



Designation: B171/B171M – 18

Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers¹

This standard is issued under the fixed designation B171/B171M; 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 specification² establishes the requirements for copper-alloy plate, sheet, and circles cut from plate and sheet for pressure vessels, condensers, and heat exchangers. The following alloys are covered:

Copper Alloy	Previously Used Designation
C36500	Leaded Muntz Metal
C44300	Admiralty, Arsenical
C44400	Admiralty, Antimonial
C44500	Admiralty, Phosphorized
C46400	Naval Brass, Uninhibited
C46500	Naval Brass, Arsenical
C61300	Aluminum Bronze
C61400	Aluminum Bronze D
C63000	10 % Aluminum-Nickel Bronze
C63200	9 % Aluminum-Nickel Bronze
C70600	90-10 Copper Nickel
C70620	90-10 Copper Nickel-(modified for welding)
C71500	70-30 Copper Nickel
C71520	70-30 Copper Nickel-(modified for welding)
C72200	...

1.2 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. 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.

1.3 *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.*

¹ This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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² For *ASME Boiler and Pressure Vessel Code* applications, see related Specification SB-171 in Section II of that Code.

2. Referenced Documents

2.1 *ASTM Standards*:³

[B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar](#)

[B248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar \(Metric\)](#)

[B846 Terminology for Copper and Copper Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes \(Withdrawn 2002\)⁴](#)

[E62 Test Methods for Chemical Analysis of Copper and Copper Alloys \(Photometric Methods\) \(Withdrawn 2010\)⁴](#)

[E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition](#)

[E478 Test Methods for Chemical Analysis of Copper Alloys](#)

[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. Ordering Information

4.1 Include the following specified choices when placing orders for product under this specification, as applicable:

4.1.1 ASTM designation and year of issue;

4.1.2 Whether inch-pound or SI units are applicable (see [1.2](#));

4.1.3 Copper [Alloy] UNS. No. (see Section [6](#), [Table 1](#));

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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Requirements

Copper Alloy UNS No. ^A	Composition, % max (Unless Shown as a Range)									
	Copper, incl Silver	Tin	Nickel, incl Cobalt	Manganese, max	Lead	Iron	Zinc	Aluminum	Chromium	Other Named Elements
C36500	58.0-61.0 ^B	0.25	...	...	0.25-0.7	0.15	remainder	...	...	...
C44300	70.0-73.0 ^B	0.8-1.2	...	...	0.07	0.06	remainder	...	...	0.02-0.06 As
C44400	70.0-73.0 ^B	0.8-1.2	...	...	0.07	0.06	remainder	...	...	0.02-0.10 Sb
C44500	70.0-73.0 ^B	0.8-1.2	...	...	0.07	0.06	remainder	...	...	0.02-0.10 P
C46400	59.0-62.0 ^B	0.50-1.0	...	...	0.20	0.10	remainder	...	...	...
C46500	59.0-62.0 ^B	0.50-1.0	...	...	0.20	0.10	remainder	...	...	0.02-0.06 As
C61300 ^C	remainder	0.20-0.50	0.15	0.20	0.01	2.0-3.0	0.10 ^D	6.0-7.5	...	0.10 Si 0.015 P
C61400	remainder	...	...	1.0	0.01	1.5-3.5	0.20	6.0-8.0	...	0.015 P
C63000	remainder	0.20	4.0-5.5	1.5	...	2.0-4.0	0.30	9.0-11.0	...	0.25 Si
C63200	remainder	...	4.0-4.8 ^E	1.2-2.0	0.02	3.5-4.3 ^E	...	8.7-9.5	...	0.10 Si
C70600	remainder	...	9.0-11.0	1.0	0.05 ^D	1.0-1.8	1.0 ^D	...	...	...
C70620	86.5 min	...	9.0-11.0	1.0	0.02	1.0-1.8	0.50	...	...	0.05 C 0.02 P 0.02 S
C71500	remainder	...	29.0-33.0	1.0	0.05 ^D	0.40-1.0	1.0 ^D	...	...	...
C71520	65.0 min	...	29.0-33.0	1.0	0.02	0.40-1.0	0.50	...	...	0.05 C 0.02 P 0.02 S
C72200	remainder	...	15.0-18.0	1.0	0.05 ^D	0.50-1.0	1.0 ^D	...	0.30-0.70	0.03 Si 0.03 Ti ^D

^A Designation established in accordance with Practice E527.

^B Not including silver.

^C When the product is for subsequent welding applications, and is so specified by the purchaser, chromium shall be 0.05 % max, cadmium 0.05 % max, zirconium 0.05 % max and zinc 0.05 % max.

^D When the product is for subsequent welding applications, and is so specified by the purchaser, zinc shall be 0.50 % max, lead 0.02 % max, phosphorus 0.02 % max, sulfur 0.02 % max, and carbon 0.05 % max.

^E Iron content shall not exceed the nickel content.

4.1.4 Whether the alloy ordered will be used in applications requiring it to be welded (see Table 1, footnotes C and D for UNS Nos. C61300 and C72200, respectively, and UNS Nos. C70620 and C71520 in place of UNS Nos. C70600 and C71500);

4.1.5 Whether plate is to be machined (see 9.1.3);

4.1.6 How tolerance is specified (Table 2, footnote A); and

4.1.7 Weight (total for each size).

4.2 The following options are available but may not be included unless specified at the time of placing the order, when required.

4.2.1 Certification, if required (Section 17);

4.2.2 Test report, if required (Section 18);

4.2.3 Special marking, if required (Section 20);

4.2.4 Whether yield strength 0.2 % offset is required;

4.2.5 Heat identification or traceability details (5.1.2); and

4.2.6 Source inspection (15.2).

5. Materials and Manufacture

5.1 Material:

5.1.1 The material of manufacture shall be cast cake of the Copper Alloy UNS No. specified in the purchase order of such purity and soundness as to be suitable for processing into the products prescribed herein.

5.1.2 When specified in the contract or purchase order that heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

TABLE 2 Thickness Tolerances

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus, ^{A,B} in. [mm] for Diameters or Widths			
	36 in. [1000 mm] or Under, incl	Over 36 to 60 in. [1000 to 1500 mm], incl	Over 60 to 96 in. [1500 to 2500 mm], incl	Over 96 to 132 in. [2500 to 3500 mm], incl
Over 0.125 to 0.250 [3.0 to 6.0 mm], incl	0.010 [0.25]	0.012 [0.30]	0.022 [0.56]	0.028 [0.71]
Over 0.250 to 0.500 [6.0 to 12.0 mm], incl	0.025 [0.64]	0.027 [0.69]	0.029 [0.74]	0.031 [0.79]
Over 0.500 to 0.750 [12.0 to 19.0 mm], incl	0.028 [0.71]	0.030 [0.76]	0.032 [0.81]	0.035 [0.89]
Over 0.750 to 1.000 [19.0 to 25.0 mm], incl	0.033 [0.84]	0.035 [0.89]	0.037 [0.94]	0.040 [1.0]
Over 1.000 to 1.500 [25.0 to 38.0], incl	0.038 [0.97]	0.040 [1.0]	0.042 [1.1]	0.045 [1.1]
Over 1.500 to 1.750 [38.0 to 44.0 mm], incl	0.043 [1.1]	0.045 [1.1]	0.047 [1.2]	0.050 [1.3]
Over 1.750 to 2.000 [44.0 to 50.0 mm], incl	0.050 [1.3]	0.055 [1.4]	0.062 [1.6]	0.065 [1.7]
Over 2.000 to 5.000 [50.0 to 127 mm], incl	0.058 [1.5]	0.062 [1.6]	0.065 [1.7]	...

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

^B See 9.1.2 for specific alloys with a difference tolerance.

5.2 Manufacture:

5.2.1 The product shall be manufactured by such hot working, cold working, and annealing processes as to produce a uniform wrought structure in the finished product.

5.2.2 The product shall be hot or cold worked to the finished size, and subsequently annealed, when required, to meet the temper properties specified.

6. Chemical Composition

6.1 The materials shall conform to the chemical compositional requirements specified in **Table 1** for the copper [alloy] UNS designations specified in the ordering information.

6.2 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.

6.3 For the alloys listed below, zinc is listed as “remainder,” either copper or zinc, respectively, may be taken as the difference between the sum of all the elements analyzed and 100 %. When all the elements in **Table 1** are analyzed their sum shall be as shown below:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C36500	99.6
C44300	99.6
C44400	99.6
C44500	99.6
C46400	99.6
C46500	99.6

6.3.1 For the alloys listed below, copper may be taken as the difference between the sum of all the elements and 100 %. When all of the elements in **Table 1** are analyzed, their sum shall be as shown below:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C61300	99.8
C61400	99.5
C63000	99.5
C63200	99.5
C70600	99.5
C70620	99.5
C71520	99.5
C71500	99.5
C72200	99.8

7. Temper

7.1 The standard tempers for products described in this specification are given in **Table 3**.

7.1.1 As Hot Rolled Temper M20.

7.1.2 As Hot Forged-Air Cooled M10.

7.1.3 Hot Forged and Annealed O20.

7.1.4 Hot Rolled and Annealed O25.

7.1.5 Products manufactured for *ASME Boiler and Pressure Vessel Code* applications must be certified to the O25 or O20 temper.

7.1.6 Products manufactured for other than *ASME Boiler and Pressure Vessel Code* applications may be produced in either the M20, M10, O20, or O25 temper.

8. Mechanical Property Requirements

8.1 Tensile Strength Requirements:

8.1.1 Product furnished under this specification shall conform to the mechanical property requirements prescribed in **Table 3**, when tested in accordance with Test Methods **E8/E8M**.

8.1.2 Acceptance or rejection shall be based upon the **8.1.1** mechanical properties.

TABLE 3 Tensile Requirements—M20, M10, O20, and O25 Tempers

Copper Alloy UNS No.	Thickness, in. [mm]	Tensile Strength, min, ksi ^A [MPa]	Yield Strength, ^B min, ksi ^A [MPa]	Yield Strength 0.2 % Offset, min, ksi ^A [MPa]	Elongation in 2 in. [50.0 mm], min, %
C36500	2 [50.0] and under	50 [345]	20 [140]	20 [140]	35 [35]
	over 2 to 3.5 [50.0 to 100.0], incl	45 [310]	15 [105]	15 [105]	35 [35]
	over 3.5 to 5 [100.0 to 140.0], incl	40 [275]	12 [85]	12 [85]	35 [35]
C44300, C44400, and C44500	4 [100.0] and under	45 [310]	15 [105]	15 [105]	35 [35]
C46400, C46500	3 [80.0] and under	50 [345]	20 [140]	20 [140]	35 [35]
	over 3 to 5 [80.0 to 140.0], incl	50 [345]	18 [125]	18 [125]	35 [35]
C61300	2 [50.0] and under	75 [515]	37 [255]	36 [250]	30 [30]
	over 2 to 3 [50.0 to 80.0], incl	70 [485]	30 [205]	28 [195]	35 [35]
	over 3 to 5 [80.0 to 140.0], incl	65 [450]	28 [195]	26 [180]	35 [35]
C61400	2 [50.0] and under	70 [485]	30 [205]	28 [195]	35 [35]
	over 2 to 5 [50.0 to 140.0], incl	65 [450]	28 [195]	26 [180]	35 [35]
C63000 and C63200	2 [50.0] and under	90 [620]	36 [250]	34 [235]	10 [10]
	over 2 to 3.5 [50.0 to 100.0], incl	85 [585]	33 [230]	31 [215]	10 [10]
	over 3.5 to 5.0 [100.0 to 140.0], incl	80 [550]	30 [205]	28 [195]	10 [10]
C70600 and C70620	2.5 [60.0] and under	40 [275]	15 [105]	15 [105]	30 [30]
	over 2.5 to 5 [60.0 to 140.0], incl	40 [275]	15 [105]	15 [105]	30 [30]
C71500 and C71520	2.5 [60.0] and under	50 [345]	20 [140]	20 [140]	30 [30]
	over 2.5 to 5 [60.0 to 140.0], incl	45 [310]	18 [125]	18 [125]	30 [30]
C72200	2.5 [60.0] and under	42 [290]	16 [110]	16 [110]	35 [35]

^A ksi = 1000 psi.

^B Yield strength is measured at 0.5 % extension under load (that is, 0.01 in. [0.254 mm] in a gage length of 2 in. [50.0 mm]).