



Designation: B 584 – 04

# Standard Specification for Copper Alloy Sand Castings for General Applications<sup>1</sup>

This standard is issued under the fixed designation B 584; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

## 1. Scope\*

1.1 This specification covers requirements for copper alloy sand castings for general applications. Nominal compositions of the alloys defined by this specification are shown in **Table 1**.<sup>2</sup> This is a composite specification replacing former documents as shown in **Table 1**.

NOTE 1—Other copper alloy castings are included in the following ASTM specifications: **B 22**, **B 61**, **B 62**, **B 66**, **B 67**, **B 148**, **B 176**, **B 271**, **B 369**, **B 427**, **B 492**, **B 505/B 505M**, **B 763**, **B 770**, and **B 806**.

1.2 Component part castings produced to this specification may be manufactured in advance and supplied from stock. In such cases the manufacturer shall maintain a general quality certification of all castings without specific record or date of casting for a specific casting.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

- B 22** Specification for Bronze Castings for Bridges and Turntables
- B 61** Specification for Steam or Valve Bronze Castings
- B 62** Specification for Composition Bronze or Ounce Metal Castings
- B 66** Specification for Bronze Castings for Steam Locomotive Wearing Parts
- B 67** Specification for Car and Tender Journal Bearings, Lined<sup>4</sup>
- B 148** Specification for Aluminum-Bronze Sand Castings

- B 176** Specification for Copper-Alloy Die Castings
  - B 208** Practice for Preparing Tension Test Specimens for Copper Alloy Sand, Permanent Mold, Centrifugal, and Continuous Castings
  - B 271** Specification for Copper-Base Alloy Centrifugal Castings
  - B 369** Specification for Copper-Nickel Alloy Castings
  - B 427** Specification for Gear Bronze Alloy Castings
  - B 492** Specification for Cast Copper-Nickel Ship Tailshaft Sleeves<sup>4</sup>
  - B 505/B 505M** Specification for Copper-Base Alloy Continuous Castings
  - B 763** Specification for Copper Alloy Sand Castings for Valve Application
  - B 770** Specification for Copper-Beryllium Alloy Sand Castings for General Applications
  - B 806** Specification for Copper Alloy Permanent Mold Castings for General Applications
  - B 824** Specification for General Requirements for Copper Alloy Castings
  - B 846** Terminology for Copper and Copper Alloys
  - E 255** Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
  - E 527** Practice for Numbering Metals and Alloys (UNS)
- ### 2.2 ASME Code:
- ASME Boiler and Pressure Vessel Code<sup>5</sup>

## 3. Terminology

3.1 Definitions of terms relating to copper alloys can be found in Terminology **B 846**.

## 4. General Requirements

4.1 The following sections of Specification **B 824** form a part of this specification. In the event of a conflict between this specification and Specification **B 824**, the requirements of this specification shall take precedence.

- 4.1.1 Terminology,
- 4.1.2 Other Requirements,
- 4.1.3 Dimensions, Mass, and Permissible Variations,
- 4.1.4 Workmanship, Finish, and Appearance,

<sup>1</sup> 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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<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> Withdrawn.

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5900.

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

**TABLE 1 Nominal Compositions**

| Classification                               | Copper Alloy UNS No. | Previous Designation | Commercial Designation             | Copper | Tin | Lead | Zinc | Nickel | Iron | Aluminum | Manganese | Silicon | Niobium | Bismuth |
|--|----------------------|----------------------|------------------------------------|--------|-----|------|------|--------|------|----------|-----------|---------|---------|---------|
| Leaded red brass                             | C83450               | ...                  | ...                                | 88     | 2½  | 2    | 6½   | 1      | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C83600               | B 145-4A             | 85-5-5-5 or No. 1 composition      | 85     | 5   | 5    | 5    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C83800               | B 145-4B             | commercial red brass, 83-4-6-7     | 83     | 4   | 6    | 7    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
| Leaded semi-red brass                        | C84400               | B 145-5A             | valve composition, 81-3-7-9        | 81     | 3   | 7    | 9    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C84800               | B 145-5B             | semi-red brass, 76-2½-6½-15        | 76     | 2½  | 6½   | 15   | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
| Leaded yellow brass                          | C85200               | B 146-6A             | high-copper yellow brass           | 72     | 1   | 3    | 24   | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C85400               | B 146-6B             | commercial No. 1 yellow brass      | 67     | 1   | 3    | 29   | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C85700               | B 146-6C             | leaded naval brass                 | 61     | 1   | 1    | 37   | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
| High-strength yellow brass                   | C86200               | B 147-8B             | high-strength manganese bronze     | 63     | ... | ...  | 27   | ...    | 3    | 4        | 3         | ...     | ...     | ...     |
|  | C86300               | B 147-8C             | high-strength manganese bronze     | 61     | ... | ...  | 27   | ...    | 3    | 6        | 3         | ...     | ...     | ...     |
|  | C86400               | B 147-7A             | leaded manganese bronze            | 58     | 1   | 1    | 38   | ...    | 1    | ½        | ½         | ...     | ...     | ...     |
|  | C86400               | B 132-A              | ...                                | ...    | ... | ...  | ...  | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C86500               | B 147-8A             | No. 1 manganese bronze             | 58     | ... | ...  | 39   | ...    | 1    | 1        | 1         | ...     | ...     | ...     |
|  | C86700               | B 132-B              | leaded manganese bronze            | 58     | 1   | 1    | 34   | ...    | 2    | 2        | 2         | ...     | ...     | ...     |
| Silicon bronze + silicon brass               | C87300               | B 198-12A            | silicon bronze                     | 95     | ... | ...  | ...  | ...    | ...  | ...      | 1         | 4       | ...     | ...     |
|  | C87400               | B 198-13A            | silicon brass                      | 82     | ... | ½    | 14   | ...    | ...  | ...      | ...       | 3½      | ...     | ...     |
|  | C87500               | B 198-13B            | silicon brass                      | 82     | ... | ...  | 14   | ...    | ...  | ...      | ...       | 4       | ...     | ...     |
|  | C87600               | B 198-13C            | silicon bronze                     | 91     | ... | ...  | 5    | ...    | ...  | ...      | ...       | 4       | ...     | ...     |
|  | C87610               | B 198-12A            | silicon bronze                     | 92     | ... | ...  | 4    | ...    | ...  | ...      | ...       | 4       | ...     | ...     |
| Bismuth selenium brass                       | C89510 <sup>A</sup>  | ...                  | sebiloy I                          | 87     | 5   | ...  | 5    | ...    | ...  | ...      | ...       | ...     | ...     | 1.0     |
|  | C89520 <sup>B</sup>  | ...                  | sebiloy II                         | 86     | 5½  | ...  | 5    | ...    | ...  | ...      | ...       | ...     | ...     | 1.9     |
| Bismuth semi-red brass                       | C89844               | ...                  | bismuth brass                      | 84½    | 4   | ...  | 8    | ...    | ...  | ...      | ...       | ...     | ...     | 3       |
|  | C90300               | B 143-1B             | modified "G" bronze, 88-8-0-4      | 88     | 8   | ...  | 4    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
| Tin bronze + leaded tin bronze               | C90500               | B 143-1A             | "G" bronze, 88-10-0-2              | 88     | 10  | ...  | 2    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C92200               | B 143-2A             | steam or valve bronze-Navy "M"     | 88     | 6   | 1½   | 4½   | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C92210               | ...                  | ...                                | 88     | 5   | 2    | 4    | 1      | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C92300               | B 143-2B             | 87-5-1-4, Navy PC                  | 87     | 8   | 1    | 4    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C92600               | ...                  | 87-10-1-2                          | 87     | 10  | 1    | 2    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C93200               | B 144-3B             | 83-7-7-3                           | 83     | 7   | 7    | 3    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C93500               | B 144-3C             | 85-5-9-1                           | 85     | 5   | 9    | 1    | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
| High-lead tin bronze                         | C93700               | B 144-3A             | 80-10-10                           | 80     | 10  | 10   | ...  | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C93800               | B 144-3D             | 78-7-15                            | 78     | 7   | 15   | ...  | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C94300               | B 144-3E             | 71-5-24                            | 71     | 5   | 24   | ...  | ...    | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C94700               | B 292-A              | nickel-tin bronze Grade "A"        | 88     | 5   | ...  | 2    | 5      | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C94800               | B 292-B              | leaded nickel-tin bronze Grade "B" | 87     | 5   | 1    | 2    | 5      | ...  | ...      | ...       | ...     | ...     | ...     |
| Nickel-tin bronze + leaded nickel-tin bronze | C94900               | ...                  | leaded nickel-tin bronze Grade "C" | 80     | 5   | 5    | 5    | 5      | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C96800               | ...                  | ...                                | 82     | 8   | ...  | ...  | 10     | ...  | ...      | ...       | ...     | 0.2     | ...     |
|  | C97300               | B 149-10A            | 12 % leaded nickel silver          | 57     | 2   | 9    | 20   | 12     | ...  | ...      | ...       | ...     | ...     | ...     |
| Leaded nickel bronze                         | C97600               | B 149-11A            | 20 % leaded nickel silver          | 64     | 4   | 4    | 8    | 20     | ...  | ...      | ...       | ...     | ...     | ...     |
|  | C97800               | B 149-11B            | 25 % leaded nickel silver          | 66     | 5   | 2    | 2    | 25     | ...  | ...      | ...       | ...     | ...     | ...     |

<sup>A</sup> Selenium 0.5.

<sup>B</sup> Selenium 0.9.

- 4.1.5 Sampling,
- 4.1.6 Number of Tests and Retests,
- 4.1.7 Specimen Preparation,
- 4.1.8 Test Methods,
- 4.1.9 Significance of Numerical Limits,
- 4.1.10 Inspection,
- 4.1.11 Rejection and Rehearing,
- 4.1.12 Certification,
- 4.1.13 Test Report,
- 4.1.14 Product Marking,
- 4.1.15 Packaging and Package Marking, and
- 4.1.16 Supplementary Requirements.

## 5. Ordering Information

5.1 Orders for castings under this specification should include the following information:

- 5.1.1 Specification title, number, and year of issue,
- 5.1.2 Quantity of castings,
- 5.1.3 Copper alloy UNS Number (**Table 1**) and temper (as-cast, heat treated, and so forth),
- 5.1.4 Pattern or drawing number, and condition (as-cast, machined, etc.),
- 5.1.5 *ASME Boiler and Pressure Vessel Code*—compliance (**Section 10**),
- 5.1.6 When material is purchased for agencies of the U.S. government, the Supplementary Requirements of Specification **B 824** may be specified.

5.2 The following options are available and should be specified in the purchase order when required:

- 5.2.1 Chemical analysis of residual elements (**7.3**),

5.2.2 Pressure test or soundness requirements (Specification **B 824**),

5.2.3 Approval of weld repair or impregnation, or both (Section **9**),

5.2.4 Certification (Specification **B 824**),

5.2.5 Foundry test report (Specification **B 824**),

5.2.6 Witness inspection (Specification **B 824**), and

5.2.7 Product marking (Specification **B 824**).

## 6. Manufacture

6.1 Copper alloy UNS Nos. C94700 and C96800 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.

6.2 Separately cast test bar coupons representing castings made in copper alloy UNS Nos. C94700HT and C96800HT shall be heat treated with the castings.

**TABLE 2 Mechanical Requirements**

| Copper Alloy<br>UNS No. | Tensile Strength,<br>min |                  | Yield Strength, <sup>A</sup> min |                  | Elongation in<br>2 in.<br>or 50 mm,<br>min, % |
|-------------------------|--------------------------|------------------|----------------------------------|------------------|---|
|                         | ksi <sup>B</sup>         | MPa <sup>C</sup> | ksi <sup>B</sup>                 | MPa <sup>C</sup> |   |
| C83450                  | 30                       | 207              | 14                               | 97               | 25  |
| C83600                  | 30                       | 207              | 14                               | 97               | 20  |
| C83800                  | 30                       | 207              | 13                               | 90               | 20  |
| C84400                  | 29                       | 200              | 13                               | 90               | 18  |
| C84800                  | 28                       | 193              | 12                               | 83               | 16  |
| C85200                  | 35                       | 241              | 12                               | 83               | 25  |
| C85400                  | 30                       | 207              | 11                               | 76               | 20  |
| C85700                  | 40                       | 276              | 14                               | 97               | 15  |
| C86200                  | 90                       | 621              | 45                               | 310              | 18  |
| C86300                  | 110                      | 758              | 60                               | 414              | 12  |
| C86400                  | 60                       | 414              | 20                               | 138              | 15  |
| C86500                  | 65                       | 448              | 25                               | 172              | 20  |
| C86700                  | 80                       | 552              | 32                               | 221              | 15  |
| C87300                  | 45                       | 310              | 18                               | 124              | 20  |
| C87400                  | 50                       | 345              | 21                               | 145              | 18  |
| C87500                  | 60                       | 414              | 24                               | 165              | 16  |
| C87600                  | 60                       | 414              | 30                               | 207              | 16  |
| C87610                  | 45                       | 310              | 18                               | 124              | 20  |
| C89510                  | 26                       | 184              | 17                               | 120              | 8   |
| C89520                  | 25                       | 176              | 17                               | 120              | 6   |
| C89844                  | 28                       | 193              | 13                               | 90               | 15  |
| C90300                  | 40                       | 276              | 18                               | 124              | 20  |
| C90500                  | 40                       | 276              | 18                               | 124              | 20  |
| C92200                  | 34                       | 234              | 16                               | 110              | 22  |
| C92210                  | 32                       | 225              | 15                               | 103              | 20  |
| C92300                  | 36                       | 248              | 16                               | 110              | 18  |
| C92600                  | 40                       | 276              | 18                               | 124              | 20  |
| C93200                  | 30                       | 207              | 14                               | 97               | 15  |
| C93500                  | 28                       | 193              | 12                               | 83               | 15  |
| C93700                  | 30                       | 207              | 12                               | 83               | 15  |
| C93800                  | 26                       | 179              | 14                               | 97               | 12  |
| C94300                  | 24                       | 165              | ...                              | ...              | 10  |
| C94700                  | 45                       | 310              | 20                               | 138              | 25  |
| C94700 (HT)             | 75                       | 517              | 50                               | 345              | 5   |
| C94800                  | 40                       | 276              | 20                               | 138              | 20  |
| C94900                  | 38                       | 262              | 15                               | 103              | 15  |
| C96800                  | 125                      | 862              | 100 <sup>D</sup>                 | 689 <sup>D</sup> | 3   |
| C96800 (HT)             | 135                      | 931              | 120 <sup>D</sup>                 | 821 <sup>D</sup> | ...   |
| C97300                  | 30                       | 207              | 15                               | 103              | 8   |
| C97600                  | 40                       | 276              | 17                               | 117              | 10  |
| C97800                  | 50                       | 345              | 22                               | 152              | 10  |

<sup>A</sup> 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. or 50 mm.

<sup>B</sup> ksi = 1000 psi.

<sup>C</sup> See **Appendix X1**.

<sup>D</sup> Yield strength 0.2 %, offset.

**TABLE 3 Suggested Heat Treatments**

| Copper Alloy<br>UNS No. | Solution Treatment<br>(not less than 1 h followed by<br>water quench) | Annealing Treatment<br>(not less than 2 h followed<br>by air cool)            |
|-------------------------|---|---|
| C96800                  | 1500°F (815°C)  | (Age to develop properties)<br>660°F (350°C)<br>Precipitation hardening (5 h) |
| C94700                  | 1425–1475°F<br>(775–800°C)  | 580–620°F<br>(305–325°C)  |

## 7. Chemical Composition

7.1 The castings shall conform to the compositional requirements for named elements as shown in **Table 4** for the copper alloy UNS numbers specified in the purchase order.

7.2 These specification limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements agreed upon between manufacturer or supplier and purchaser. Copper or zinc, when zinc is 20 % or greater, 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 4** are analyzed, their sum shall be as specified in **Table 5**.

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

## 8. Mechanical Properties

8.1 Mechanical properties shall be determined from separately cast test bar castings, and shall meet the requirements shown in **Table 2**.

## 9. Casting Repair

9.1 The castings shall not be weld repaired without approval of the purchaser (**5.2.3**).

9.2 The castings shall not be impregnated without approval of the purchaser (**5.2.3**).

## 10. ASME Requirements

10.1 When specified in the purchase order to meet ASME Boiler and Pressure Vessel Code requirements, castings in copper alloy UNS Nos. C92200, C93700, and C97600 shall comply with the following:

10.1.1 Certification requirements of Specification **B 824**.

10.1.2 Foundry test report requirements of Specification **B 824**.

10.1.3 Castings shall be marked with the manufacturer's name, the copper alloy UNS number, and the casting quality factor. In addition, heat numbers or serial numbers that are traceable to heat numbers shall be marked on all pressure-containing castings individually weighing 50 lbs (22.7 kg) or more. Pressure-containing castings weighing less than 50 lbs (22.7 kg) shall be marked with either the heat number or a serial number that will identify the casting as to the month in which it was poured. Marking shall be in such a position as to not impair the usefulness of the casting.

10.2 The castings shall not be repaired, plugged, welded, or "burned in" unless permission from the purchaser has been