Designation: B395/B395M – 18

Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes[1]

This standard is issued under the fixed designation B395/B395M; 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[2] establishes the requirements for condenser, evaporator, and heat exchanger U-bend tubes that are manufactured from seamless copper and copper alloy tube.

1.2 *Units*—The values stated in either SI units or inch-pound 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 specification is applicable to product 2 in. [50 mm] or less, inclusive, in diameter.

1.4 The product shall be produced from one of the following coppers or copper alloys, as specified in the ordering information:

Copper or Copper Alloy UNS No.	Previously Used Designation	Type of Metal
C10200	OF[A]	oxygen-free without residual deoxidants
C10300	...	oxygen-free, extra low phosphorus
C10800	...	oxygen-free, low phosphorus
C12000	DLP[A]	phosphorized, low residual phosphorus
C12200	DHP[A]	phosphorized, high residual phosphorus
C14200	DPA[A]	phosphorized, arsenical
C19200	...	phosphorized, 1 % iron
C23000	...	red brass
C44300	Type B	admiralty metal
C44400	Type C	admiralty metal
C44500	Type D	admiralty metal
C60800	...	aluminum bronze
C68700	Type B	aluminum brass
C70400	...	95-5 copper-nickel
C70600	...	90-10 copper-nickel
C70620	...	90-10 copper-nickel-(modified for welding)
C71000	...	80-20 copper-nickel
C71500	...	70-30 copper-nickel
C71520	...	70-30 copper-nickel-(modified for welding)
C72200	...	copper-nickel

[A] Designations listed in Classification B224.

1.5 The following safety hazard caveat pertains only to the test methods described in this specification.

1.5.1 *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. (***Warning—***Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Safety Data Sheet (SDS) for additional information. Users should be aware that selling mercury and/or mercury containing products into your state or country may be prohibited by law.)*

1.6 *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 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

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[2] For *ASME Boiler and Pressure Vessel Code* applications see related Specification SB-395 in Section II of that Code.

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

2.2 *ASTM Standards:*[3]
B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
B154 Test Method for Mercurous Nitrate Test for Copper Alloys
B224 Classification of Coppers
B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
B846 Terminology for Copper and Copper Alloys
B858 Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys
B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies
B968/B968M Test Method for Flattening of Copper and Copper-Alloy Pipe and Tube
E3 Guide for Preparation of Metallographic Specimens
E8/E8M Test Methods for Tension Testing of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry
E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[4]
E112 Test Methods for Determining Average Grain Size
E118 Test Methods for Chemical Analysis of Copper-Chromium Alloys (Withdrawn 2010)[4]
E243 Practice for Electromagnetic (Eddy Current) Examination of Copper and Copper-Alloy Tubes
E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
E478 Test Methods for Chemical Analysis of Copper Alloys
E2575 Standard Test Method for Determination of Oxygen in Copper and Copper Alloys (Withdrawn 2017)[4]

2.3 *Other Standard:*[5]
ASME Boiler and Pressure Vessel Code

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dual-gage tube, n*—a tube which has more than one wall-gage thickness contained within the length of the tube.

3.2.2 *squareness of cut, n*—the maximum deviation of one side of a cross section of tube from the opposite side, when measured against the projected perpendicularity of the plane of the projected center of the tube at the ends.

3.2.3 *u-bend tube, n*—a tube bent 180° in a single plane into a U-shape.

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 Copper or copper alloy UNS No. designation (Section 6),
4.1.3 Temper (Section 7),
4.1.4 *Dimensions*—X–diameter and wall thickness of the tube (see 12.1 and 12.2),
4.1.5 Schedule of bending radii (must include the number of pieces of each radii) (see 12.2.5),
4.1.6 Length of U-bend tube legs (see 12.2.8),
4.1.7 If the product is to be subsequently welded (see Table 1), and
4.1.8 Intended application, and
4.1.9 If the product is to be for U.S. Government.

4.2 The following options are available but may not be included unless specified at the time of placing of the order when required:
4.2.1 Heat identification or traceability details (see 5.1.2).
4.2.2 Tension test (see 9.1),
4.2.3 Relief anneal of U-bent portion of copper-nickel U-bend tubes (see 7.6),
4.2.4 Dual-gage, a schedule of tubes required in dual-gage and length of heavy gage section must be furnished with this option (see 5.2.2 and 12.2.3),
4.2.5 Flattening Test (Section 10.2).
4.2.6 Expansion Test (Section 10.1).
4.2.7 Certification, if required (see Section 21), and
4.2.8 Mill Test Report, if required (see Section 22).

4.3 If product is purchased for agencies of the U.S. Government, it shall be in accordance with the requirements specified in the Supplementary Requirements section, when specified in the contract or purchase order.

4.4 If product is ordered for ASME Boiler and Pressure Vessel Code Application (See Certification Section 21).

5. Materials and Manufacture

5.1 *Materials:*

5.1.1 The material of manufacture shall be of the copper alloys defined in 1.4 and of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification for the applicable alloy and temper.

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 casting into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of 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.

[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.

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

TABLE 1 Chemical Requirements

Copper or Copper Alloy UNS No.	Composition,%												
	Copper	Tin	Aluminum	Nickel, incl Cobalt	Lead, max	Iron	Zinc	Manganese	Arsenic	Antimony	Phosphorus	Chromium	Other Named Elements
C10200[A,B]	99.95 min	...	...	...	...	...	...	...	...	...	...	...	10 ppm max O
C10300[A]	99.95[C] min	...	...	...	...	...	...	...	...	...	0.001–0.005	...	...
C10800[A]	99.95[C] min	...	...	...	...	...	...	...	...	...	0.005–0.012	...	...
C12000[A]	99.90 min	...	...	...	...	...	...	...	...	...	0.004–0.012	...	...
C12200[A]	99.9 min	...	...	...	...	...	...	...	...	...	0.015–0.040	...	...
C14200[A]	99.4 min	...	...	...	...	...	...	...	0.15–0.50	...	0.015–0.040	...	...
C19200[D]	98.5 min	...	...	...	...	0.8–1.2	0.20 max	...	...	...	0.01–0.04	...	...
C23000[D]	84.0–86.0	...	...	...	0.05	0.05 max	remainder	...	...	...	...	...	...
C44300[E]	70.0–73.0	0.9–1.2	...	...	0.07	0.06 max	remainder	...	0.02–0.06	...	...	...	...
C44400[E]	70.0–73.0	0.9–1.2	...	...	0.07	0.06 max	remainder	...	...	0.02–0.10	...	...	...
C44500[E]	70.0–73.0	0.9–1.2	...	...	0.07	0.06 max	remainder	...	...	...	0.02–0.10	...	...
C60800[A,F]	remainder	...	5.0–6.5	...	0.10	0.10 max	...	...	0.02–0.35	...	...	...	...
C68700[A,F]	76.0–79.0	...	1.8–2.5	...	0.07	0.06 max	remainder	...	0.02–0.06	...	...	...	...
C70400[A,F]	remainder	...	...	4.8–6.2	0.05	1.3–1.7	1.0 max	0.30 to 0.8	...	...	...	...	...
C70600[A,F]	remainder	...	...	9.0–11.0	0.05	1.0–1.8	1.0 max	1.0 max[G]	...	...	...	...	...
C70620[A,F]	86.5 min	...	...	9.0–11.0	0.02	1.0–1.8	0.50 max	1.0 max	...	...	0.02 max	...	0.05C max
C71000[A,F,G]	remainder	...	...	19.0–23.0	0.05[G]	1.0 max	1.0 max[G]	1.0 max[G]	...	...	[G]	...	0.02S max [G]
C71500[A,F]	remainder	...	...	29.0–33.0	0.05	0.40–1.0	1.0 max	1.0 max	...	...	...	...	...
C71520[A,F]	65.0 min	...	...	29.0–33.0	0.02	0.40–1.0	0.50 max	1.0 max	...	...	0.02 max	...	0.05C max
C72200[A,D,G]	remainder	...	...	15.0–18.0	0.05[G]	0.50–1.0	1.0 max[G]	1.0 max	...	...	...[G]	0.30–0.70	0.02S max [G,H]

[A] Silver counting as copper.
[B] This is a high conductivity copper which has, in the annealed condition, a minimum conductivity of 101 % IACS.
[C] Includes P.
[D] Cu + sum of named elements, 99.8 % min.
[E] Cu + sum of named elements, 99.6 % min.
[F] Cu + sum of named elements, 99.5 % min.
[G] When the product is for subsequent welding applications, and 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.
[H] Silicon shall be 0.03 % max, titanium shall be 0.03 % max.