



# Standard Specification for Copper Alloy Strip for Flexible Metal Hose<sup>1</sup>

This standard is issued under the fixed designation B 508; 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 ( $\epsilon$ ) 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 the requirements for annealed copper-alloy strip for the manufacture of flexible metal hose produced from Copper Alloy UNS Nos. C41100 and C50500.

1.1.1 The nominal compositions are as follows:

Copper Alloy UNS No.	Copper	Zinc	Tin
C41100	91.0	8.5	0.5
C50500	98.7	...	1.3

1.2 The values stated in inch-pound units are to be regarded as the standard, except grain size, which is given in SI units. The values given in parentheses are for information only.

1.3 The following precautionary statement pertains only to the test method portion, Section 13, of this specification: *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 ASTM Standards:

- B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast<sup>2</sup>
- B 846 Terminology for Copper and Copper Alloys<sup>2</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>3</sup>
- E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Method)<sup>4</sup>
- E 112 Test Methods for Determining the Average Grain Size<sup>5</sup>
- E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition<sup>3</sup>

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

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<sup>2</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>5</sup> Annual Book of ASTM Standards, Vol 03.01.

## E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>4</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 For definitions of terms related to copper and copper alloys, refer to Terminology B 846.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *coil (as applied to a flat product)*—a length of the product spirally wound into a series of connected turns. The unqualified term “coil” as applied to “flat product” usually refers to a coil in which the product is spirally wound, with the successive layers on top of one another (sometimes called a “roll”).

3.2.2 *level or traverse wound*—a coil in which the turns are positioned into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another.

3.2.3 *level or traverse wound on a reel or spool*—a coil in which the turns are positioned into layers on a reel or spool parallel to the axis of the reel or spool such that successive turns in a given layer are next to one another.

3.2.4 *reel or spool*—a cylindrical device that has a rim at each end and an axial hole for a shaft or spindle, and on which the product is wound to facilitate handling and shipping.

3.2.5 *strip*—a rolled flat product, other than flat wire, up to and including 0.188 in. [4.78 mm] thick, in straight lengths, coils (rolls), or traverse wound on reels or spools: with slit, sheared, or slit and rolled edges in widths up to 24 in. [610 mm] inclusive; or, with finished drawn or rolled edges in widths over 1/4 to 12 in. [31.8 to 305 mm] inclusive.

## 4. Ordering Information

4.1 Orders for product under this specification should include the following information:

4.1.1 ASTM designation and year of issue,

4.1.2 Copper Alloy UNS No. (see Section 1 and Table 1),

4.1.3 Temper (see 7.1 and Table 2),

4.1.4 Quantity, number of pieces or total weight of each alloy and size, and

4.1.5 *Dimensions*—Thickness and width; and length, if applicable (see 8.2 and 8.3).

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



TABLE 1 Chemical Requirements

Element	Composition, %	
	Copper Alloy UNS Nos.	
	C41100	C50500
Copper	89.0–92.0	...
Tin	0.30–0.7	1.0–1.7
Phosphorus	...	0.03–0.35
Iron, max	0.05	0.10
Lead, max	0.10	0.05
Zinc	remainder	0.30 max
Copper + tin + phosphorus, min	...	99.5

TABLE 2 Grain Size Requirements

Temps Standard Designation <sup>A</sup>	Grain Size, mm		
	Nominal	Minimum	Maximum
OS050	0.050	0.035	0.090
OS035	0.035	0.025	0.050
OS025	0.025	0.015	0.035
OS015	0.015	<sup>B</sup>	0.025

<sup>A</sup> Standard designations defined in Classification B 601.

<sup>B</sup> Although no minimum grain size is required, this material must be fully recrystallized.

4.2 The following options are available and should be specified at the time of placing the order, when required:

4.2.1 *How furnished*—Coils (inside and outside diameters), pounds per inch of width; stock or specific lengths, with or without ends;

4.2.2 *Packing*—Type of pallet, skid, or box: interleaving, banding, maximum weight, and so forth; and

4.2.3 Special surface condition requirements, if any (see 9.3).

## 5. Materials and Manufacture

### 5.1 Material:

5.1.1 The material of manufacture shall be cast bar, slab, cake, billet, or so forth of Copper Alloy UNS No. C41100 or C50500 of such soundness as to be suitable for processing in to the products prescribed herein.

5.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

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

### 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, if required, to meet the temper properties specified.

5.2.3 *Edges*—Slit edges shall be furnished unless otherwise specified in the contract or purchase order.

## 6. Chemical Composition

6.1 The material shall conform to the requirements prescribed in Table 1 for the alloy specified in the ordering information.

6.2 These composition limits do not preclude the presence of other elements. Limits for unnamed elements may be established and analysis required by agreement between the manufacturer or supplier and purchaser.

6.3 Zinc, when given as the “remainder,” is the differences between the sum of the results for all elements analyzed and 100 %.

6.3.1 Copper may be taken as the difference between the sum of all elements analyzed and 100 % and, when so determined, the difference value shall conform to the requirements given in Table 1.

6.4 When analyzed, the sum of results for all elements listed in Table 1 for Copper Alloy UNS C41100 shall be 99.7 % minimum and 99.5 % minimum for Copper Alloy UNS C50500.

## 7. Grain Size of Annealed Tempers

7.1 The average grain size of each of two samples of annealed material, as determined on a longitudinal cross section, shall be within the limit prescribed of the four nominal grain sizes listed in Table 2 when tested in accordance with Test Method E 112.

7.2 In the case of thin-gage material 0.010 in. [0.25 mm] and under, there shall exist no less than six grains per stock thickness, averaged for five locations one thickness apart.

## 8. Dimensions, Mass, and Permissible Variations

8.1 *General*—For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension may be cause for rejection.

8.2 *Thickness*—The standard method of specifying thickness shall be in decimal fractions of an inch. For material 0.021 in. [0.533 mm] and under in thickness, it is recommended that the nominal thickness be stated not closer than the nearest 0.0005 in. [0.013 mm]. For example, specify 0.006 or 0.0065 in. [0.152 or 0.165 mm], but not 0.0063 in. [0.160 mm]. For material over 0.021 [0.533 mm] in thickness, it is recommended that the nominal thickness’ be stated not closer than the nearest 0.001 in. [0.025 mm]. For example, specify 0.128 or 0.129 in. [3.25 or 3.28 mm] but not 0.1285 in. [3.26 mm]. A list of preferred thickness is shown in Appendix X1. The thickness tolerances shall be those shown in Table 3.

8.3 *Width*—The width tolerances shall be those shown in Table 4.

8.4 *Straightness*—The straightness tolerances shall be those shown in Table 5.

## 9. Workmanship, Finish, and Appearance

9.1 The product shall be uniform in quality and soundness and free of internal and external defects. However, surface blemishes that do not interfere with the intended application are acceptable.

9.2 The product shall be well cleaned and free of dirt.

9.3 A superficial film or residual light lubricant shall be permissible, unless otherwise specified in the contract or purchase order.



TABLE 3 Thickness Tolerances

Thickness, in.	Thickness Tolerances, plus and minus, <sup>A</sup> in.					
	Copper Alloy UNS No. C41100			Copper Alloy UNS No. C50500		
	8 in. and under in Width in. [mm]	Over 8 to 14 in., incl in Width in. [mm]	Over 14 to 20 in., incl in Width in. [mm]	8 in. and under in Width in. [mm]	Over 8 to 14 in., incl in Width in. [mm]	Over 14 to 20 in., incl in Width in. [mm]
0.004 and under	0.0003 [0.008]	0.0006 [0.015]	...	0.0004 [0.010]	0.0008 [0.020]	...
Over 0.004 to 0.006, incl	0.0004 [0.010]	0.0008 [0.020]	0.0013 [0.033]	0.0006 [0.015]	0.0010 [0.025]	0.0015 [0.038]
Over 0.006 to 0.009, incl	0.0006 [0.015]	0.0010 [0.035]	0.0015 [0.038]	0.0008 [0.020]	0.0013 [0.033]	0.002 [0.051]
Over 0.009 to 0.013, incl	0.0008 [0.020]	0.0013 [0.033]	0.0018 [0.046]	0.0010 [0.025]	0.0015 [0.038]	0.0025 [0.064]
Over 0.013 to 0.017, incl	0.0010 [0.028]	0.0015 [0.038]	0.002 [0.051]	0.0013 [0.033]	0.002 [0.051]	0.0025 [0.064]
Over 0.017 to 0.021, incl	0.0013 [0.033]	0.0018 [0.046]	0.002 [0.051]	0.0015 [0.038]	0.0025 [0.064]	0.003 [0.076]
Over 0.021 to 0.026, incl	0.0015 [0.038]	0.002 [0.051]	0.0025 [0.064]	0.002 [0.051]	0.0025 [0.064]	0.003 [0.076]
Over 0.026 to 0.037, incl	0.002 [0.051]	0.002 [0.051]	0.0025 [0.064]	0.0025 [0.064]	0.003 [0.076]	0.0035 [0.089]
Over 0.037 to 0.050, incl	0.002 [0.051]	0.0025 [0.064]	0.003 [0.076]	0.003 [0.076]	0.0035 [0.089]	0.004 [0.102]
Over 0.050 to 0.073, incl	0.0025 [0.064]	0.003 [0.076]	0.0035 [0.084]	0.0035 [0.089]	0.004 [0.102]	0.0045 [0.114]
Over 0.073 to 0.130, incl	0.003 [0.076]	0.0035 [0.089]	0.004 [0.102]	0.004 [0.102]	0.0045 [0.114]	0.005 [0.127]
Over 0.130 to 0.188, incl	0.0035 [0.089]	0.004 [0.102]	0.0045 [0.114]	0.0045 [0.114]	0.005 [0.127]	0.006 [0.152]

<sup>A</sup> When tolerances are specified as all plus or all minus, double the values given.

TABLE 4 Width Tolerances

Width, in. [mm]	Width Tolerances, <sup>A</sup> plus and minus, in. [mm]		
	For Thicknesses 0.004 [0.102 mm] to 0.032 in. [0.813 mm], incl	For Thicknesses Over 0.032 [0.813 mm] to 0.125 in. [3.18 mm], incl	For Thicknesses Over 0.125 [3.18 mm] to 0.188 in. [4.78 mm], incl
2 [50.8] under	0.005 [0.13]	0.010 [0.25]	0.012 [0.30]
Over 2 to 8 [50.8 to 203], incl	0.008 [0.20]	0.013 [0.33]	0.015 [0.38]
Over 8 to 20 [203 to 508], incl	1/64 [0.40]	1/64 [0.40]	1/64 [0.40]

<sup>A</sup> If tolerances are specified as all plus or all minus, double the values given.

TABLE 5 Straightness Tolerances for Silt Metal

NOTE 1—Maximum edgewise curvature (depth of arc) in any 72 in. [1.82 m] portion of the total length.

Width, in. [mm]	Straightness Tolerance, in. [mm]
Over 1/4 to 3/8 [6.35 to 9.53] incl	2 [51]
Over 3/8 to 1/2 [9.53 to 12.7] incl	1 1/2 [38]
Over 1/2 to 1 [12.7 to 25.4] incl	1 [25]
Over 1 to 2 [25.4 to 50.8] incl	3/8 [16]
Over 2 to 4 [50.8 to 102] incl	1/2 [13]
Over 4 [102]	3/8 [9.5]

## 10. Sampling

10.1 The lot size, portion size, and selection of pieces shall be as follows:

10.1.1 *Lot Size*—15 000 lb, [6825 kg], or less material of the same mill form, alloy, temper, and thickness, subject to inspection at one time.

10.1.2 *Portion Size*—A portion shall be four or more pieces selected as to be representative of each lot. If the lot consists of less than four pieces, representative samples shall be taken from each piece.

10.2 *Chemical Analysis*—A sample for chemical analysis shall be taken and prepared in accordance with Practice E 255.

10.2.1 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of determining conformance to chemical composition as follows: Conformance shall be determined by the manufacturer by analyzing samples taken at the time the castings are poured or samples taken from the semifinished product. If the manufacturer determined the chemical composition of the material during the

course of manufacture, he shall not be required to sample and analyze the finished product. The number of samples taken for determination of chemical composition shall be as follows:

10.2.1.1 When samples are taken at the time the castings are poured, at least one sample shall be taken for each group of castings poured simultaneously from the same source of molten metal.

10.2.1.2 When samples are taken from the semifinished product, a sample shall be taken to represent each 10 000 lb [4550 kg] or fraction thereof, except that not more than one sample shall be required per piece.

10.3 *Grain Size*—Samples for grain size shall be taken from material in the finished condition. A sample shall be taken to represent each 10 000 lb [4550 kg] or fraction thereof, except that not more than one sample shall be required per piece.

## 11. Number of Tests and Retests

11.1 *Tests*:

11.1.1 Chemical composition shall be determined as the average of results from at least two replicate determinations of each specified element.

11.1.2 *Other Tests*—For other tests, test specimens shall be taken from two of the sample pieces selected in accordance with 10.1.2. The required tests shall be made on each of the specimens so selected.

11.2 *Retests*:

11.2.1 When requested by the manufacturer or supplier, a retest shall be permitted should test results obtained by the purchaser fail to conform with specification requirements.

11.2.2 Retesting shall be as directed in the product specification for the initial test(s), except that the number of test specimens shall be twice that normally required for the test.

11.2.3 Test results for all specimens shall conform to the product specification requirements in retest and failure to conform shall be cause for lot rejection.

## 12. Specimen Preparation

12.1 *Chemical Analysis*—Prepare a composite sample of the semifinished or finished product in accordance with Practice E 255, or as described in 10.2. Preparation of the analytical specimen shall be the responsibility of the reporting laboratory.



12.2 Prepare specimens in accordance with the method prescribed in 13.2 for other tests. Use full cross-section specimens whenever possible. Samples shall be representative of the condition of the material, and state particular specimen preparation techniques in the specific product specification.

13. Test Methods

13.1 Determine the chemical composition in case of disagreement, as follows:

Element	ASTM Test Method
Copper	E 478
Tin	E 478 (Iodometric Titrimetric)
Phosphorus	E 62
Iron	E 478
Lead	E 478 (AA)
Zinc	E 478 (EDTA titrimetric)

13.1.1 Test method(s) for the determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the supplier and purchaser.

13.2 Other Test—The product shall conform with the grain size requirements found in Table 2 when tested in accordance with the following test method:

Test	ASTM Test Method
Grain size	E 112 (Heyn Intercept)

14. Significance of Numerical Limits

14.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E 29:

Property	% Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right hand place of figures of the specified limit
Grain size	nearest multiple of 0.005 mm

15. Inspection

15.1 The manufacturer shall inspect and make the tests necessary to verify that the product furnished conforms to the requirements of this specification.

15.2 If, in addition, source inspection of the material by the purchaser is agreed upon between the manufacturer and the purchaser as part of the purchase contract, the nature of the facilities needed to satisfy the inspector representing the purchaser that the product is being furnished in accordance with this specification shall be included in the agreement. All tests and the inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

15.3 The manufacturer and the purchaser, by mutual agreement, may accomplish the final inspection simultaneously.

16. Rejection and Rehearing

16.1 Rejection:

16.1.1 Product that fails to conform to the specification requirements when inspected or tested by the purchaser, or purchaser’s agent, are subject to rejection.

16.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly and in writing.

16.1.3 In case of dissatisfaction with results of the test upon which rejection is based, the manufacturer, or supplier, may make claim for a rehearing.

16.2 Rehearing—As a result of product rejection, the manufacturer or supplier may make claim for a retest to be conducted by the manufacturer, or supplier, and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or alternatively, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

17. Certification

17.1 When specified in the contract or purchase order, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met.

18. Test Report

18.1 When specified in the contract or purchase order, a report of test results shall be furnished.

19. Packaging and Package Marking

19.1 Packaging—The product shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from the normal hazards of transportation.

19.2 Package Marking—Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight, and name of supplier. The specification number shall be shown, when specified.

20. Keywords

20.1 copper alloy strip; flexible metal hose



**APPENDIXES**

**(Nonmandatory Information)**

**X1. PREFERRED THICKNESS**

X1.1 It is recommended that wherever possible, material purchased to this specification be ordered in thicknesses as listed in Table X1.1.

**TABLE X1.1 Preferred Thicknesses**

NOTE 1—All values in inches [millimetres].

0.004 [0.102]	0.020 [0.508]	0.080 [2.03]
0.005 [0.127]	0.022 [0.559]	0.090 [2.29]
0.006 [0.152]	0.025 [0.635]	0.100 [2.54]
0.007 [0.178]	0.028 [0.711]	0.112 [2.84]
0.008 [0.203]	0.032 [0.813]	0.125 [3.18]
0.009 [0.229]	0.036 [0.914]	0.140 [3.56]
0.010 [0.254]	0.040 [1.02]	0.160 [4.06]
0.011 [0.279]	0.045 [1.14]	0.180 [4.57]
0.012 [0.305]	0.050 [1.27]	0.200 [5.08]
0.014 [0.356]	0.056 [1.42]	0.224 [6.29]
0.016 [0.406]	0.063 [1.60]	...
0.018 [0.457]	0.071 [1.80]	...

**X2. STANDARD WEIGHT**

X2.1 For information purposes, for estimating weights, cross sections, and so forth, the density of Copper Alloy Nos. 411 and 505 (UNS Nos. C41100 and C50500) are included in Table X2.1.

**TABLE X2.1 Standard Weight**

Copper Alloy UNS No.	Density, lb/in. <sup>3</sup> [g/cm <sup>3</sup> ]
C41100	0.318 [8.80]
C50500	0.321 [8.89]

**SUMMARY OF CHANGES**

B 508 – 86 was discontinued in 1993 and reinstated in 1997.

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