



Designation: B 22 – 9502

# Standard Specification for Bronze Castings for Bridges and Turntables<sup>1</sup>

This standard is issued under the fixed designation B 22; 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 Department of Defense.*

<sup>1</sup> This ~~practice~~ 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 requirements for bronze castings for turntables, movable bridges and bridge parts, and bronze castings suitable for use in bridges and other structures for fixed and expansion bearings in which motion is slow and intermittent. The following Copper Alloys are specified: UNS No. C86300, C90500, C91100, C91300, and C93700.

NOTE 1—Historically, the alloys in this specification have been used in the applications listed in Appendix X1. Actual practice may vary.<sup>2</sup>

1.2 ~~Units~~—The values stated in inch-/pound or SI units are ~~to be regarded separately as standard. SI~~ The values given stated in ~~each~~ each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 The following documents in the current issue of the Book of Standards 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-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings<sup>3</sup>

B 824 Specification for General Requirements for Copper Alloy Castings<sup>3</sup>

B 846 Terminology for Copper and Copper Alloys<sup>3</sup>

E 408 Test Methods for Brinell Hardness Tension Testing of Metallic Materials<sup>4</sup>

E 8M Test Methods for Tension Testing of Metallic Materials (Metric)<sup>4</sup>

E 10 Test Method for Brinell Hardness of Metallic Materials<sup>4</sup>

E 255 Practice for Sampling of Copper and Copper Alloys for the Determination of Chemical Composition<sup>5</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>6</sup>

## 3. Terminology

3.1 ~~For definitions of terms relating~~ related to copper alloys can be found in alloys, refer to Terminology B 846.

## 4. Ordering Information

4.1 ~~Orders for castings under~~ General Requirements

<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> Annual Book of ASTM Standards, Vol 02.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.01; 03.05.

<sup>6</sup> Annual Book of ASTM Standards, Vol 01.01.

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

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 following information:

4.1.1 ~~Specification title, number, requirements of this specification shall take precedence.~~

4.1.1 Terminology (Section 3),

4.1.2 Other Requirements (Section 7),

4.1.3 Dimensions, Mass, and ~~Permissible Variations~~ (Section 8),

4.1.4 Workmanship, Finish, and Appearance (Section 9),

4.1.5 Sampling (Section 10),

4.1.6 Number of issue;

4.1.2 ~~Quantity Tests and Retests~~ (Section 11),

4.1.7 Specimen Preparation (Section 12),

4.1.8 Test Methods (Section 13),

4.1.9 Significance of castings;

4.1.3 ~~Copper Alloy UNS Number (Table 1 Numerical Limits~~ (Section 14),

4.1.10 Inspection (Section 15),

4.1.11 Rejection and Rehearing (Section 16),

4.1.12 Certification (Section 17),

4.1.13 Test Report (Section 18),

4.1.14 Product Marking (Section 19),

4.1.15 Packaging and Package Marking (Section 20),

4.1.16 Keywords (Section 21), and

4.1.17 Supplementary Requirements. );

4.1.4 ~~Pattern or drawing number and condition (as-cast, machined, and so forth), and~~

4.1.5 ~~When material is purchased for agencies of the U.S. Government, the Supplementary Requirements in Specification B 824 may be specified.~~

4.2 The following are optional and should be specified in the purchase order when required:

4.2.1 Chemical analysis of residual elements (Section 5.3);

4.2.2 Soundness requirements (Specification B 824);

4.2.3 Certification (Specification B 824);

4.2.4 Foundry test report (Specification B 824);

4.2.5 Witness inspection (Specification B 824), and

4.2.6 Product marking (Specification B 824).

## 5. Chemical Composition

5.1 The castings shall conform to Ordering Information

5.1 Include the compositional requirements following information when placing order for named elements as shown in Table 1 castings products under this specification:

5.1.1 ASTM designation and year of issue (for example, B 22-95),

5.1.2 Number of castings or total weight, for each size and form,

5.1.3 Copper Alloy UNS Numbers specified in the purchase order.

5.2 These specification limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements agreed upon between the manufacturer Number (see Table 1), and

5.1.4 Pattern or supplier drawing number and the purchaser.

**TABLE 1 Chemical Requirements**

Composition, % max-E, except as indicated

Copper Alloy UNS No.	Major Elements							Residual Elements							
	Copper	Tin	Lead	Zinc	Iron	Nickel Including Cobalt	Aluminum	Manganese	Iron	Antimony	Nickel Incl. Cobalt	Sulfur	Phosphorus	Aluminum	Silicon
C86300	60.0–66.0	0.20	0.20	22.0–28.0	2.0–4.0	...	5.0–7.5	2.5–5.0	...	...	1.0	...	...	...	...
C90500	86.0–89.0	9.0–11.0	0.30	1.0–3.0	...	1.0 <sup>A</sup>	...	...	0.20	0.20	...	0.05	0.05 <sup>B</sup>	0.005	0.005
C91100	82.0–85.0	15.0–17.0	0.25	0.25	...	...	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005
C91300	79.0–82.0	18.0–20.0	0.25	0.25	...	0.50 <sup>A</sup>	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005
C93700	78.0–82.0	9.0–11.0	0.25	0.25	...	0.50 <sup>A</sup>	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005
C93700	78.0–82.0	9.0–11.0	0.25	0.25	...	0.50 <sup>A</sup>	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005
C93700	78.0–82.0	9.0–11.0	0.25	0.25	...	0.50 <sup>A</sup>	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005
C93700	78.0–82.0	9.0–11.0	0.25	0.25	...	0.50 <sup>A</sup>	...	...	0.25	0.20	...	0.05	1.0 <sup>B</sup>	0.005	0.005

<sup>A</sup> In determining copper minimum, copper may be calculated as copper plus nickel.

<sup>B</sup> For continuous castings, phosphorus shall be 1.5 % max.

5.3 ~~Copper or zinc may be taken as the difference between the sum of all elements determined condition (as-cast, machined, and 100% so forth).~~

~~5.1.5 When material is purchased for Copper Alloy UNS No. C86300.~~

5.4 ~~Copper may be taken as agencies of the difference between U.S. government, the sum of all elements determined and 100 % for Copper Alloy UNS Nos. C90500, C91100, C91300, and C93700.~~

5.5 ~~When all named elements listed Supplementary Requirements in Table 1 are determined their sum shall be as given below:~~

Elements, % min	Copper Alloy UNS No. Copper Plus Named
C86300	99.7
C90500	99.4
C91100	99.4
C91300	99.0
C93700	99.0

5.6 ~~It is recognized that residual elements Specification B 824 may be present in cast copper base alloys. Analysis shall specified.~~

5.2 ~~The following are optional and should be made for residual elements only when specified in the inquiry or purchase order when required:~~

- 5.2.1 ~~Chemical analysis of residual elements (see 7.6),~~
- 5.2.2 ~~Soundness requirements (Specification B 824),~~
- 5.2.3 ~~Certification (Specification B 824),~~
- 5.2.4 ~~Foundry test report (Specification B 824),~~
- 5.2.5 ~~Witness inspection (Specification B 824), and~~
- 5.2.6 ~~Product marking (Specification B 824).~~

**6. Mechanical Properties**

6.1 ~~Mechanical properties~~Materials and Manufacture

6.1 *Material(s):*

6.1.1 ~~The material of manufacture shall be determined from separately cast test bars a casting of Copper Alloy UNS No.(s) C86300, C90500, C91100, C91300, or C93700 of such purity and soundness as to be suitable for processing in to the products prescribed herein.~~

6.1.2 ~~In the event heat identification or traceability is required, the purchaser shall meet specify the details desired.~~

6.2 *Manufacture:*

6.2.1 ~~The product shall be manufactured by such casting methods to produce a uniform finished product.~~

**7. Chemical Composition**

7.1 ~~The castings shall conform to the compositional requirements for named elements as shown in Table 1 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 the manufacturer or supplier and the purchaser.~~

7.3 ~~Copper or zinc may be taken as the difference between the sum of all elements determined and 100 % for Copper Alloy UNS No. C86300.~~

7.4 ~~Copper may be taken as the difference between the sum of all elements determined and 100 % for Copper Alloy UNS Nos. C90500, C91100, C91300, and C93700.~~

7.5 ~~When all named elements listed in Table 1 are determined their sum shall be as given in Table 2-~~

6.2 ~~The deformation limit in compression shall be determined as.~~

7.6 ~~It is recognized that load which produces a permanent set of 0.001 in. (0.025 mm) in the compression test specimen described in 10.2.~~

**TABLE 2 MechSum of All Named Elements Requirements Analyzed**

Copper Alloy UNS No. Elements, % min	C86300	Copper Alloy UNS No. C90500	C91100	C91300	C93700	Copper Plus Named
— Compression C86300	99.0					
— Deformation limit, min, ksi <sup>A</sup> (MPa <sup>B</sup> ) C90500	55 (380)	...	18 (125)	24 (165)	...	...
— Tension C91100	99.4					
— Tensile strength, min, ksi <sup>A</sup> (MPa <sup>B</sup> ) C91300	110 (760)	40 (275)	...	...	30 (207)	
— Yield strength, min, ksi <sup>A</sup> (MPa <sup>B</sup> ) C93700	110 (760) 60 (415)	40 (275) 18 (125)	99.7 ...	...	30 (207) 12 (83)	4
— Elongation in 2 in. (51 mm), min; 12 %	60 (415)	18 (125) 20	99.7 ...	...	12 (83) 15	
— Hardness Brinell hardness	223 min	...	...	...	...	...

<sup>A</sup>1 ksi = 1000 psi.  
<sup>B</sup>See Appendix X1.

**TABLE 3 Mechanical Requirements**

Copper Alloy UNS No.	Tensile Strength, mm		Yield Strength, at 0.05 % Extension Under Load, min		Elongation in 2 in. (50 mm), %	Brinell Hardness, min	Compression Deformation Limit, min	
	ksi <sup>A</sup>	(MPa) <sup>B</sup>	ksi <sup>A</sup>	(MPa) <sup>B</sup>			ksi <sup>A</sup>	(MPa) <sup>B</sup>
C86300	110	(760)	60	(415)	12	223 (3000 kg)	55	(380)
C90500	40	(275)	18	(125)	20	...	...	...
C91100	...	...	...	...	...	...	18	(125)
C91300	...	...	...	...	...	...	24	(165)
C93700	30	(207)	12	(83)	15	...	...	...

<sup>A</sup> 1 ksi = 1000 psi.

<sup>B</sup> See Appendix X1.

6.3 The yield strength in tension shall residual elements may be determined as the stress producing an elongation under load of 0.5 %, that is, 0.01 in. (0.254 mm) present in a gage length of 2 in. (50.8 mm).

6.4 Finished castings in Copper Alloy UNS No. C86300 cast copper-base alloys. Analysis shall be tested for Brinell hardness.

6.5 One compression test shall be made from each lot for Copper Alloy UNS Nos. C91100 and C91300 castings and one tension test from each lot for Copper Alloy UNS No. C90500 castings. For Copper Alloy UNS No. C86300 castings, one tension test, one compression test, and two hardness tests shall be made for each four castings from the same lot and the same pattern. For castings of any grade weighing over 100 lb (45 kg) finished, the residual elements only when specified tests shall be made for each casting.

## 7. Test Methods

7.1 Analytical chemical methods are given in Specification B 824.

7.2 Brinell hardness testing of Copper Alloy UNS No. C86300 castings shall be performed in accordance with Test Method E 10 with the exception that the load shall be 3000 kg and shall be applied for 30 s to a finished plane surface.

7.3 Test methods to be followed for the determination of elements resulting from contractual inquiry or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser order.

## 8. Mechanical Property Requirements

8.1 Mechanical properties shall be determined from separately cast test bars and shall meet the requirements shown in Table 3.

8.2 The deformation limit in compression shall be determined as that load which produces a permanent set of 0.001 in. (0.025 mm) in the compression test specimen described in 9.3.

8.3 The yield strength in tension 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).

8.4 Finished castings in Copper Alloy UNS No. C86300 shall not be tested for Brinell hardness.

8.5 One compression test shall be made from each lot for Copper Alloy UNS Nos. C91100 and C91300 castings and one tension test from each lot for Copper Alloy UNS No. C90500 castings. For Copper Alloy UNS No. C86300 castings, one tension test, one compression test, and two hardness tests shall be made for each four castings from the same lot and the same pattern. For castings of any grade weighing over 100 lb (45 kg) finished, the purchaser-specified tests shall be made for each casting.

## 9. General Requirements

9.1 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:

- 9.1.1 Terminology (Section 3);
- 9.1.2 Other Requirements (Section 6);
- 9.1.3 Dimensions, Mass, and Permissible Variations (Section 7);
- 9.1.4 Workmanship, Finish, and Appearance (Section 8);
- 9.1.5 Sampling (Section 9);
- 9.1.6 Number of Tests and Retests (Section 10);
- 9.1.7 Specimen Preparation (Section 11);
- 9.1.8 Test Methods (Section 12);
- 9.1.9 Significance of Numerical Limits (Section 13);
- 9.1.10 Inspection (Section 14);
- 9.1.11 Rejection and Rehearing (Section 15);
- 9.1.12 Certification (Section 16);
- 9.1.13 Test Report (Section 17);
- 9.1.14 Product Marking (Section 18);
- 9.1.15 Packaging and Package Marking (Section 19), and
- 9.1.16 Supplementary Requirements.

## **10. Sampling**

10.1 Sampling shall be accordance with the requirements of Practice E 255.

10.2 Copper Alloy UNS No. C86300 test bar castings shall be cast to the form and dimensions shown in Figs. 1 or Figs. 2 of Practice B 208. For all other alloys listed in this specification, test bars shall be cast to the form and dimensions shown in Figs. 2, Figs. 3, or Figs. 4 of Practice B 208.

10.23 Compression test specimens for Copper Alloy UNS No. C86300, C91100, and C91300 shall be cylinders 1 in.<sup>2</sup> (506.7 mm<sup>2</sup>) in cross-sectional area, and 1 in. (25.4 mm) in height which and shall be cast as an integral part of the casting and shall be fed and cooled under the same conditions as the casting.

## **10. Test Methods**

10.1 Analytical chemical methods are given in Specification B 824.

10.2 Brinell hardness testing of Copper Alloy UNS No. C86300 castings shall be performed in accordance with Test Method E 10 with the exception that the load shall be 3000 kg and shall be applied for 30 s to a finished plane surface.

10.3 Test methods to be followed for the determination of elements resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

## **11. Casting Repair**

11.1 The castings shall not be repaired without approval of the purchaser.

## **12. Keywords**

12.1 bridge plates; bronze castings; copper-alloy castings; copper-base alloy castings; expansion bearings

# **APPENDIXES**

## **(Nonmandatory Information)**

### **X1. APPLICATIONS FOR ALLOYS IN THIS STANDARD**

X1.1 The alloys in this specification have historically been used in the following applications. This information is provided for “information only” and should not be considered as recommendations.

X1.1.1 *Copper Alloy UNS No. C91300 (Formerly Alloy A)*—For contact with hardened steel disks at low speeds under pressures not over 3 ksi (20 MPa), for example, disk-bearing metals used in center-bearing swing bridges.

X1.1.2 *Copper Alloy UNS No. C91100 (Formerly Alloy B)*—For contact with hardened steel disks at low speeds under pressures not over 2.5 ksi (17 MPa), for example, disk-bearing metals used in turntable and center-bearing swing bridges; for contact with steel (tensile strength 60 ksi (415 MPa), min) at low speeds under pressures not over 1.5 ksi (10 MPa), for example, trunnions of movable bridges; and for bearing and expansion plates under pressures not to exceed 2.5 ksi.

X1.1.3 *Copper Alloy UNS No. C90500 (Formerly Alloy D)*—For gears, worm wheels, nuts, and similar parts that are subjected to other than compressive stresses.

X1.1.4 *Copper Alloy UNS No. C86300 (Formerly Alloy E)*—For bushings for bridge pins and similar applications in which angular movement is slight and compressive stresses may attain 8 ksi (55 MPa).

X1.1.5 *Copper Alloy UNS No. C93700 (Formerly Alloy C)*—For ordinary machinery bearings and for bearing and expansion plates under pressures not to exceed 1 ksi (6.9 MPa).

### **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 1 kg, gives it an acceleration of 1 m/s<sup>2</sup> (N = kg·m/s<sup>2</sup>). The derived SI unit for pressure or stress is the newton per square metre (N/m<sup>2</sup>), 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<sup>2</sup> and N/mm<sup>2</sup>.

**SUMMARY OF CHANGES**

This section identifies principle Committee B05 has identified the location of selected changes to this specification standard since the last issue (B 22 - 95) that may impact the use of this standard.

~~(1) Section 1 was revised. The nonmandatory information Comprehensive 5-year review completed. Some sections were renumbered, and in Section 1 was moved some cases, reworded to Appendix X1. conform to the new *Form and Style for ASTM Standards (Blue Book)*.~~

~~(2) New Section 3 Terminology) The safety caveat was added.~~

~~(3) Old Sections 3 and 9 were revised.) Table 1, Chemical Requirements has been changed to reflect the current CDA Standard Designations. Some required chemical compositions have been changed.~~

~~(4) New) Practice E 255 has been added to Section 7 Test Methods was added. 2, Referenced Documents and Section 9, Sampling.~~

~~(5) Material(s) and Manufacture, Section 6, has been added per the requirements *Outline of Form C9*.~~

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