



Standard Specification for Aluminum-Bronze Sand Castings¹

This standard is issued under the fixed designation B 148; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

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

^{ε1} NOTE—Table 3 was editorially corrected in January 2001.

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 shall be regarded as the standard. Metric values given in parentheses are for information only.

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:

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

B 824 Specification for General Requirements for Copper Alloy Castings³

E 10 Test Method for Brinell Hardness of Metallic Materials⁴

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁴

E 527 Practice for Numbering Metals and Alloys (UNS)⁵

3. General Requirements

3.1 Material furnished under this specification shall conform to the applicable requirements of Specification B 824.

4. Ordering Information

4.1 Orders for castings under this specification shall include the following information:

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.

Current edition approved May 10, 1997. Published October 1997. Originally published as B 148 – 41 T. Last previous edition B 148 – 93a.

² The UNS system for copper and copper alloys (see Practice E 527) 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 Annual Book of ASTM Standards, Vol 02.01.

⁴ Annual Book of ASTM Standards, Vol 03.01.

⁵ Annual Book of ASTM Standards, Vol 01.01.

- 4.1.1 Quality of castings required,
- 4.1.2 Copper alloy number (Table 1) and temper (as-cast, heat treated, and so forth),
- 4.1.3 Specification title, number, and year of issue,
- 4.1.4 Pattern or drawing number and condition (cast, machined, and so forth),
- 4.1.5 Analysis of residual elements, if specified in the purchase order (Specification B 824),
- 4.1.6 Pressure test requirements, if specified in the purchase order (Specification B 824),
- 4.1.7 Soundness requirements, if specified in the purchase order (Specification B 824),
- 4.1.8 Certification, if specified in the purchase order (Specification B 824),
- 4.1.9 Test report, if specified in the purchase order (Specification B 824),
- 4.1.10 Witness inspection, if specified in the purchase order (Specification B 824),
- 4.1.11 Approval of weld procedure and records of repairs, if specified in the purchase order (Section 8),
- 4.1.12 ASME Boiler and Pressure Vessel Code⁶ application (9.2 and Section 11),
- 4.1.13 Castings for seawater service (5.3), and
- 4.1.14 Product marking, if specified in the purchase order (Specification B 824).

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

5. Materials and Manufacture

5.1 For better corrosion resistance in seawater applications, castings in Copper Alloy UNS No. C95800 shall 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.

5.2 Copper Alloy UNS Nos. C95300, C95400, C95410, and C95500 may be supplied in the heat-treated condition to obtain the higher mechanical properties shown in Table 3. Suggested

⁶ Available from the American Society of Mechanical Engineers, Headquarters, Three Park Ave., New York, NY 10016-5990.

*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 | ... | ... |

^AThese grades respond to heat treatment.

TABLE 2 Chemical Requirements

| Classification | Aluminum Bronze | | | Nickel Aluminum Bronze | | | Silicon Aluminum Bronze | Manganese-Nickel Aluminum Bronze | Nickel Aluminum Bronze | Aluminum Bronze | | |
|----------------------|----------------------|----------|-----------|------------------------|-----------|-----------|-------------------------|----------------------------------|------------------------|-----------------|---------------------|-----------|
| | Copper Alloy UNS No. | 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 | 12.0–13.5 | 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 | 4.0–5.0 | 3.0–5.0 |
| 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 | 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 | 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 | 0.5 max | 0.5 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 | ... | ... |

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

^BZinc shall be 0.2 max and tin 0.02 max.

^CIron content shall not exceed the nickel content.

heat treatments for these alloys and Copper Alloy UNS No. C95520 are given in Table 4. Actual practice may vary by manufacturer.

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

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

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

5.6 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.

6. Chemical Composition

6.1 The castings shall conform to the chemical requirements shown in Table 2.

6.2 These specification limits do not preclude the presence of other elements. Limits may be established by agreement between manufacturer or supplier and purchaser for these unnamed elements. Copper may be given as remainder and may be taken as the difference between the sum of all elements analyzed and 100 %. When all the elements in the table are analyzed, their sum 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 |

7. Mechanical Properties

7.1 Mechanical properties shall be determined from separately cast test bar castings and shall meet the requirements shown in Table 3.

8. Casting Repair

8.1 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.

8.2 Excavations that exceed those described in 8.1 may be made at the manufacturer's discretion except that when required (4.1.11) the weld procedure shall be approved by the purchaser and the following records shall be maintained:



TABLE 3 Mechanical Requirements

| Classification | Aluminum Bronze | | | Nickel Aluminum Bronze | | Silicon Aluminum Bronze | Manganese-Nickel Aluminum Bronze | Nickel Aluminum Bronze | Aluminum Bronze |
|------------------------------------------------------------------------|-----------------|----------|-------------------|------------------------|------------------------------------|-------------------------|----------------------------------|------------------------|---------------------|
| | As-Cast | | C95400 and C95410 | 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 (300-kg load) | ... | 160 | 190 | 200 | 255 ^I | ... | ... | ... | 241 min |

^AAs cast or temper annealed.

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

^Cksi = 1000 psi.

^DSee Appendix X1.

^EYield 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).

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

^GFor information only.

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

^ISand castings and sand cast test specimens shall be 25 HRC or equivalent minimum.

TABLE 4 Suggested Heat Treatments

| Copper Alloy UNS No. | Solution Treatment (Not Less Than 1 h Followed by Water Quench) | Annealing Treatment (Not Less than 2 h Followed by Air Cool) |
|----------------------|-----------------------------------------------------------------|--------------------------------------------------------------|
| C95300 | 1585-1635°F (800-890°C) | 1150-1225°F (620-660°C) |
| C95400 | 1600-1675°F (870-910°C) | 1150-1225°F (620-660°C) |
| C95410 | | |
| C95500 | (2 h followed by water quench) | 925-1000°F (495-540°C) |
| C95520 | 1600-1700°F (870-925°C) | |

8.2.1 A sketch or drawing showing the dimensions, depth, and location of excavations,

8.2.2 Postweld heat treatment, when applicable,

8.2.3 Weld repair inspection results,

8.2.4 Casting identification number,

8.2.5 Weld procedure identification number,

8.2.6 Welder identification, and

8.2.7 Name of inspector.

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

9. Sampling

9.1 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 B 208.

9.2 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.

10. Test Methods

10.1 Brinell readings shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Method E 10, with the exception that a 3000-kg load shall be used.

10.2 Rockwell hardness readings shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Methods E 18.

10.3 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.

11. Certification

11.1 When castings are specified to meet the requirements of the *ASME Boiler and Pressure Vessel Code*, the certification requirements of Specification B 824 are mandatory.

12. Keywords

12.1 aluminum-bronze castings; copper alloy castings; copper-base alloy castings



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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. Referenced Documents

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

S1.1.1 *Federal Standards:*⁷

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

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

S1.1.2 *Military Standards:*⁷

MIL-STD-129 Marking for Shipment and Storage

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

S1.1.3 *Military Specification:*⁷

MIL-C-3993 Packaging of Copper and Copper-Base Alloy Mill Products

S2. First Article Inspection

S2.1 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.

S2.2 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.

S3. Soundness

S3.1 Castings shall meet the soundness requirements of MIL-STD-278 for the category, subcategory, and criticality level specified in the purchase order.

S4. Pressure Test

S4.1 Castings shall meet the pressure test requirements of MIL-STD-278.

S5. Weld Repair

S5.1 All repair welding shall be in accordance with MIL-

STD-278 using welders and welding procedures qualified in accordance with MIL-STD-248.

S5.2 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 1/4 in. of these surfaces shall be postweld heat treated in accordance with 5.3.

S6. Quality Assurance

S6.1 *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.

S7. Marking

S7.1 The castings shall be marked in accordance with Specification B 824. Additionally, the marking shall include the manufacturer's trademark, specification, and alloy number.

S8. Preparation for Delivery

S8.1 *Preservation, Packaging, and Packing:*

S8.1.1 *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 MIL-C-3993.

S8.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S8.2 *Marking:*

S8.2.1 *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.

S8.2.2 *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.

⁷ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.



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

This section identifies the principal changes to this specification since the last issue.

1. Paragraph 1.1 was rewritten.
2. Copper minimums were added to Table 2 to agree with CDA⁸ officially registered chemistries.
3. The entire specification was revised to comply with Specification B 824.

⁸ Copper Development Association, Inc., 260 Madison Ave., New York, NY 10016.

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