Designation: B 505/B 505M – 02

Standard Specification for Copper Alloy Continuous Castings[1]

This standard is issued under the fixed designation B 505/B 505M; 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.

1. Scope*

1.1 This specification establishes requirements for continuously cast rod, bar, tube, and shapes produced from copper alloys with nominal compositions as listed in Table 1.[2]

1.2 Castings produced to this specification may be manufactured for and supplied from stock. In such cases the manufacturer shall maintain heat traceability to specific manufacturing date and chemical analysis.

1.3 The values stated in inch/pound or SI units are to be regarded separately as standard. The values stated in 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.

1.4 *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 Alloys for Sand, Permanent Mold, Centrifugal and Continuous Castings[3]

B 824 Specification for General Requirements for Copper Alloy Castings[3]

B 846 Terminology for Copper and Copper Alloys[3]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 8M Test Methods for Tension Testing of Metallic Materials (Metric)[4]

E 10 Test Method for Brinell Hardness of Metallic Materials[4]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[4]

E 255 Practice for Sampling of Copper and Copper Alloys for the Determination of Chemical Composition[5]

E 527 Practice for Numbering Metals and Alloys (UNS)[6]

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology B 846.

4. General Requirements

4.1 The following sections of Specification B 824 form a part of this specification. The definition of a casting lot as defined in Section 12, Sampling, takes precedence over Specification B 824.

4.1.1 Terminology (Section 3),
4.1.2 Other Requirements (Section 7),
4.1.3 Workmanship, Finish, and Appearance (Section 9),
4.1.4 Number of Tests and Retests (Section 11),
4.1.5 Specimen Preparation (Section 12),
4.1.6 Test Methods (Section 13),
4.1.7 Significance of Numerical Limits (Section 14),
4.1.8 Inspection (Section 15),
4.1.9 Rejection and Rehearing (Section 16),
4.1.10 Certification (Section 17),
4.1.11 Test Report (Section 18),
4.1.12 Product Marking (Section 19),
4.1.13 Packaging and Package Marking (Section 20),
4.1.14 Keywords (Section 21), and
4.1.15 Supplementary Requirements.

5. Ordering Information

5.1 Include the following information in orders for product:

[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 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 03.05.

[6] *Annual Book of ASTM Standards*, Vol 01.01.

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

TABLE 1 Nominal Composition

Copper Alloy UNS No.	Designation	Composition, %							
		Copper	Tin	Lead	Zinc	Nickel	Aluminum	Iron	Manganese
C83600	leaded red brass	85	5	5	5	...	...	...	...
C83800	leaded red brass	82.9	3.8	6	6.5	...	...	...	...
C84200	leaded semi-red brass	80	5	2.5	13	...	...	...	...
C84400	leaded semi-red brass	80	2.9	7	8.5	...	...	...	...
C84800	leaded semi-red brass	76	2.5	6.2	15	...	...	...	...
C85700	leaded naval brass	61	1	1.2	36	...	...	...	...
C86200	high-strength yellow brass	63	...	...	25	...	4	3	3.8
C86300	high-strength yellow brass	63	...	...	25	...	6.2	3	3.8
C86500	high-strength yellow brass	57.5	...	...	39	...	1	1.2	0.8
C89320[A]	bismuth tin bronze	89	6	...	...	...	...	...	...
C90300	tin bronze	87.5	8.2	...	4	...	...	...	...
C90500	tin bronze	87.5	10	...	2	...	...	...	...
C90700	tin bronze	89	11	...	...	...	...	...	...
C91000	tin bronze	85	15	...	...	...	...	...	...
C91300	tin bronze	80.5	19	...	...	...	...	...	...
C92200	leaded tin bronze	88	6	1.5	4	...	...	...	...
C92300	leaded tin bronze	87	8.2	0.6	3.8	...	...	...	...
C92500	nickel-phosphor bronze	86.5	11	1.2	...	1.2	...	...	...
C92700	leaded tin bronze	87.5	10	1.8	...	...	...	...	...
C92800	leaded tin bronze	80	16	5	...	...	...	...	...
C92900	leaded nickel-tin bronze	84	10	2.6	...	3.4	...	...	...
C93200	high-leaded tin bronze	83	6.9	7	3	...	...	...	...
C93400	high-leaded tin bronze	83.5	8	8	...	...	...	...	...
C93500	high-leaded tin bronze	84.5	5.2	9	1	...	...	...	...
C93600	high-leaded tin bronze	81	7	12	...	...	...	...	...
C93700	high-leaded tin bronze	80	10	9.5	...	...	...	...	...
C93800	high-leaded tin bronze	77	6.9	14.5	...	...	...	...	...
C93900	high-leaded tin bronze	78	6	16	...	...	...	...	...
C94000	high-leaded tin bronze	70.5	13	15	...	...	...	...	...
C94100	high-leaded tin bronze	75.5	5.5	20	...	...	...	...	...
C94300	high-leaded tin bronze	69.5	5.2	25	...	...	...	...	...
C94700	nickel-tin bronze	87.5	5.2	0	1.8	5.2	...	...	...
C94800	leaded nickel-tin bronze	86.5	5.2	0.6	1.8	5.2	...	...	...
C95200	aluminum bronze	87.8	...	...	...	...	9	3.2	...
C95300	aluminum bronze	88.8	...	...	...	...	10	1.2	...
C95400	aluminum bronze	85.2	...	...	...	...	10.8	4	...
C95410	aluminum bronze	83.2	...	...	...	2	10.8	4	...
C95500	nickel-aluminum bronze	81	...	...	...	4.2	10.8	4	...
C95520	nickel-aluminum bronze	79.1	...	...	...	5.1	11	4.8	...
C95700	manganese nickel aluminum bronze	74.8	...	...	...	2.2	7.5	3	12.5
C95800	nickel-aluminum bronze	81.3	...	...	...	4.5	9	4	1.2
C95900	aluminum bronze	83.2	...	...	...	...	12.8	4.0	...
C96400	copper-nickel	67	...	...	...	30	...	0.90	...
C96900	copper-nickel	76.8	8	...	...	15	...	...	0.20
C97300	leaded nickel bronze	55.5	2.2	9.5	21	12.5	...	...	...
C97600	leaded nickel bronze	65	4	4	6	20.2	...	...	...
C97800	leaded nickel bronze	65.5	4.8	1.8	2.5	25.5	...	...	...
C99500[B]	special alloy	89.1	...	...	1.2	4.5	1.2	4.0	...

[A] Bismuth 5.0
[B] Silicon 1.3

5.1.1 ASTM designation and year of issue (for example, B 505/B 505M-96),

5.1.2 Copper Alloy UNS No. (for example, C93200), including HT if heat treatment is required.

5.1.3 Condition (Table 9) and (as cast, heat treated, and so forth),

5.1.4 Dimensions: inside diameter, outside diameter, thickness and width,

5.1.5 Form: cross-section, such as tube, round, hexagon, octagon, square, or rectangle,

5.1.6 Tolerances, if different from Section 10 and Tables 2-8.

5.1.7 Length (including length tolerance if other than mill lengths),

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

5.1.9 *ASME Boiler and Pressure Vessel Code*[7] requirements (if required see Section 9),

5.1.10 When castings are purchased for agencies of the U.S. government, the Supplementary Requirements of Specification B 824 may be specified.

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

5.2.1 Chemical analysis of residual elements (Section 7 and Specification B 824),

5.2.2 Mechanical requirements, (Section 8 Test Methods E 8),

5.2.3 Witness inspection (Specification B 824),

[7] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

TABLE 2 Suggested Heat Treatments

Copper Alloy UNS No.	Solution Treatment (not less than 1 h followed by water quench), °F(°C)	Annealing Treatment (not less than 2 h followed by air cool), °F(°C)
C95300	1585–1635 (860–890)	1150–1225 (620–660)
C95400, C95410, C95500	1600–1675 (870–910)	1150–1225 (620–660)
C95520	(2 h followed by water quench) 1600–1700 (870–925)	925–1000 (495–540)

TABLE 3 Finishing Allowances for Tube (Round Only)

Finished Outside Diameter, in. (mm)	Finish Allowances Added to Finished or Print Dimensions of the Part, in. (mm)	
	Inside Diameter	Outside Diameter
All Alloys Except as Noted Below		
Up to 4 (102), excl	−0.031 (−0.79)	+ 0.031 (0.79)
4 (102)–5 (127), incl	−0.063 (−1.6)	+ 0.063 (1.6)
Over 5 (127)	−0.094 (−2.4)	+ 0.094 (2.4)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, and C96400		
Up to 3 (76.2), incl	−0.125 (−3.2)	+ 0.063 (1.6)
Over 3 (76.2)–4 (102), incl	−0.125 (−3.2)	+ 0.094 (2.4)
Over 4 (102)–5½ (140), incl	−0.188 (−4.8)	+ 0.125 (3.2)
Over 5½ (140)	−0.250 (−6.4)	+ 0.188 (4.8)

TABLE 4 Finishing Allowances for Rod and Bar

Finished Outside Diameter or Distance Between Parallel Surfaces, in. (mm)	Rounds	Squares, Rectangles, Hexagons, Octagons
All Alloys Except as Noted Below		
Up to 4 (102), excl	+ 0.031 (0.79)	+ 0.031 (0.79)
4 (102)–5 (127), incl	+ 0.063 (1.6)	+ 0.063 (1.6)
Over 5 (127)	+ 0.094 (2.4)	+ 0.094 (2.4)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, C96400		
Up to 3 (76.2), incl	+ 0.0625 (1.6)	+ 0.0625 (1.6)
Over 3 (76.2)–4 (102), incl	+ 0.093 (2.4)	+ 0.093 (2.4)
Over 4 (102)–5½ (140), incl	+ 0.125 (3.2)	+ 0.125 (3.2)
Over 5½ (140)	+ 0.188 (4.8)	+ 0.188 (4.8)

5.2.4 Certification (Specification B 824),

5.2.5 Foundry test report (Specification B 824),

5.2.6 Product marking (Specification B 824),

5.2.7 Castings for seawater service (Section 6), and

5.2.8 Approval of weld repair and records of repair (Section 11).

6. Materials and Manufacture

6.1 For better corrosion resistance in seawater applications, castings in Copper Alloy UNS No. C95800 shall be given a temperature 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 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 9. Suggested

TABLE 5 Diameter Tolerances for Rod and Bar

Diameter or Distance Between Parallel Surfaces, in. (mm)	Tolerances, Plus[A] and Minus,[A] in. (mm)	
	Rounds	Squares, Rectangles, Hexagons, Octagons
All Alloys Except as Noted Below		
Up to 4 (102), excl	0.005 (0.13)	0.016 (0.41)
4 (102)–5 (127), incl	0.008 (0.20)	0.016 (0.41)
Over 5 (127)	0.016 (0.41)	0.016 (0.41)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, and C96400		
Up to 3 (76.2), incl	0.010 (0.25)	0.020 (0.51)
Over 3 (76.2)–4 (102), incl	0.015 (0.38)	0.020 (0.51)
Over 4 (102)–5½ (140), incl	0.020 (0.51)	0.020 (0.51)
Over 5½ (140)	0.025 (0.64)	0.025 (0.64)

[A] When tolerances are specified as all plus or all minus, double the values given.

TABLE 6 Diameter Tolerances for Tube (Round Only)

Average Outside Diameter, in. (mm)	Tolerances, in. (mm)		
	Outside Diameter	Inside Diameter	
	Plus[A] or Minus[A]	Plus[B]	Minus[B]
All Alloys Except as Noted Below			
Up to 4 (102), excl	0.005 (0.13)	0.012 (0.30)	0.033 (0.84)
4 (102)–5 (127), incl	0.008 (0.20)	0.016 (0.41)	0.046 (1.2)
Over 5 (127)	0.016 (0.41)	0.032 (0.81)	0.064 (1.6)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, and C96400			
Up to 3 (76), incl	0.010 (0.25)	0.012 (0.32)	0.033 (0.84)
Over 3 (76)–4 (102), incl	0.015 (0.38)	0.015 (0.38)	0.050 (1.3)
Over 4 (102)–5½ (140), incl	0.020 (0.51)	0.025 (0.64)	0.070 (1.8)
Over 5½ (140)	0.025 (0.64)	0.035 (0.86)	0.090 (2.3)

[A] When tolerances are specified as all plus or all minus double the values given.
[B] When tolerances are specified as all plus or all minus, total the values given.

TABLE 7 Roundness Tolerances

Outside Diameter, in. (mm)	Maximum Out-of-Roundness,[A] in. (mm)
Up to 4 (102), excl	0.020 (0.51)
4 (102)–5 (127), incl	0.032 (0.81)
Over 5 (127)	0.064 (1.6)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, and C96400	
Up to 3 (76.2), incl	0.025 (0.64)
Over 3 (76.2)–4 (102), incl	0.040 (1.0)
Over 4 (102)–5½ (140), incl	0.060 (1.5)
Over 5½ (140)	0.075 (1.9)

[A] The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube.

TABLE 8 Tolerances for Shapes

Outside Dimension,[A] in. (mm)		Inside Dimension,[B] in. (mm)	
All Alloys Except as Noted Below			
Plus	Minus	Plus	Minus
0.016 (0.41)	0.016 (0.41)	0.032 (0.81)	0.064 (1.6)
Copper Alloy UNS Nos. C86200, C86300, C86500, C95200, C95300, C95400, C95500, C95800, C95900, and C96400			
Dimensional tolerances shall be subject to agreement between purchaser and manufacturer.			

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] When tolerances are specified as all plus or all minus, total the values given.

TABLE 9 Mechanical Requirements

Copper Alloy UNS No.	Tensile Strength, min[A]		Yield Strength, at 0.5 % Extension Under Load, min[A]		Elongation in 2 in. or 50 mm, min, %	Brinell Hardness, min	Remarks
	ksi[B]	MPa[C]	ksi[B]	MPa[C]			
C83600	36	248	19	131	15		
C83800	30	207	15	97	16		
C84200	32	221	16	110	13		
C84400	30	207	15	103	16		
C84800	30	207	15	103	16		
C85700	40	276	14	97	15		
C86200	90	621	45	310	18		
C86300	110	758	62	427	14		
C86500	70	483	25	172	25		
C89320	35	241	18	124	15		
C90300	44	303	22	152	18		
C90500	44	303	25	172	10		
C90700	40	276	25	172	10		
C91000	30	207	...	...	...	160 (3000 kg)	
C91300	...	...	...	...	...		
C92200	38	262	19	131	18		
C92300	40	276	19	131	16		
C92500	40	276	24	165	10		
C92700	38	252	20	138	8	...	Rockwell
C92800	...	...	...	...	...		B 72–82
C92900	45	310	25	172	8		
C93200	35	241	20	138	10		
C93400	34	234	20	138	8		
C93500	30	207	16	110	12		
C93600	33	227	20	138	10		
C93700	35	241	20	138	6		
C93800	25	172	16	110	5		
C93900	25	172	16	110	5		
C94000	...	...	...	...	...	80 (500 kg)	
C94100	25	172	17	117	7		
C94300	21	145	15	103	7		
C94700	45	310	20	138	25		
C94700HT	75	517	50	345	5		heat treated
C94800	40	276	20	138	20		
C95200	68	469	26	179	20		
C95300	70	483	26	179	25		
C95300HT	80	552	40	276	12		heat treated
C95400	85	586	32	221	12		
C95400HT	95	655	45	310	10		heat treated
C95410	85	586	32	221	12		
C95410HT	95	655	45	310	10		heat treated
C95500	95	655	42	290	10		
C95500HT	110	758	62	427	8		heat treated
C95520HT	125	862	95[D]	655[D]	2	262 (3000 kg)	heat treated[E]
C95700	90	620	40	275	15		
C95800[F]	85	586	35	241	18		
C95900	...	...	...	...	...	241 (3000 kg)	
C96400	65	448	35	241	25		
C96900HT	110	758	105[D]	724[D]	4		Rockwell C32
C97300	30	207	15	103	8		
C97600	40	276	20	138	10		
C97800	45	310	22	152	8		
C99500	70	483	40	276	12		

[A] Minimum tensile strength and yield strength shall be reduced 10 % for cast bars having a cross section, thickness, diameter, or wall of 4 in. (102 mm) or more. The cross sections are the diameter of a round solid, the distance across the flats of a solid hexagon, the thickness of a rectangle, and the wall thickness of a tube.
[B] ksi = 1000 psi.
[C] See Appendix.
[D] Yield strength at 0.2 % offset, min[A], ksi[B], MPa[C].
[E] Copper Alloy UNS No. C95520 used only in the quench-hardened and tempered (TQ30) condition.
[F] As cast or temper annealed.

heat treatments for these alloys and Copper Alloy UNS No. C95520 are given in Table 2. Actual practice may vary by manufacturer.

6.3 Copper Alloy UNS No. C95520 is used only in the quench-hardened and tempered (TQ30) condition, see Table 2.

6.4 Copper Alloy UNS No. C96900 is normally supplied heat treated at 1520°F (825°C) for 1 h followed by a water quench, then aged at 800°F (425°C) for 4 h followed by a water quench.

6.5 If test bar coupons representing castings made in Copper Alloy UNS Nos. C94700HT, C95300HT, C95400HT, C95410HT, C95500HT, C95520HT, C95800 temper annealed, C95900 annealed, and C96900 are removed from the continuous castings before heat treatment, the coupons shall be heat treated with the continuous castings.

7. Chemical Composition

7.1 The continuous castings shall conform to the requirements for major elements shown in Table 10.

TABLE 10 Chemical Requirements

Copper Alloy UNS No.	Composition, % max, except as indicated															
	Major Elements								Residual Elements							
	Copper	Tin	Lead	Zinc	Iron	Nickel Including Cobalt	Aluminum	Manganese	Iron	Antimony	Nickel Including Cobalt	Sulfur	Phosphorus	Aluminum	Manganese	Silicon
C83600	84.0–86.0	4.0–6.0	4.0–6.0	4.0–6.0	...	1.0[A]	...	...	0.30	0.25	...	0.08	1.5	0.005	...	0.005
C83800	82.0–83.8	3.3–4.2	5.0–7.0	5.0–8.0	...	1.0[A]	...	...	0.30	0.25	...	0.08	1.5	0.005	...	0.005
C84200	78.0–82.0	4.0–6.0	2.0–3.0	10.0–16.0	...	0.8[A]	...	...	0.40	0.25	...	0.08	1.5	0.005	...	0.005
C84400	78.0–82.0	2.3–3.5	6.0–8.0	7.0–10.0	...	1.0[A]	...	...	0.40	0.25	...	0.08	1.5	0.005	...	0.005
C84800	75.0–77.0	2.0–3.0	5.5–7.0	13.0–17.0	...	1.0[A]	...	...	0.40	0.25	...	0.08	1.5	0.005	...	0.005
C85700	58.0–64.0	0.50–1.5	0.8–1.5	32.0–40.0	...	...	...	...	0.7	...	1.0[A]	...	...	0.80	...	0.05
C86200	60.0–66.0	0.20	0.20	22.0–28.0	2.0–4.0	...	3.0–4.9	2.5–5.0	...	...	1.0[A]	...	...	...	...	...
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[A]	...	...	...	...	...
C86500	55.0–60.0	1.0	0.40	36.0–42.0	0.40–2.0	...	0.50–1.5	0.10–1.5	...	...	1.0[A]	...	...	...	...	...
C89320[B]	87.0–91.0	5.0–7.0	0.09	1.0	...	1.0	...	...	0.20	0.35	...	0.08	0.30	0.005	...	0.005
C90300	86.0–89.0	7.5–9.0	0.30	3.0–5.0	...	1.0[A]	...	...	0.20	0.20	...	0.05	1.5	0.005	...	0.005
C90500	86.0–89.0	9.0–11.0	0.30	1.0–3.0	...	1.0[A]	...	...	0.20	0.20	...	0.05	1.5	0.005	...	0.005
C90700	88.0–90.0	10.0–12.0	0.50[A]	0.50	...	0.50[A]	...	...	0.15	0.20	...	0.05	1.5	0.005	...	0.005
C91000	84.0–86.0	14.0–16.0	0.20	1.5	...	0.8[A]	...	...	0.10	0.20	...	0.05	1.5	0.005	...	0.005
C91300	79.0–82.0	18.0–20.0	0.25	0.25	...	0.50[A]	...	...	0.25	0.20	...	0.05	1.5	0.005	...	0.005
C92200	86.0–90.0	5.5–6.5	1.0–2.0	3.0–5.0	...	1.0[A]	...	...	0.25	0.25	...	0.05	1.5	0.005	...	0.005
C92300	85.0–89.0	7.5–9.0	0.3–1.0	2.5–5.0	...	1.0[A]	...	...	0.25	0.25	...	0.05	1.5	0.005	...	0.005
C92500	85.0–88.0	10.0–12.0	1.0–1.5	0.50	...	0.8–1.5[A]	...	...	0.30	0.25	...	0.05	1.5	0.005	...	0.005
C92700	86.0–89.0	9.0–11.0	1.0–2.5	0.7	...	1.0[A]	...	...	0.20	0.25	...	0.05	1.5	0.005	...	0.005
C92800	78.0–82.0	15.0–17.0	4.0–6.0	0.8	...	0.8[A]	...	...	0.20	0.25	...	0.05	1.5	0.005	...	0.005
C92900	82.0–86.0	9.0–11.0	2.0–3.2	0.25	...	2.8–4.0	...	...	0.20	0.25	...	0.05	1.5	0.005	...	0.005
C93200	81.0–85.0	6.3–7.5	6.0–8.0	2.0–4.0	...	1.0[A]	...	...	0.20	0.35	...	0.05	1.5	0.005	...	0.005
C93400	82.0–85.0	7.0–9.0	7.0–9.0	0.8	...	1.0[A]	...	...	0.20	0.50	...	0.08	1.5	0.005	...	0.005
C93500	83.0–86.0	4.3–6.0	8.0–10.0	2.0	...	1.0[A]	...	...	0.20	0.30	...	0.08	1.5	0.005	...	0.005
C93600	79.0–83.0	6.0–8.0	11.0–13.0	1.0	...	1.0	...	...	0.20	0.55	...	0.08	1.5	0.005	...	0.005
C93700[C]	78.0–82.0	9.0–11.0	8.0–11.0	0.8	...	0.50	...	...	0.70	0.50	...	0.08	1.5	0.005	...	0.005
C93800	75.0–79.0	6.3–7.5	13.0–16.0	0.8	...	1.0	...	...	0.15	0.80	...	0.08	1.5	0.005	...	0.005
C93900	76.5–79.5	5.0–7.0	14.0–18.0	1.5	...	0.8	...	...	0.40	0.50	...	0.08	1.5	0.005	...	0.005
C94000	69.0–72.0	12.0–14.0	14.0–16.0	0.50	...	0.5–1.0	...	...	0.25	0.50	...	0.08	1.5	0.005	...	0.005
C94100	72.0–79.0	4.5–6.5	18.0–22.0	1.0	...	1.0	...	...	0.25	0.8	...	0.08	1.5	0.005	...	0.005
C94300	67.0–72.0	4.5–6.0	23.0–27.0	0.8	...	1.0	...	...	0.15	0.8	...	0.08	1.5	0.005	...	0.005
C94700[D]	85.0–90.0	4.5–6.0	0.10	1.0–2.5	...	4.5–6.0	...	...	0.25	0.15	...	0.05	0.05	0.005	0.20	0.005
C94800	84.0–89.0	4.5–6.0	0.3–1.0	1.0–2.5	...	4.5–6.0	...	...	0.25	0.15	...	0.05	0.05	0.005	0.20	0.005
C95200	86.0 min	...	...	...	2.5–4.0	...	8.5–9.5	...	...	...	...	...	...	...	...	...
C95300	86.0 min	...	...	...	0.8–1.5	...	9.0–11.0	...	...	...	...	...	...	...	...	...
C95400	83.0 min	...	...	...	3.0–5.0	1.5	10.0–11.5	0.50	...	...	...	...	...	...	...	...
C95410	83.0 min	...	...	...	3.0–5.0	1.5–2.5	10.0–11.5	0.50	...	...	...	...	...	...	...	...
C95500	78.0 min	...	...	...	3.0–5.0	3.0–5.5	10.0–11.5	3.5	...	...	...	...	...	...	...	...
C95520[E]	74.5 min	0.25	0.03	0.30	4.0–5.5	4.2–6.0	10.5–11.5	1.5	...	...	...	...	...	...	...	...
C95700	71.0 min	...	0.03	...	2.0–4.0	1.5–3.0	7.0–8.0	11.0–14.0	...	...	...	...	...	...	...	0.10
C95800[F]	79.0 min	...	0.03	...	3.5–4.5	4.0–5.0	8.5–9.5	0.8–1.5	...	...	...	...	...	...	...	0.10
C95900	remainder	...	...	...	3.0–5.0	0.5	12.0–13.5	1.5	...	...	...	...	...	...	...	...
C96400[G]	65.0–69.0	...	0.01	...	0.25–1.50	28.0–32.0	...	1.5	...	...	...	0.02	0.02	...	...	0.50
C96900[H]	remainder	7.5-8.5	0.02	0.50	...	14.5-15.5	...	0.05-0.30	0.5	...	...	...	...	...	...	...
C97300	53.0–58.0	1.5–3.0	8.0–11.0	17.0–25.0	...	11.0–14.0	...	...	1.5	0.35	...	0.08	0.05	0.005	0.50	0.15
C97600	63.0–67.0	3.5–4.5	3.0–5.0	3.0–9.0	...	19.0–21.5	...	...	1.5	0.25	...	0.08	0.05	0.005	1.0	0.15
C97800	64.0–67.0	4.0–5.5	1.0–2.5	1.0–4.0	...	24.0–27.0	...	...	1.5	0.20	...	0.08	0.05	0.005	1.0	0.15
C99500[I]	remainder	...	0.25	0.5-2.0	3.0-5.0	3.5-5.5	0.5-2.0	0.5	...	...	...	...	...	...	...	...

[A] In determining copper minimum, copper may be calculated as copper plus nickel.
[B] Bismuth 4.0–6.0
[C] Fe shall be 0.35 % max, when used for steel-backed bearings.
[D] It is possible that the mechanical requirements of Copper Alloy UNS No. C94700 in the heat-treated condition will not be attained if the lead content exceeds 0.01 %.
[E] Chromium content shall be 0.05 max, cobalt 0.20 max, and silicon 0.15 max.
[F] Iron content shall not exceed nickel content. Other major element chemical requirements: Silicon 0.10 % max.
[G] Chemical requirements for other elements: Sulfur 0.02 % max (major), carbon 0.15 % max (residual), and niobium 0.5-1.5 (major).
[H] Magnesium 0.15 max (major), silicon 0.30 max (residual), niobium 0.10 max (residual).
[I] Silicon 0.5-2.0

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. Copper or zinc 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 10 are analyzed, their sum shall be as specified in Table 11.

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

8. Mechanical Property Requirements

8.1 Reference should be made to Table 9 for minimum mechanical requirements.

8.2 Mechanical tests are required only when specified by the purchaser in the purchase order.

8.3 Exceptions to mechanical property requirements may be taken in the case of small diameter solids or castings having section thicknesses less than the ½-in. (12.7-mm) diameter of the standard tension test specimen. In these cases, mechanical property requirements shall be subject to agreement between the purchaser and the manufacturer. For suggested dimensions of substandard test bars, see Test Methods E 8.

9. ASME Requirements

9.1 When specified in the purchase order to meet *ASME Boiler and Pressure Vessel Code* requirements, continuous castings shall comply with the following:

9.1.1 Certification requirements of Specification B 824.

9.1.2 Foundry test report requirements of Specification B 824.

9.1.3 Continuous castings shall be marked with the manufacturer's name, the Copper Alloy UNS No., 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 lb (22.7 kg) or more. Pressure-containing castings weighing less than 50 lb (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 not to injure the usefulness of the casting.

9.1.4 When Copper Alloy UNS No. C95200 is specified to meet *ASME Boiler and Pressure Vessel Code* requirements, a sample from each 2000-lb interval or continuous casting shall be tested. Each continuous casting from which the test bar was taken shall be identified should retesting be required. If all of the test bars from the initial sampling meet the requirements, the lot shall be acceptable. The fractured bars shall be retained for chemical verification.

TABLE 11 Sum of All Named Elements Analyzed

Copper Alloy UNS No.	Copper Plus Named Elements, %min	Copper Alloy UNS No.	Copper Plus Named Elements, %min
C83600	99.3	C93600	99.3
C83800	99.3	C93700	99.0
C84200	99.3	C93800	99.0
C84400	99.3	C93900	98.9
C84800	99.3	C94000	98.7
C85700	98.7	C94100	98.7
C86200	99.0	C94300	99.0
C86300	99.0	C94700	98.7
C86500	99.0	C94800	98.7
C89320	99.5	C95200	99.0
C90300	99.4	C95300	99.0
C90500	99.7	C95400	99.5
C90700	99.4	C95410	99.5
C91000	99.4	C95500	99.5
C91300	99.4	C95520	99.5
C92200	99.3	C95700	99.5
C92300	99.3	C95800	99.5
C92500	99.3	C95900	99.5
C92700	99.3	C96400	99.5
C92800	99.3	C96900	99.5
C92900	99.3	C97300	99.0
C93200	99.0	C97600	99.7
C93400	99.0	C97800	99.6
C93500	99.0	C99500	99.7

TABLE 12 Straightness Tolerances

Product	Length,[A] ft (m)	Maximum Curvature[B] (Depth of Arc), in. (mm)
Round rod or tube	up to 10 (3.05)	¼ (6.4) in any 5-ft (1.52-m) portion
	10 (3.05) and over	½ (13) in any 10-ft (3.05-m) portion[A]
Bar and shape	any length	½ (13) in any 6-ft (1.83-m) portion[A,B]

[A] Of total length.
[B] Applicable to any longitudinal surface or edge.

10. Dimensions and Permissible Variations

10.1 Allowance for finishing over maximum outside dimension and under inside dimension of round tubes to be machined shall be as shown in Table 3. Allowances for finishing the outside diameter of rounds and distance between parallel surfaces of bars to be machined shall be as shown in Table 4. Table 3 and Table 4 are to be used in conjunction with Tolerance Table 6 and Table 5, respectively.

10.2 *Concentricity*:

10.2.1 *All Alloys Except as Noted in* 10.2.2—The outside periphery of continuously cast tubing shall be concentric with the bore within a permissible variation of 2 % of the nominal wall thickness over ¼ in. (6.35 mm). If the wall thickness is ¼ in. or less, permissible variations in concentricity shall be subject to agreement between the purchaser and the manufacturer.

10.2.2 *Copper Alloy UNS Nos. C86200, C86300, C86400, C95200, C95300, C95400, C95410, C95500, C95520, C95800, C95900, and C96400*—The outside periphery of continuously cast tubing shall be concentric with the bore within a permissible variation of 4 % of the nominal wall thickness.

10.3 *Diameter Tolerances for Continuously Cast Rod and Bar*—See Table 5.

10.4 *Diameter Tolerances for Continuously Cast Tube (Round only)*—See Table 6.

10.5 *Roundness*—For continuously cast tubing in straight lengths, the roundness tolerances shall be as shown in Table 7.

10.6 *Dimensional Tolerances for All Other Shapes (not Covered by* 10.1 *or* 10.2*)*—See Table 8.

11. Casting Repair

11.1 Continuous castings shall not be mechanically repaired, plugged, or burned in.

11.2 Weld repair is permitted for Copper Alloy UNS Nos. C95200, C95300, C95400, C95410, C95500, C95800, and C95900.

11.3 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.

11.4 Excavations that exceed those described in 11.3 may be made at the manufacturer's discretion, except that when specified in the purchase order (5.2), the weld procedure shall be approved by the purchaser and the following records shall be maintained:

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

11.4.2 Post-weld heat treatment, when applicable,

11.4.3 Weld repair inspection results,

11.4.4 Casting identification number,

11.4.5 Weld procedure identification number,

11.4.6 Welder identification, and

11.4.7 Name of inspector.

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

11.6 Weld repair of other alloys in this specification is not permitted without approval by the purchaser.

12. Sampling

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

12.2 Unless otherwise specified, a lot shall consist of castings of the same composition and same cross-sectional dimensions, produced during the continuous operation of one casting machine, and submitted for inspection at one time.

12.3 A sample for chemical analysis shall be taken from each lot at each interval of 2000 lb (910 kg) of continuous production of the lot. When castings are produced from alloy ingots of known composition, the sampling interval may be raised to one sample for each 4000 lb (1810 kg) of continuous production of the lot.

12.4 When mechanical testing is specified by the purchaser in the purchase order one sample for tension testing shall be taken from each lot. This sample may be taken before mechanical straightening. Test bar specimens shall be positively identified with the castings they represent. Where castings are heat treated, test bar specimens shall be heat treated with the castings they represent.

12.5 When Copper Alloy UNS No. C95200 is specified for ASME boiler and pressure vessel application, a sample from each 2000-lb interval or continuous casting shall be tested. Each continuous cast bar from which the test bar was taken shall be identified should retesting be required. If all of the test bars from the initial sampling meet the requirements, the lot shall be acceptable.

12.5.1 The fractured bars shall be retained for chemical verification.

12.6 Tension test bar specimens shall be taken from continuous castings in accordance with Fig. 6 of Practice B 208.

13. Test Methods

13.1 Analytical chemical methods are given in Specification B 824 (Section 13).

13.2 Brinell Hardness Reading shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Method E 10. If a Brinell hardness is required and a tension test is not required, testing shall be in accordance with Test Method E 10.

13.3 Rockwell Hardness Reading shall be taken on the grip end of the tension test bar and shall be made in accordance with Test Methods E 18. If a Rockwell hardness is required and a tension test is not required, testing shall be in accordance with Test Method E 18.

14. Product Marking

14.1 At the request of the purchaser castings shall be marked with the alloy number.

15. Keywords

15.1 continuous castings; copper alloy castings

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 which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). 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 ksi = 6 894 757 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 location of selected changes to this standard since the last issue (B 505 – 96) that may impact the use of this standard.

(*1*) Comprehensive 5-year review completed. Some sections were renumbered, and, in some cases reworded to conform to the new Committee B05 *Outline of Form for Specifications* (OFS) and *Form and Style for ASTM Standards* (Blue Book).
(*2*) The safety caveat was added.
(*3*) The Terminology section was added.
(*4*) Table 1, Nominal Composition was revised.
(*5*) Table 10, Chemical Requirements has been changed to reflect the current CDA Standard Designations. Some required chemical compositions have been changed.

(*6*) Added UNS Nos. C89320 and C93600 to Table 11, Sum of All Named Elements Analyzed. These additions reflect the current CDA Standard Designations.

(*7*) UNS No. C93800 has been changed to reflect the current CDA Standard Designations.

(*8*) Practice E 255 has been added to Section 2, Referenced Documents and Section 12, Sampling.