

Designation: B 505/B 505M - 02

Standard Specification for Copper Alloy Continuous Castings¹

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 Castings³
 - B 824 Specification for General Requirements for Copper Alloy Castings³
 - B 846 Terminology for Copper and Copper Alloys³
- $^{\rm 1}$ 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 Oct. 10, 2002. Published November 2002. Originally published as B 505 70. Last previous edition B 505 96.
- 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.

- E 8 Test Methods for Tension Testing of Metallic Materials⁴
- E 8M Test Methods for Tension Testing of Metallic Materials (Metric)⁴
- E 10 Test Method for Brinell Hardness of Metallic Materials⁴
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁴
- E 255 Practice for Sampling of Copper and Copper Alloys for the Determination of Chemical Composition⁵
- 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:

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.

TABLE 1 Nominal Composition

Copper Alloy UNS	Dogigneties	Composition, %							
No.	Designation -	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Iron	Manganes
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	OS				
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	uanu	al wis.		·ai	9	3.2	
C95300	aluminum bronze	88.8	•••				10	1.2	
C95400	aluminum bronze	85.2		D			10.8	4	
C95410	aluminum bronze	83.2		F rev		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 AS]	M B505/I	B505M-02	···	2.2	7.5	3	12.5
C95800	nickel-aluminum bronze	81.3	ce4646-67	dc-4e9f-b	e45-53b3	2924.585	65/a9tm-b	504-b	505n1.2)2
C95900	aluminum bronze	83.2					12.8	4.0	02
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

- 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 Code⁷ 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),

^B Silicon 1.3

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)
,	2 h followed by water quench) 600-1700 (870-925)	925–1000 (495–540)

TABLE 3 Finishing Allowances for Tube (Round Only)

in the least of th	manicoo ioi Tabo (ito	una omy,			
		Finish Allowances Added to			
Finished Outside Diameter.	Finished	Finished or Print			
in. (mm)	Dimensions of the	Dimensions of the Part, in. (mm)			
111. (111111)	Inside Diameter	Outside			
	inside Diameter	Diameter			
All Alloys Ex	cept 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, C	86300, C86500, C95200,	C95300, C95400,			
C95500, C9580	0, 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)-51/2 (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 of 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. C86 C95400, C9550	5200, C86300, C86500, C 10, C95800, C95900, C96	
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)-51/2 (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 \pm 50°F (675 \pm 10°C) for 6 h minimum. Cooling shall be by the fastest means

TABLE 5 Diameter Tolerances for Rod and Bar

Diameter or Distance Be-	Tolerances, Plus ^A and Minus, ^A in. (mm)			
tween Parallel Surfaces,		Squares, Rectangles,		
•	Rounds	Hexagons,		
in. (mm)		Octagons		
All Alloys I	Except as Noted Below	W		
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, C9	5200, C95300, C95400,		
C95500, C95	800, C95900, and C96	6400		
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)-51/2 (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)

	Tolerances, in. (mm)					
Average Outside Diameter,	Outside	Inside D	iameter			
in. (mm)	Diameter	Illiside D	iameter			
111. (111111)	Plus ^A or	Plus ^B	Minus ^B			
	Minus ^A	Flus	IVIIIIUS			
All Alloy	s Except as Not	ted 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. C8620	0, C86300, C86	5500, C95200, C9	5300, 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)-51/2 (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)			
A140						

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, C8630 C95500, C95800, C9	00, C86500, C95200, C95300, C95400,
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 Dimer	nsion, ^A in. (mm)	Inside Dimens	ion, ^B in. (mm)			
	All Alloys Excep	t 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, C	95900, 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.

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

^B When tolerances are specified as all plus or all minus, total the values given.

TABLE 9 Mechanical Requirements

C83600 36	Copper Alloy UNS No.	Tensile Strength, min ^A			Yield Strength, at 0.5 % Extension Under Load, min ^A		Brinell Hardness,	Remarks
C83800 30 207 15 97 16 C84200 32 221 16 110 13 C84400 30 207 15 103 16 C84400 30 207 15 103 16 C86800 30 207 15 103 16 C86800 40 276 14 97 15 C86800 110 758 62 427 14 C86800 110 758 62 427 14 C86800 35 241 18 124 15 C86800 36 24 47 14 C86800 37 20 48 3 25 177 25 C86800 40 276 14 18 124 15 C86800 36 24 47 14 C86800 37 20 48 3 25 177 25 C86800 31 22 41 18 124 15 C86800 40 276 25 172 10 C86800 40 276 19 131 18 C93200 38 262 19 131 18 C93200 40 276 19 131 18 C93200 40 276 19 131 16 C93200 40 276 19 131 16 C93200 40 276 19 131 16 C93200 38 252 20 138 8 Rockwell C93200 40 276 19 131 16 C93200 40 276 19 131 16 C93200 38 252 20 138 8 Rockwell C93200 35 241 20 138 10 C93200 35 241 20 138 10 C93200 36 25 177 2 8 C93200 45 310 25 177 8 8 C93200 36 25 177 8 8 C93200 37 24 234 20 138 10 C93200 36 25 177 16 10 10 5 C93200 37 22 17 20 138 10 C93200 36 25 177 16 10 15 C93200 37 24 234 20 138 10 C93200 36 25 177 16 10 15 C93200 37 25 177 16 10 15 C93200 36 25 177 16 10 15 C93200 37 25 177 2 18 C93200 36 25 177 16 10 5 C93200 37 25 177 16 10 5 C93200 37 24 234 20 138 10 C93200 36 25 177 16 10 5 C93200 37 24 234 20 138 10 C93200 36 40 276 20 138 20 C93200 37 25 177 16 10 5 C93200 38 227 20 138 20 C93200 36 5 24 1 20 138 20 C93200 37 25 177 16 10 10 5 C93200 38 227 20 138 20 C93200 36 5 44 224 20 138 20 C93200 37 25 177 17 7 7 C93200 38 227 20 138 20 C93200 36 5 44 224 20 138 20 C93200 37 25 177 17 7 7 C93200 38 227 20 138 20 C93200 36 5 44 22 20 138 20 C93200 36 68 49 20 20 138 20 C93200 40 276 20 138 20 C93200 40 276 20 138 20 C93200 40 276 20 138 20 C93200 40 276 20 138 20 C93200 40 40 276 20 138 20 C93200 40 55 40 40 276 20 138 20 C93200 68 49 50 50 50 50 50 50 50 50 50 50 50 50 50	UNS NO.	ksi ^B	MPa ^C	ksi ^B	MPa ^C	min, %	min	
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C91000 30 207 160 (3000 kg) C91300								
C91300							160 (3000 kg)	
C93200							100 (3000 kg)	
C92300								
C92500								
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C92800								Doolawell
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C97800 45 310 22 152 8								
GM9000 /U 465 40 //6 1/	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.

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 $1520^{\circ}F$ (825°C) for 1 h followed by a water quench, then aged at $800^{\circ}F$ (425°C) for 4 h followed by a water quench.

^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.