Designation: B176 – 17

Standard Specification for Copper-Alloy Die Castings[1]

This standard is issued under the fixed designation B176; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope*

1.1 This specification establishes the requirements for copper-alloy die castings. The alloys specified are Copper Alloy UNS Nos. C85470, C85700, C85800, C86500, C87800, C99700, and C99750.[2]

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B824 Specification for General Requirements for Copper Alloy Castings

B846 Terminology for Copper and Copper Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E23 Test Methods for Notched Bar Impact Testing of Metallic Materials

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ADCI/NADCA Standards:*[4]

"E" Series Product Standards

2.3 *Federal Standard:*[5]

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

2.4 *Military Standards:*[5]

MIL-STD-129 Marking for Shipment and Storage (Military Agencies)

MIL-P-116 Methods of Preservation

3. General Requirements

3.1 The following sections of Specification B824 constitute a part of this specification.

3.1.1 Terminology (Section 3),

3.1.2 Number of Tests and Retests (Section 11) (Note to users: Paragraph 10.3 of Specification B824 applies only when mechanical requirements are specified in the purchase order.),

3.1.3 Test Methods (Section 13),

3.1.4 Significance of Numerical Limits (Section 14),

3.1.5 Inspection (Section 15),

3.1.6 Rejection and Rehearing (Section 16),

3.1.7 Certification (Section 17),

3.1.8 Test Report (Section 18),

3.1.9 Product Marking (Section 19), and

3.1.10 Supplementary Requirements.

3.2 In addition, when a section with a title identical to that referenced in 3.1, above, appears in this specification, it contains additional requirements which supplement those appearing in Specification B824.

4. Terminology

4.1 For general terms related to copper and copper alloys, refer to Terminology B846.

[1] This specification is under the jurisdiction of ASTM Committee 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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[2] The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix can be used to accommodate composition variations of the base alloy.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from North American Die Casting Association (NADCA), 3250 Arlington Heights Rd., Suite 101, Arlington Heights, IL 60004, http://www.diecasting.org..

[5] Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, http://quicksearch.dla.mil/

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

5. Ordering Information

5.1 Include the following information when placing orders for die castings under this specification as applicable:

5.1.1 Specification title, number, and year of issue,

5.1.2 Part name and number,

5.1.3 Copper Alloy UNS Number,

5.1.4 Quantity and delivery schedule, as required,

5.1.5 Engineering drawing of die casting, when required, giving all necessary dimensions and tolerances and showing latest revisions and allowances for machining, if any. Location of ejector pin marks or parting lines shall be at the option of the manufacturer unless specifically designated on the drawing.

5.1.6 When die castings are purchased for agencies of the U.S. Government the Supplementary Requirements of Specification B824 may be specified.

5.2 The following requirements are optional and should be specified in the purchase order when required.

5.2.1 Inspection lot sampling (Section 9),

5.2.2 Soundness requirements (10.1),

5.2.3 Mechanical requirements (Section 7),

5.2.4 Special requirements (Section 10),

5.2.5 Certification (Specification B824),

5.2.6 Foundry test report (Specification B824),

5.2.7 Witness inspection (Specification B824),

5.2.8 Product marking (Specification B824), and

5.2.9 Packaging requirements (Section 12).

6. Chemical Composition

6.1 The castings shall conform to the requirements for major elements as shown in Table 1.

6.2 These specification composition limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements agreed upon between the manufacturer or supplier and the purchaser. Copper or zinc may be given as remainder and may be taken as the difference between the sum of all elements analyzed and 100 %. When all named elements in Table 1 are analyzed, their sum shall be as specified in Table 2.

6.3 It is recognized that residual elements may be present in cast copper-base alloys. Analysis shall be made for residual elements only when specified in the purchase order.

TABLE 2 Sum of All Named Elements Analyzed

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C85470	99.5
C85700	98.7
C85800	98.7
C86500	99.0
C87800	99.5
C99700	99.7
C99750	99.7

6.4 If the producer's or supplier's method of composition control is acceptable, sampling for chemical analysis may be waived at the discretion of the purchaser.

7. Mechanical Property Requirements

7.1 Unless specified in the purchase order, acceptance of die castings under this specification shall not depend on mechanical properties determined by tension or impact tests. Table X1.1 shows typical mechanical properties.

7.2 When minimum mechanical properties are specified in the purchase order the mechanical properties shall be agreed upon between the manufacturer or supplier and the purchaser.

8. Dimensions, Mass, and Permissible Variations

8.1 Permissible variations in dimensions shall be within the limits specified on the drawings or in the contract or purchase order.

8.1.1 Any dimensions for which a tolerance is not specified shall be in accord with ADCI Product Standard Series E1 to E16 inclusive.

9. Sampling

9.1 An inspection lot shall consist of the production from each die or compound die on each machine for each 24 h during the first week of normal operation and the production for each 48 h thereafter of normal operation. Any significant change in the machine, composition, die or continuity of operation shall be considered as the start of a new lot. Die castings inspected by this method shall be so marked or handled during the finishing operations as not to lose their identity.

TABLE 1 Chemical Requirements

Copper Alloy UNS No.	Composition, % max (unless shown as a range or min)											
	Copper	Tin	Lead	Zinc	Iron	Nickel including Cobalt	Aluminum	Manganese	Antimony	Sulfur	Phosphorus	Silicon
C85470	60.0–65.0	1.0–4.0	0.09	Rem	0.20	...	0.10–1.0	...	...	...	0.02–0.25	...
C85700	58.0–64.0[A]	0.50–1.5	0.8–1.5	32.0–40.0	0.7	1.0	0.8	...	...	...	...	0.05
C85800	57.0 min[A]	1.5	1.5	31.0–41.0	0.50	0.50	0.55	0.25	0.05	0.05	0.01	0.25[B]
C86500	55.0–60.0[A]	1.0	0.40	36.0–42.0	0.40–2.0	1.0	0.50–1.5	0.10–1.5	...	...	...	...
C87800	80.0 min[A]	0.25	0.09	12.0–16.0	0.15	0.20	0.15	0.15	0.05	0.05	0.01	3.8–4.2[B,C]
C99700	54.0 min[A]	1.0	2.0	19.0–25.0	1.0	4.0–6.0	0.50–3.0	11.0–15.0	...	...	...	...
C99750	55.0–61.0	...	0.50–2.5	17.0–23.0	1.0[D]	5.0	0.25–3.0	17.0–23.0	...	...	...	...

[A] In determining copper min, copper may be determined as copper plus nickel.
[B] Arsenic 0.05 max.
[C] Magnesium 0.01 max.
[D] Iron content above the nickel content may cause hard spots resulting in decreased machinability.

9.2 Each die casting of a randomly selected sample shall be examined to determine conformance to the requirements with respect to general quality, dimensions and identification marking. The producer or supplier may use a system of statistical quality control for such examinations.

9.3 *Sampling for Chemical Analysis*—Refer to the Sampling section of Specification B824 and Practice E255 for sampling methodology.

10. Special Requirements

10.1 *Internal Soundness*—When specified, the soundness of die castings shall conform to standards or requirements agreed upon between the producer or supplier and the purchaser. The number and extent of imperfections shall not exceed those specified by the purchaser. The standards or requirements may consist of radiographs, photographs or sectioned die castings.

10.2 Imperfections inherent in the die castings shall not be cause for rejection provided it is demonstrated that the die castings are in accordance with the requirements and standards agreed upon.

10.3 *Workmanship*—Die castings shall be of uniform quality, free of injurious discontinuities that will adversely affect their serviceability.

10.4 *Finish*—When specified in the contract or purchase order the as-cast surface finish required shall conform to standards agreed upon between the purchaser and the producer or supplier, or as prescribed in ADCI Product Standard.

10.5 *Pressure Tightness*—When specified in the contract or purchase order the pressure tightness of die castings shall conform to standards agreed upon between the purchaser and the producer or supplier, or as prescribed in ADCI Product Standard.

11. Test Methods

11.1 Analytical chemical methods are given in Specification B824 (Section 13).

11.2 When tension or impact tests are made, the tension test specimen shown in Fig. 18, Standard Tension Test Specimens for Die Castings, of Test Methods E8/E8M and the impact test specimen shown in Fig. 6, Charpy (Simple-Beam) Impact Test Specimens, Types A, B, and C, of Test Methods E23, shall be used.

11.3 The Rockwell B hardness reading shall be made in accordance with Test Methods E18.

12. Packaging and Package Marking

12.1 *Packaging*—Unless otherwise specified, the die castings shall be packaged to provide adequate protection during normal handling and transportation. Each package shall contain only one type of item unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producer's discretion, provided they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

12.2 *Marking*—Each shipping container shall be legibly marked with the purchase order number, gross and net weights, and the supplier's name or trademark. Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for Military agencies.

12.3 *Preservation*—Material intended for prolonged storage in unheated locations shall be adequately packed and protected to avoid deterioration and damage. When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of MIL-P-116. The applicable levels shall be as specified in the contract or order.

13. Keywords

13.1 copper-alloy castings; die castings; UNS No. C85470; UNS No. C85700; UNS No. C85800; UNS No. C86500; UNS No. C87800; UNS No. C99700; UNS No. C99750

APPENDIXES

(Nonmandatory Information)

X1. TYPICAL MECHANICAL PROPERTIES

TABLE X1.1 Typical Mechanical Properties of Test Specimens[A]

Copper Alloy UNS No.	Tensile Strength, ksi (MPa)	Yield Strength psi (0.2% Offset), ksi (MPa)	Elongation in 2 in., (50 mm) %	Impact Strength Charpy, ft·lbf (J)	Hardness, Rockwell B	Modulus of Elasticity ($\times 10^3$) ksi (GPa)
C85470	50 (345) min	21[B] (150)[B] min	15 min	...	...	...
C85800	55 (379)	30 (207)	15	40 (54)	55 to 60	15 000 (103)
C87800	85 (586)	50 (345)	25	70 (95)	85 to 90	20 000 (138)

[A] ksi = 1000 psi. For explanation of SI unit MPa, see X3.1.
[B] 0.5 % Extension under load.

X1.1 The data in Table X1.1 do not constitute a part of this specification. They will indicate to the purchaser the mechanical properties that may be expected of test specimens when made in a die, the test specimens being cast in a test bar die and conforming to the chemical composition specified. It should be thoroughly understood that the following figures represent

die-cast test specimens and not specimens cut from commercial die-cast parts. In the tension testing of die-cast brass specimens, the rate of stressing up to the yield strength shall not exceed 100 ksi (700 MPa)/min. Exceedingly slow rates of testing may result in creep and hence are to be avoided. Beyond the yield strength, the rate of straining shall not exceed 0.25 in./in.·min measured on the gage length of the specimen.

X2. CHARACTERISTICS

TABLE X2.1 Die Casting and Other Characteristics

NOTE 1—*Rating System*—the various alloys are rated 1 to 5 according to the positive to negative qualities in the listed categories. A rating of 1 gives the best performance, 5 the poorest performance. No one alloy is best in all categories. A rating of 5 in any one or more categories does not rule an alloy out of commercial usefulness if its other attributes are especially favorable. However, ratings of 5 may present manufacturing difficulties.

Copper Alloy UNS No.	Die Casting Characteristics						Other Characteristics				
	Approximate Melting Point	Resistance to Hot Cracking	Pressure Tightness	Die Filling Capacity	Anti-Solder to Die	[A]	Corrosion Resistant	Machining	Polishing	Electroplating	High Temperature Strength
C85800	1600–1650	2	3	3	2	4	3	1	3	1	3
C87800	1510–1680	2	2	2	1	1	1	5	4	2	1

[A] Surface smoothness-as cast.

X2.1 Table X2.1 shows certain casting and other outstanding characteristics which are usually considered when selecting a die casting alloy for a specific application.

X3. METRIC EQUIVALENTS

X3.1 The SI unit for strength properties (MPa) 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 ($N = kg \cdot m/s^2$). 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 ksi = 6 894 757 Pa the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B176–14) that my impact the use of this standard. (Approved April 1, 2017.)

(1) Added UNS Alloy No. C85470 to 1.1.
(2) Revised Section 3 to correct errors in referencing the appropriate section number of Specification B824.
(3) Revised 5.2 to correct errors in referencing the appropriate section of Specification B176.
(4) Removed 5.2.2.