Designation: ~~B505/B505M – 18~~ B505/B505M – 22

Standard Specification for Copper Alloy Continuous Castings[1]

This standard is issued under the fixed designation B505/B505M; 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*

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 either SI units or inch-pound 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 non-conformance with the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *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
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
E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

[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 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~~standard's Document Summary page on the ASTM website.

***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	Silicon	Phosphorus	Bismuth	Sulfur
C83470	low-lead sulfur tin bronze	93	4	...	2	0.5	...	...	...	...	...	...	0.5
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	...	...	...	...	...	...	...	...
C85470	yellow brass	62.5	2.5	...	34.3	...	0.5	...	...	...	0.13	...	...
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	...	...	...	...
C87700	silicon bronze	88.5	...	...	8	...	...	...	...	3	...	...	...
C87710	silicon bronze	86	...	...	10	...	...	...	...	4	...	...	...
C87850	silicon brass	76	...	...	20.9	...	...	...	...	3	0.12	...	...
C89320	bismuth tin bronze	89	6	...	...	...	...	...	...	...	...	5.0	...
C89545	bismuth brass	69.0	...	...	29.0	0.5	1.0	...	...	...	0.08	0.55	...
~~C89720[A]~~	~~bismuth brass~~	~~67.4~~	~~1~~	~~...~~	~~29~~	~~...~~	~~0.5~~	~~...~~	~~...~~	~~0.5~~	~~...~~	~~1.5~~	~~...~~
C89720[A]	bismuth brass	67.4	1	...	29	...	0.5	...	...	0.5	...	1.5	...
C89838	bismuth brass	81.5	2.75	...	15.0	...	...	...	...	...	...	0.55	...
C89845	bismuth semi-red brass	85.0	4.0	...	7.5	2.0	...	...	...	...	...	1.5	...
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	...	...	...	...
C96970	copper-nickel-tin	85	6	...	...	9.0	...	...	...	...	...	...	...
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	special alloy	89.1	...	...	1.2	4.5	1.2	4.0	...	1.3	...	...	...

[A] Antimony 0.07, Boron 0.001.

2.2 *Other Standard:*[4]
ASME Boiler and Pressure Vessel Code

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

4. General Requirements

4.1 The following sections of Specification B824 form a part of this specification. The definition of a casting lot as defined in Section 12, Sampling, takes precedence over Specification B824.

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:

5.1.1 ASTM designation and year of issue (for example, B505/B505M – 04),

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),

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

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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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]

5.1.4 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* 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 B824 may be specified.

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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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.

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 B824),

5.2.2 Mechanical requirements, (Section 8 Test Methods E8/E8M),

5.2.3 Witness inspection (Specification B824),

5.2.4 Certification (Specification B824),

5.2.5 Foundry test report (Specification B824),

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. C85470, C86200, C86300, C86500, C87700, C87710, C87850, C89720, C89845, 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.

5.2.6 Product marking (Specification B824),

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~~1250 °F ± ~~50°F [675~~50 °F [675 °C ± ~~10°C]~~10 °C] for ~~6 h~~ 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 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]~~1520 °F [825 °C] for 1 h followed by a water quench, then aged at ~~800°F [425°C]~~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 elements shown in Table 10.

7.2 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

7.3 For alloys in which copper is listed as “remainder,” copper is the difference between the sum of results of all elements determined and 100 %.

7.4 For alloys in which zinc is listed as “remainder,” either copper or zinc may be taken as the difference between the sum of results of all other elements determined and 100 %.

7.5 When all named elements in Table 10 with values are analyzed, their sum shall be as specified in Table 11.

7.6 Analysis shall be made for Other Elements only when specified in the purchase order, and shall be considered outside the limits specified in Table 11.

TABLE 9 Mechanical Requirements

Copper Alloy UNS No.	Tensile Strength, min[A]		Yield Strength, at 0.5 % Extension Under Load, min[A]		Elongation in 4D or 2 in. or 50 mm, min, %	Brinell Hardness, min	Remarks
	ksi[B]	MPa[C]	ksi[B]	MPa[C]			
C83470	36	248	15	103	15		
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		
C85470	50	345	21	150	15		
C85700	40	276	14	97	15		
C86200	90	621	45	310	18		
C86300	110	758	62	427	14		
C86500	70	483	25	172	25		
C87700	25	172	17	117	18		
C87710	64	441	22	152	20		
C87850	65	448	25	172	8	103 [500 kg]	
C89320	35	241	18	124	15		
C89545	36	248	15	103	20		
~~C89720~~	~~36~~	~~250~~	~~16~~	~~110~~	~~18~~	~~70 [1000 kg]~~	
C89720	36	250	16	110	18	70 [1000 kg]	
C89838	36	248	15	103	20		
C89845	36	248	15	103	15		
C90300	44	303	22	152	18		
C90500	44	303	25	172	10		
C90700	40	276	25	172	10		
C91000	30	207	...	...	...		
C91300	...	...	...	...	...	160 [3000 kg]	
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 B72–82
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
C96970	105	723	90[D]	620[D]	3		Rockwell C27
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.