 1. Referee analytical methods for copper-beryllium alloys are given in the Annex of Specification B 194.

13.1.3 The determination of magnesium, niobium, zirconium, and titanium, for which no recognized test method is known to be published, shall be subject to agreement between the manufacturer and the purchaser.

13.1.4 Analytical methods for elements ~~whose~~ with ranges ~~are~~ beyond those given in Table 1 shall be subject to agreement between the manufacturer and the purchaser.

13.1.5 Analytical methods for the determination of elements required by the purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

13.2 *Mechanical Properties:*

13.2.1 Tension testing shall be performed in accordance with Test Methods E 8.

TABLE 1 Referee Chemical Analytical Methods

Element	Range or % max	Test Methods
Aluminum (Al)	0.005–13.5	E 478
Antimony (Sb)	0.05–0.70	E 62
Arsenic (As)	0.0–0.50	E 62
Carbon (C)	0.0–0.50	E 76
Copper (Cu)	50.0–99.75	E 478
Iron (Fe)	0.003–1.25	E 478
	0.0–5.0	E 54
Lead (Pb)	0.002–15.0	E 478; Atomic
	2.0–30.0	Absorption
		E 478; Titrimetric
<u>Lead (Pb)</u>	<u>0.002–15.0</u>	<u>E 478;</u>
	<u>2.0–30.0</u>	<u>Atomic Absorption</u>
		<u>E 478; Titrimetric</u>
Manganese (Mn)	0.10–12.0	E 62
	12.0–23.0	E 581
Nickel (Ni)	0.0–5.0	E 478; Photometric
<u>(incl Cobalt (Co))</u>		
(incl Cobalt (Co))		
Phosphorus (P)	0.01–1.0	E 62
Silicon (Si)	0.005–5.50	E 54;
		Perchloric Acid
		Dehydration
Sulfur (S)	0.05–0.08	E 76: Direct
		Combustion
Tin (Sn)	0.01–1.0	E 478; Photometric
	0.50–20.0	E 478; Titrimetric
Zinc (Zn)	0.02–2.0	E 478; Atomic
	2.0–40.0	Absorption
		E 478; Titrimetric
<u>Zinc (Zn)</u>	<u>0.02–2.0</u>	<u>E 478; Atomic</u>
	<u>2.0–40.0</u>	<u>Absorption</u>
		<u>E 478; Titrimetric</u>

14. Significance of Numerical Limits

14.1 For the purposes of determining compliance with the specified limits for ~~chemical composition and mechanical properties~~, requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated in accordance with the ~~Rounding-Off~~ rounding method of Practice E 29.

Property	Rounded Limit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand significance digit used in expressing the limiting value
<u>Chemical Composition</u>	<u>nearest unit in the last right-hand significance digit used in expressing the limiting value</u>
Hardness	
<u>Electrical Resistivity</u>	<u>nearest unit in the last right-hand significance digit used in expressing the limiting value</u>
<u>Electrical Conductivity</u>	
Tensile strength	
Yield strength	
<u>Yield Strength</u>	<u>Strength</u>
Elongation	
<u>Elongation</u>	<u>nearest 1 %</u>
Grain Size:	
<u>Grain Size:</u>	<u>nearest ksi (5 MPa)</u>
Elongation 5 % and over	
<u>Under 0.060 mm</u>	<u>nearest 1 % multiple of 0.005 mm</u>
<u>0.060 mm and over</u>	<u>nearest multiple of 0.005 mm</u> <u>nearest 0.01 mm</u>

15. Inspection

15.1 The manufacturer shall inspect and make tests necessary to verify that the product furnished conforms to the specified requirements.

15.2 The purchaser may have a representative inspect or witness the inspection and testing of the material prior to shipment. Such an arrangement shall be made by the purchaser and the manufacturer as part of the purchase order. When such inspection or witness of inspection and testing is agreed upon, the manufacturer shall afford the purchaser's representative all reasonable facilities necessary to confirm that the product meets the requirements of the purchase order. The purchaser's inspection and tests shall be conducted in such a manner that they will not interfere unnecessarily with the manufacturer's operation.

16. Rejection and Rehearing

16.1 Rejection:

16.1.1 Castings that fail to comply with the requirements of the casting product specification, when tested by the purchaser, may be rejected.

16.1.2 Rejection shall be reported to the manufacturer promptly and in writing.

16.1.3 In case of disagreement or dissatisfaction with the results of the test upon which rejection was based, the manufacturer or supplier may make claim for a rehearing.

16.2 Rehearing:

16.2.1 As a result of casting rejection, the manufacturer or supplier may make claim for retesting to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected castings shall be taken in accordance with the casting specification and Practice E 255 and tested by both parties in accordance with the casting specification, or alternatively, upon agreement between the manufacturer or supplier and the purchaser, an independent laboratory may be selected to perform the test prescribed in the casting specification. The number of specimens to be retested shall be as given in 11.2.

17. Certification

17.1 When specified in the purchase order, a manufacturer's certificate of compliance shall be furnished to the purchaser stating that samples representing each lot have been tested and inspected in accordance with the material specification and that the requirements have been met.

18. Test Report

18.1 When specified in the purchase order, the manufacturer or supplier shall furnish to the purchaser a manufacturer's test report showing the results of the required tests, including chemical analysis.

19. Product Marking

19.1 Castings shall be marked as shown on the drawing or as prescribed in the purchase order.

19.2 When specified in the purchase order, the castings shall be marked with the manufacturer's name or identifying mark and pattern number or mark at a location on the casting where it will not be removed in machining to finished dimensions.

19.3 The marking of lot identification numbers shall be agreed upon between the manufacturer and the purchaser.

19.4 Castings containing bismuth or bismuth-selenium additives shall be marked with the identification BI or B depending on available space. This marking shall be at a location on the casting so as not to ~~injure~~ affect the usefulness of the casting and where it will not be removed during machining while concurrently enabling scrap castings to be segregated and prevented from entering the unregulated scrap metal stream.

20. Packaging and Package Marking

20.1 The material shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ~~ensure~~ acceptance by common carrier for ~~transportation and to afford protection from the normal hazards of transportation.~~

20.2 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, gross and net weight, and name of supplier. The specification number shall be shown, when specified in the purchase order.

21. Keywords

21.1 copper alloy castings; copper-base alloy castings; UNS No. C94700; UNS No. C95300; UNS No. C95400; UNS No. C95410; UNS No. C95500; UNS No. C95520; UNS No. C96800

SUPPLEMENTARY REQUIREMENTS

Supplementary requirements S1 to S4 shall apply only when specified by the purchaser in the inquiry, contract, or order, for agencies of the U.S. ~~G~~ government.

S1. Referenced Documents

S1.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

S1.1.1 ASTM Standard:

B 900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies³

S1.1.2 Federal Standards:¹⁰

Fed. Std. No. 102 Preservation, Packaging, and Packaging Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. No. 185 Identification Marking of Copper and Copper-Base Alloy Mill Products

~~S1.1.2 Military Standard:~~⁸

~~MIL-STD-129 Marking for Shipment and Storage~~

S1.1.3 Military Specification: Standard:

MIL-C-3993 Packaging of Copper¹⁰

MIL-STD-129 Marking for Shipment and Copper-Base Alloy Mill Products Storage

S1.1.4 Military Specification:¹⁰

S2. Quality Assurance

S2.1 Responsibility for Inspection:

S2.1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections or tests set forth when such inspections and tests are deemed necessary to ensure that the material conforms to prescribed requirements.

S3. Identification Marking

S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification and the alloy number shall be used.

S4. Preparation for Delivery

S4.1 Preservation, Packaging, Packing:

S4.1.1 Military Agencies—The material shall be separated by size, composition, grade, or class and shall be preserved and packaged, ~~±~~ Level A or C, packed ~~±~~ Level A, B or C₂ as specified in the contract or purchase order, in accordance with the requirements of ~~MIL-C-3993. Practice B 900.~~

S4.1.2 Civil Agencies—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

¹⁰ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

S4.2 *Marking:*

S4.2.1 *Military Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with MIL-STD-129.

S4.2.2 *Civil Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with Fed. Std. No. 123.

APPENDIXES

(Nonmandatory Information)

X1. MECHANICAL PROPERTIES OF COPPER ALLOY CASTINGS

X1.1 The mechanical properties of copper alloy castings are influenced by the cooling rate during and after solidification, by chemical composition, by heat treatment, by the design and nature of the mold, by the location and effectiveness of gates and risers, and by certain other factors.

X1.2 The cooling rate in the mold and, therefore, the properties developed in any particular casting section are influenced by the presence of cores, chills, and chaplets; changes in section thickness; and the existence of bosses, projections, and intersections, such as junctions of ribs and bosses. Because of the interactions of these factors, no precise quantitative relationship can be stated between the properties of the metal in various locations of the same casting or between the properties of a casting and those of a separately cast test bar.

X2. METRIC EQUIVALENTS

X2.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which, when applied to a body having a mass of one kilogram, gives it an acceleration of one metre per second squared ($N = \text{kg}\cdot\text{m}/\text{s}^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2 .

SUMMARY OF CHANGES

This section identifies

Committee B05 has identified the principle location of selected changes to this specification standard since the last issue.

1. Paragraph 19.4 issue (B 824 – 96) that may impact the use of this standard.

(1) A comprehensive five-year review was conducted. Most sections were updated to conform with current form and style guidelines (Committee B05's *Outline of Form for Specifications (OFS)* and *Form and Style for ASTM Standards (Blue Book)*).

(2) The use of Practice E 255 was instituted (see Sections 2, 10, 12, and 16).

(3) Definitions of terms were removed and placed in Terminology B 846, with reference made.

(4) Appendix X2, Metric Equivalents, was added.

(5) Under Supplementary Requirements, Practice B 900 was added, and MIL-STD-C3993, which is discontinued, was removed.

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