

# ASTM B171 / ASME SB171

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

This specification establishes the requirements for copper-alloy plate, sheet, and circles cut from plate and sheet for pressure vessels, condensers, and heat exchangers.

### A. Chemical Composition :-

- The materials shall conform to the chemical compositional requirements specified in Table 1.

**Table 1**

Copper Alloy UNS No. <sup>A</sup>	Composition, % max (Unless Shown as a Range)									
	Copper, incl Silver	Tin	Nickel, incl Cobalt	Manganese, max	Lead	Iron	Zinc	Aluminium	Chromium	Other Named Elements
C36500	58.0-61.0	0.25	...	...	0.25-0.7	0.15	remainder	...	...	...
C44300	70.0-73.0	0.8-1.2	...	...	0.07	0.06	remainder	...	...	As 0.02-0.06
C44400	70.0-73.0	0.8-1.2	...	...	0.07	0.06	remainder	...	...	Sb 0.02-0.10
C44500	70.0-73.0	0.8-1.2	...	...	0.07	0.06	remainder	...	...	P 0.02-0.10
C46400	59.0-62.0	0.50-1.0	...	...	0.2	0.10	remainder	...	...	...
C46500	59.0-62.0	0.50-1.0	...	...	0.2	0.10	remainder	...	...	As 0.02-0.06
C61300 <sup>B</sup>	remainder	0.2-0.5	0.15	0.2	0.01	2.0-3.0	0.10 <sup>C</sup>	6.0-7.5	...	Si 0.1, P 0.015
C61400	remainder	...	...	1.0	0.01	1.5-3.5	0.2	6.0-8.0	...	P 0.015
C63000	remainder	0.2	4.0-5.5	1.5	...	2.0-4.0	0.3	9.0-11.0	...	Si 0.25
C63200	remainder	...	4.0-4.8 <sup>D</sup>	1.2-2.0	0.02	3.5-4.3 <sup>D</sup>	...	8.7-9.5	...	Si 0.1
C70600	remainder	...	9.0-11.0	1.0	0.05 <sup>C</sup>	1.0-1.8	1.0 <sup>C</sup>	...	...	...
C70620	86.5 min	...	9.0-11.0	1.0	0.02	1.0-1.8	0.5	...	...	C 0.05, P 0.02, S 0.02
C71500	remainder	...	29.0-33.0	1.0	0.05 <sup>C</sup>	0.40-1.0	1.0 <sup>C</sup>	...	...	...
C71520	65 min	...	29.0-33.0	1.0	0.02	0.40-1.0	0.5	...	...	C 0.05, P 0.02, S 0.02
C72200	remainder	...	15.0-18.0	1.0	0.05 <sup>C</sup>	0.50-1.0	1.0 <sup>C</sup>	...	0.30-0.70	Si 0.03, Ti 0.03, <sup>C</sup>

<sup>A</sup> Designation established in accordance with Practice E527.

<sup>B</sup> 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.

<sup>C</sup> 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.

<sup>D</sup> Iron content shall not exceed the nickel content.

- For the alloys listed below, depending on analytical methodology, 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

3. 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

**B. Temper :-**

1. Tempers available under this specification, and as described in Classification B601, are As Hot Rolled (M20), Hot Rolled and Annealed (O25), Hot Forged and Annealed (O20), and As Hot Forged-Air Cooled (M10) as given in Table 3.

**C. Tensile Strength Requirements :-**

1. Product furnished under this specification shall conform to the tensile property requirements prescribed in Table 2, when tested in accordance with Test Method E8/E8M.

Copper Alloy UNS No.	Thickness, in. [mm]	Tensile Strength, min, ksi <sup>A</sup> [MPa]	Yield Strength, min, ksi <sup>A</sup> [MPa]	Yield Strength 0.2 % Offset, min, ksi <sup>A</sup> [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 [520]	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]

<sup>A</sup> ksi = 1 000 psi.

<sup>B</sup> Yield strength is determined as the stress producing an elongation of 0.5 % or under load, that is 0.01 in. [0.254 mm] in a gage length of 2 in. [50.0 mm].

#### D. Test Methods :-

The properties and chemical compositions enumerated in this specification shall, in case of disagreement, be determined in accordance with the following ASTM test methods:

1. Tension—E8/E8M.
2. Chemical Analysis—In accordance with the following:

<u>Element</u>	<u>Test Method</u>
Copper	E478
Aluminum	E478
Antimony	E62
Arsenic	E62
Iron:	
<1 .3 %	E478
>1 .3 %	E54
Lead	E478 (AA)
Manganese	E62
Nickel:	
<5 %	E478 (photometric)
>5 %	E478 (gravimetric)
Phosphorus	E62
Silicon	E54 (perchloric acid)
Tin	E478
Zinc:	
<2 %	E478 (AA)
>2 %	E478 (titrametric)

NOTE 2—The tension test specimen shall conform to the dimensions shown in Figs. 7 or 8 of Test Methods E8/E8M.

**TABLE 7: Densities**

<b>Copper Alloy UNS Nos.</b>	<b>Density lb/in.<sup>3</sup> [g/cm<sup>3</sup>]</b>
C36500	0.304 [8.41]
C44300, C44400, and C44500	0.308 [8.53]
C46400, C46500	0.304 [8.41]
C61300, C61400	0.285 [7.89]
C63000 and C63200	0.274 [7.58]
C70600, C71500, C72200, C70620, and C71520	0.323 [8.94]

#### Related Keywords

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