Designation: ~~B148 – 97 (Reapproved 2009)~~ B148 – 14

Standard Specification for Aluminum-Bronze Sand Castings[1]

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~~ 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 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 ~~Orders for castings~~Include the following specified choices when placing orders for product under this specification ~~shall include the following information:~~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),

---

[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 ~~April 1, 2009~~April 1, 2014. Published ~~May 2009~~May 2014. Originally approved in 1941. Last previous edition approved in ~~2003~~2009 as B148 – 97 ~~(2003)~~(2009).~~ε1~~. DOI: ~~10.1520/B0148-97R09.~~10.1520/B0148-14.

[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.

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

TABLE 1 Nominal Compositions

Copper Alloy UNS No.	Old ~~Desig-nation~~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.

5.1.5 ~~Quality~~Quantity of castings required,
5.1.6 ~~Copper alloy number (~~Intended applications,~~Table 1) and temper (as-cast, heat treated, and so forth),~~
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 ~~8~~10),
5.1.16 *ASME Boiler and Pressure Vessel Code*[4] application (~~9.2~~12.2 and Section ~~11~~14),
5.1.17 Castings for seawater service (~~5.3~~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 ~~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.~~ *Materials:*

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

TABLE ~~2~~4 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	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~~	~~0.5 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 ~~0.2~~0.20 max and tin ~~0.02~~0.20 max.
[C] Iron content shall not exceed the nickel content.

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

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.

~~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.~~

7. Chemical Composition

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

TABLE ~~3~~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 min), %	. . .	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~~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 ~~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 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)

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.

7.1 ~~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~~ The material shall conform to the chemical composition requirements in Table 4 ~~the table are analyzed, their sum shall be as~~ for the copper alloy UNS. No. designation specified in the ~~following table:~~ ordering information.

~~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~~

7.1.1 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