



Standard Specification for Aluminum-Bronze Sand Castings¹

This standard is issued under the fixed designation B148; 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 requirements for sand castings produced from copper-base alloys having the alloy numbers,² commercial designations, and nominal compositions shown in [Table 1](#).

1.2 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.

2. Referenced Documents

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

2.2 *ASTM Standards:*³

[B208 Practice for Preparing Tension Test Specimens for Copper Alloy Sand, Permanent Mold, Centrifugal, and Continuous Castings](#)

[B824 Specification for General Requirements for Copper Alloy Castings](#)

[B846 Terminology for Copper and Copper Alloys](#)

[B950 Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E10 Test Method for Brinell Hardness of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E527 Practice for Numbering Metals and Alloys in the](#)

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.

Unified Numbering System (UNS)

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology [B846](#).

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of Specification [B824](#).

5. Ordering Information

5.1 Include the following specified choices when placing orders for product under this specification as applicable:

5.1.1 ASTM designation and year of issue,

5.1.2 Copper or Copper Alloy UNS. No. designation,

5.1.3 Temper, must include optional Heat Treatment when needed,

5.1.4 Dimensions, diameter, and wall thickness (For tube or pipe: specify either O.D./I.D., O.D./Wall, or I.D./Wall unless standard size such as type K are ordered; for flat products: thickness, width, and edges; for rod, bar, or shapes: by diameter or distance between parallel surfaces),

5.1.5 Quantity of castings required,

5.1.6 Intended applications,

5.1.7 Specification title, number, and year of issue,

5.1.8 Pattern or drawing number and condition (cast, machined, and so forth),

5.1.9 Analysis of residual elements, if specified in the purchase order (Specification [B824](#)),

5.1.10 Pressure test requirements, if specified in the purchase order (Specification [B824](#)),

5.1.11 Soundness requirements, if specified in the purchase order (Specification [B824](#)),

5.1.12 Certification, if specified in the purchase order (Specification [B824](#)),

5.1.13 Test report, if specified in the purchase order (Specification [B824](#)),

5.1.14 Witness inspection, if specified in the purchase order (Specification [B824](#)),

5.1.15 Approval of weld procedure and records of repairs, if specified in the purchase order (Section [10](#)),

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

TABLE 1 Nominal Compositions

Copper Alloy UNS No.	Old Designation	Commercial Designation	Nominal Composition, %						
			Copper	Nickel	Iron	Aluminum	Silicon	Manganese	
C95200	9A	Grade A	88.0	...	3.0	9.0	...	...
C95300 ^A	9B	Grade B	89.0	...	1.0	10.0	...	...
C95400 ^A	9C	Grade C	85.0	...	4.0	11.0	...	...
C95410 ^A	...	...	84.0	2.0	4.0	10.0	...	...
C95500 ^A	9D	Grade D	81.0	4.0	4.0	11.0	...	...
C95520 ^A	...	...	78.5	5.5	5.0	11.0	...	...
C95600	9E	Grade E	91.0	...	...	7.0	2.0	...
C95700	9F	Grade F	75.0	2.0	3.0	8.0	...	12.0	
C95800	...	...	81.3	4.5	4.0	9.0	...	1.2
C95820	...	...	79.0	5.2	4.5	9.5	...	1.0
C95900	...	...	87.5	...	4.5	13.0	...	...

^A These grades respond to heat treatment.

5.1.16 ASME Boiler and Pressure Vessel Code⁴ application (12.2 and Section 14),

5.1.17 Castings for seawater service (6.2.3), and

5.1.18 Product marking, if specified in the purchase order (Specification B824).

5.2 When material is purchased for agencies of the U.S. Government, the Supplementary Requirements of this specification may be specified.

6. Materials and Manufacture

6.1 Materials:

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

6.1.1 The material of manufacture shall be sand castings of Copper Alloys, UNS No. C95200, C95300, C95400, C95410, C95500, C95520, C95600, C95700, C95800, C95820, C95900 of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.1.2 When specified in the contract or purchase order, that heat identification or traceability is required, the purchaser shall specify the details desired.

6.2 Manufacture:

6.2.1 As a specified option, Copper Alloy UNS Nos. C95300, C95400, C95410, C95500, and C95520 may be supplied in the heat-treated condition to obtain the higher mechanical properties shown in Table 2. Suggested heat treatments for these alloys are given in Table 3. Actual practice may vary by manufacturer.

TABLE 2 Mechanical Requirements

Classification	Aluminum Bronze			Nickel Aluminum Bronze		Silicon Aluminum Bronze	Manganese- Nickel Aluminum Bronze	Nickel Aluminum Bronze	Aluminum Bronze
	As-Cast			As-Cast					
Copper Alloy UNS No.	C95200	C95300	C95400 and C95410	C95500	C95820	C95600	C95700	C95800 ^A	C95900 ^B
Tensile strength, min, ksi ^C (MPa ^D)	65 (450)	65 (450)	75 (515)	90 (620)	94 (650)	60 (415)	90 (620)	85 (585)	...
Yield strength, ^E min, ksi ^C (MPa ^D)	25 (170)	25 (170)	30 (205)	40 (275)	39 ^F (270) ^F	28 (195)	40 (275)	35 (240)	...
Elongation in 2 in. (50.8 mm), %	20	20	12	6	13	10	20	15	...
Brinell hardness No. ^G (3000-kg load)	110	110	150	190	...	...	...	...	...
Heat-Treated									
Copper Alloy UNS No.	C95300	C95400 and C95410	C95500	C95520 ^H					
Tensile strength, min, ksi ^C (MPa ^D)	...	80 (550)	90 (620)	110 (760)	125 (862)	...	...	...	...
Yield strength, ^E min, ksi ^C (MPa ^D)	...	40 (275)	45 (310)	60 (415)	95 ^F (655) ^F	...	...	...	...
Elongation in 2 in. (50.8 mm), %	...	12	6	5	2	...	...	...	...
Brinell hardness No. ^G (3000-kg load)	...	160	190	200	255 ^I	...	...	...	241 min

^A As cast or temper annealed.

^B Normally supplied annealed between 1100 and 1300°F for 4 h followed by air cooling.

^C ksi = 1000 psi.

^D See Appendix X1.

^E Yield strength shall be determined as the stress producing an elongation under load of 0.5 %, that is, 0.01 in. (0.254 mm) in a gage length of 2 in. (50.8 mm).

^F Yield strength at 0.2 % offset, min, ksi^C (MPa^D).

^G For information only.

^H Copper Alloy UNS No. C95520 is used in the heat-treated condition only.

^I Sand castings and sand cast test specimens shall be 25 HRC minimum.

TABLE 3 Suggested Heat Treatments

Copper Alloy UNS No.	Solution Treatment (Not Less than 1 h/in. Followed by Water Quench)	Annealing Treatment (Not Less than 2 h Followed by Air Cool)
C95300	1585-1635°F (860-890°C)	1150-1225°F (620-660°C)
C95400 C95410	1600-1675°F (870-910°C)	1150-1225°F (620-660°C)
C95500 C95520	(2 h followed by water quench) 1600-1700°F (870-925°C)	925-1000°F (495-540°C)
C95800 ^A		1250 ± 50°F (675 ± 10°C), 6 h minimum followed by air cooling

^A Corrosion inhibiting heat treatment, depends on agreement between the manufacturer and buyer.

6.2.2 For better corrosion resistance in seawater applications, castings in Copper Alloy UNS No. C95800 may be given a temper anneal heat treatment at 1250 ± 50°F (675 ± 10°C) for 6 h minimum. Cooling shall be by the fastest means possible that will not cause excessive distortion or cracking. Propeller castings shall be exempt from this requirement.

6.2.3 Copper Alloy UNS No. C95520 is used in the heat-treated condition only.

6.2.4 Copper Alloy UNS No. C95900 is normally supplied annealed between 1100°F (595°C) and 1300°F (705°C) followed by air cooling.

6.2.5 Copper Alloy UNS No. C95820 is supplied in the as-cast condition.

6.2.6 Separately cast test bar coupons representing castings made in Copper Alloy UNS Nos. C95300HT, C95400HT, C95410HT, C95500HT, C95520HT, C95800 temper annealed, and C95900 annealed shall be heat treated with the castings.

7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements in [Table 4](#) for the copper alloy UNS. No. designation specified in the ordering information.

7.1.1 Results of analysis of the product sample shall conform to the composition requirements within the permitted analytical variance specified in [Table 4](#).

7.1.2 These composition limits do not preclude the presence of other elements. Limits may be established by agreement between manufacturer or supplier and purchaser for the unnamed elements.

7.1.3 For alloys in which Copper is listed as remainder, copper is the difference between the sum of results of all elements determined and 100 %. When all the elements in [Table 4](#) are determined, the sum of results shall be as specified in the following table:

Copper Alloy UNS Number	Copper Plus Named Elements, min, %
C95200	99.0
C95300	99.0
C95400	99.5
C95410	99.5
C95500	99.5
C95520	99.5
C95600	99.0
C95700	99.5
C95800	99.5
C95820	99.2
C95900	99.5

8. Temper

8.1 The suggested heat treatment (tempers) for products described in this specification are given in [Table 3](#).

9. Mechanical Property Requirements

9.1 Tensile Strength Requirements:

9.1.1 The mechanical properties shall be determined from separately cast test bar castings.

9.1.2 Product furnished under this specification shall conform to the mechanical properties requirements specified in [Table 2](#), when tested in accordance with Test Methods [E8/E8M](#).

9.1.3 Acceptance or rejection based upon mechanical properties shall depend on tensile strength, yield strength, and elongation.

9.2 Hardness Requirement:

TABLE 4 Chemical Requirements

Classification	Aluminum Bronze		Nickel Aluminum Bronze				Silicon Aluminum Bronze	Manganese-Nickel Aluminum Bronze	Nickel Aluminum Bronze		Aluminum Bronze
	C95200	C95300	C95400	C95410	C95500	C95520 ^A	C95600	C95700	C95800	C95820 ^B	C95900
	Composition, %										
Copper	86.0 min	86.0 min	83.0 min	83.0 min	78.0 min	74.5 min	88.0 min	71.0 min	79.0 min	77.5 min	remainder
Aluminum	8.5–9.5	9.0–11.0	10.0–11.5	10.0–11.5	10.0–11.5	10.5–11.5	6.0–8.0	7.0–8.5	8.5–9.5	9.0–10.0	12.0–13.5
Iron	2.5–4.0	0.8–1.5	3.0–5.0	3.0–5.0	3.0–5.0	4.0–5.5	...	2.0–4.0	3.5–4.5 ^C	4.0–5.0	3.0–5.0
Manganese	...	...	0.50 max	0.50 max	3.5 max	1.5 max	...	11.0–14.0	0.8–1.5	1.5 max	1.5 max
Nickel (incl cobalt)	...	...	1.5 max	1.5–2.5	3.0–5.5	4.2–6.0	0.25 max	1.5–3.0	4.0–5.0 ^C	4.5–5.8	0.50 max
Silicon	...	...	...	...	...	0.15 max	1.8–3.2	0.10 max	0.10 max	0.10 max	...
Lead	...	...	...	...	...	0.03 max	...	0.03 max	0.03 max	0.02 max	...

^A Chromium shall be 0.05 max, cobalt 0.20 max, tin 0.25 max, and zinc 0.30 max.

^B Zinc shall be 0.20 max and tin 0.20 max.

^C Iron content shall not exceed the nickel content.

9.2.1 The approximate Brinell hardness values given in **Table 2** are for general information and assistance in testing, and shall not be used as a basis for product rejection.

10. Casting Repair

10.1 Alloys included in this specification are generally weldable. Weld repairs may be made at the manufacturer's discretion provided each excavation does not exceed 20 % of the casting section or wall thickness or 4 % of the casting surface area.

10.2 Excavations that exceed those described in **10.1** may be made at the manufacturer's discretion except that when required (**5.1.15**) the weld procedure shall be approved by the purchaser and the following records shall be maintained:

- 10.2.1 A sketch or drawing showing the dimensions, depth, and location of excavations,
- 10.2.2 Postweld heat treatment, when applicable,
- 10.2.3 Weld repair inspection results,
- 10.2.4 Casting identification number,
- 10.2.5 Weld procedure identification number,
- 10.2.6 Welder identification, and
- 10.2.7 Name of inspector.

10.3 The castings shall not be impregnated without approval of the purchaser.

11. Workmanship, Finish, and Appearance

11.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

12. Sampling

12.1 Test bar castings for the Copper Alloy UNS Nos. in this specification shall be cast to the form and dimensions shown in Figs. 1 or 2 in Practice **B208**.

12.2 When material is specified to meet the requirements of the *ASME Boiler and Pressure Vessel Code*, for small remelts the lot size shall not exceed 1000 lb (455 kg) of castings and shall consist of all of the metal from a single master heat

poured from an individual melting unit, or group of melting units, operating during the course of one-half shift, not to exceed 5 h.

13. Test Methods

13.1 Chemical Analysis:

13.1.1 In case of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer and the purchaser.

13.2 Other Tests:

13.2.1 Brinell readings shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Method **E10**, with the exception that a 3000-kg load shall be used.

13.2.2 Rockwell hardness readings shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Methods **E18**.

13.2.3 Tensile and Yield Strength shall be determined by the extension-under-load method of Test Methods **E8/E8M**.

13.2.4 When specified in the purchase order, additional hardness testing may be performed on castings. The test location and hardness values shall be agreed upon between the manufacturer and the purchaser.

14. Certification

14.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and inspected as directed in this specification and requirements have been met.

14.2 When specified in the purchase order or contract that product is purchased for *ASME Boiler and Pressure Vessel Code* application, certification to this specification is mandatory.

15. Keywords

15.1 aluminum-bronze castings; copper alloy castings; copper-base alloy castings; UNS No. C95200; UNS No. C95300; UNS No. C95400; UNS No. C95410; UNS No. C95500; UNS No. C95520; UNS No. C95600; UNS No. C95700; UNS No. C95800; UNS No. C95820; UNS No. C95900

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order for agencies of the U.S. Government.

S1. Scope

S1.1 The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order for agencies of the U.S. government.

S2. Referenced Documents

S2.1 The following documents of the issue effect on date of material purchase form a part of this specification to the extent referenced herein:

S2.1.1 Federal Standards:⁵

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

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

S2.1.2 Military Standards:⁵

MIL-STD-129 Marking for Shipment and Storage

⁵ Available from DLA Document Services, Bldg. 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil/>.

MIL-STD-248 Welded and Brazing Procedure in Performance Qualification

MIL-STD-271 Requirements for Nondestructive Testing Methods

MIL-STD-278 Welding and Casting Standard

S2.1.3 *ASTM Standards*:³

B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies

S3. First Article Inspection

S3.1 The initial casting shall be radiographically examined in accordance with MIL-STD-271 at locations specified by the purchaser. Subsequent to radiography, samples for mechanical testing shall be removed from the specified locations and tested. The acceptance criteria for all tests and examinations shall be as agreed upon between the manufacturer and the purchaser.

S3.2 Following acceptance of the initial casting by the purchaser, the manufacturer shall not change his basic foundry practice without the specific approval of the purchaser. The manufacturer may be required to perform additional tests or inspections to verify acceptability of any changes made.

S4. Soundness

S4.1 Castings shall meet the soundness requirements of MIL-STD-278 for the category, subcategory, and criticality level specified in the purchase order.

S5. Pressure Test

S5.1 Castings shall meet the pressure test requirements of MIL-STD-278.

S6. Weld Repair

S6.1 All repair welding shall be in accordance with MIL-STD-278 using welders and welding procedures qualified in accordance with MIL-STD-248.

S6.2 Surfaces of the casting that will be in contact with seawater will be identified by the purchaser. Any weld repair made on these surfaces or within ¼ in. of these surfaces shall be postweld heat treated in accordance with 6.2.3.

S7. Quality Assurance

S7.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for 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.

S8. Marking

S8.1 The castings shall be marked in accordance with Specification B824. Additionally, the marking shall include the manufacturer's trademark, specification, and alloy number.

S9. Preparation for Delivery

S9.1 *Preservation, Packaging, and Packing*:

S9.1.1 *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 C as specified in the contract or purchase order, in accordance with the requirements of Practice B900.

S9.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S9.2 *Marking*:

S9.2.1 *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.

S9.2.2 *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.

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 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 that, when applied to a body having a mass of one kilogram, gives it an acceleration of one metre per second square ($N = \text{kg}\cdot\text{m}/\text{s}^2$). 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

Committee B05 has identified the principal changes to this specification that have been incorporated since the last issue B148-97(2009) that may impact the use of this standard. (Approved April 1, 2014.)

- (1) Revised **Table 3**.
- (2) The specification was also revised to comply with Guide **B950**.

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