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 B 72–82
C92800	...	...	...	...	...		
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.