



Designation: B640 – 12a (Reapproved 2021)

Standard Specification for Welded Copper Tube for Air Conditioning and Refrigeration Service¹

This standard is issued under the fixed designation B640; 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.

1. Scope*

1.1 This specification establishes the requirements for welded copper tube for air conditioning and refrigeration service for use in connections, repairs, and alterations. The tube shall be made from one of the following coppers:

Copper UNS No.	Previously Used Designation	Type of Copper
C10100	OFE	Oxygen-free electronic
C10200	OF	Oxygen-free without-residual oxidants
C12000	DLP	Phosphorus-deoxidized, low-residual phosphorus
C12200	DHP	Phosphorus-deoxidized, high-residual phosphorus

NOTE 1—Fittings used for soldered or brazed connections in air conditioning and refrigeration systems are described in ASME Standard B 16.22.

NOTE 2—The assembly of copper tubular systems by soldering is described in Practice B828.

NOTE 3—Solders for joining copper tubular systems by described in Specification B32. The requirements for acceptable fluxes for these systems are described in Specification B813.

1.2 Copper UNS No. C12200 shall be furnished, unless otherwise specified. The copper tube shall be supplied in annealed coils or drawn temper straight lengths.

1.3 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

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.

Current edition approved Jan. 1, 2021. Published January 2021. Originally approved in 1978. Last previous edition approved in 2012 as B640 – 12a. DOI: 10.1520/B0640-12AR21.

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.

1.5 *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 ASTM Standards:²

- B32 Specification for Solder Metal
- B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
- B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes
- B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
- B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
- B813 Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
- B828 Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- B846 Terminology for Copper and 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

² 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.

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

- E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)³
- 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
- E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- 2.2 ASME Standard.⁴
- B 16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

C12000, or C12200 of such purity and soundness as to be suitable for processing into welded tube to meet the properties prescribed herein.

5.2 *Manufacture:*

5.2.1 The product shall be manufactured by forming the material into a tubular shape on a suitable forming mill and welded using an automatic process.

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

5.2.3 The product shall conform to “fully finished tube” as required in 5.2.3.1 and 5.2.3.2:

5.2.3.1 Welded tube with internal and external flash removed by scarfing, and the tube subsequently cold drawn, over a mandrel and annealed as necessary to conform to the specified temper.

5.2.3.2 Welded tube that has been mechanically worked into a smooth tube without the need for internal or external scarfing, or other metal removal and subsequently cold drawn over a mandrel and annealed as necessary to conform to the specified size and temper.

5.2.4 Coiled lengths specified as O60, soft-annealed temper, shall be bright annealed after coiling, then dehydrated, and capped, plugged, crimped, or otherwise closed at both ends so as to maintain the internal cleanness of the tubing under normal conditions of handling and storage.

5.2.5 Straight lengths specified as H58, hard-drawn temper, shall be cleaned and capped, plugged, or otherwise closed at both ends so as to maintain the internal cleanness of the tubing under normal conditions of handling and storage.

6. Chemical Composition

6.1 The material shall conform to the chemical compositional requirements in Table 1 for the Copper UNS No. designation 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.

TABLE 1 Chemical Requirements

Copper UNS No.	Copper, ^A min	Phosphorus	
		Min	Max
C10100	99.99 ^{B,C}	...	C
C10200	99.95 ^D
C12000	99.90	0.004	0.012
C12200	99.9	0.015	0.040

^A Copper (including silver).
^B This value is exclusive of silver and shall be determined by difference of “impurity total” from 100 %. “Impurity total” is defined as the sum of sulfur, silver, lead, tin, bismuth, arsenic, antimony, iron, nickel, zinc, phosphorus, selenium, tellurium, manganese, cadmium, and oxygen present in the sample.
^C Impurity parts per million maximums for C10100 shall be: antimony 4, arsenic 5, bismuth 1, cadmium 1, iron 10, lead 5, manganese 0.5, nickel 10, oxygen 5, phosphorus 3, selenium 3, silver 25, sulfur 15, tellurium 2, tin 2, and zinc 1.
^D Oxygen in C10200 shall be 10 ppm max.

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 *tube, air-conditioning, n*—a welded copper tube conforming to a standard series of sizes and to specified internal cleanness requirements, normally furnished in drawn temper straight lengths, with the ends capped or sealed.

3.2.2 *tube, refrigeration-service, n*—a welded copper tube conforming to a standard series of sizes and to special internal cleanness and dehydration requirements, normally furnished in soft temper coils, with ends capped or sealed.

4. Ordering Information

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

- 4.1.1 ASTM designation and year of issue;
- 4.1.2 Copper Alloy UNS No. designation;
- 4.1.3 Temper (Section 7);
- 4.1.4 Dimensions: diameter, wall thickness, length, and so forth (Section 11);
- 4.1.5 How furnished (straight lengths or coils); and
- 4.1.6 Quantity: total weight or number of pieces or coils of each copper, size, and temper.

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

- 4.2.1 Hydrogen embrittlement susceptibility (9.3),
- 4.2.2 Microscopical Examination (9.2),
- 4.2.3 Expansion test (9.1),
- 4.2.4 Cleanness test (10.2),
- 4.2.5 Flattening test (9.4),
- 4.2.6 Reverse bend test (9.5),
- 4.2.7 Certification (Section 20),
- 4.2.8 Test report (Section 21), and
- 4.2.9 When product is purchased for agencies of the U.S. Government (10.3).

5. Materials and Manufacture

5.1 *Material*—The material of manufacture shall be sheet or strip of Copper Alloy UNS No. C10100, or C10200, or

³ The last approved version of this historical standard is referenced on www.astm.org.
⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

7. Temper

7.1 The standard tempers for products described in this specification are given in **Table 2**.

- 7.1.1 Drawn general purpose H58.
- 7.1.2 Annealed temper O60.

7.2 Tempers are defined in Classification **B601**. Other special anneal tempers may be supplied as agreed upon between the manufacturer or supplier and the purchaser.

8. Mechanical Property Requirements

8.1 *Tensile Strength Requirements:*

8.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in **Table 2** when tested in accordance with Test Methods **E8/E8M**.

8.1.1.1 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

9. Performance Requirements

9.1 *Expansion Test:*

9.1.1 When specified in the contract or purchase order, product test specimens from tube furnished in the O60 annealed temper shall be expanded in accordance with Test Method **B153** with an expansion of the outside diameter in the following percentage:

Outside Diameter, in. (mm)	Expansion of Outside Diameter, %
5/8 (15.9) and under	30
Over 5/8 (15.9)	25

9.1.2 The expanded tube shall show no cracking or other defects visible to the unaided eye.

9.2 *Microscopical Examination*—When specified in the contract or purchase order, product test specimens of Copper UNS Nos. C10100, C10200, and C12000 shall be free of cuprous oxide as determined by Test Method A of Test Methods **B577**.

9.3 *Hydrogen Embrittlement Susceptibility*—When specified in the contract or purchase order, product test specimens of Copper UNS Nos. C10100, C10200, C12000, and C12200 shall conform to the requirements of Test Method B of Test Methods **B577**.

9.4 *Flattening Test:*

9.4.1 When specified in the contract or purchase order, the flattening test shall be performed in accordance with Test Method **B968/B968M**.

9.5 *Reverse Bend Test*—When specified in the contract or purchase order, the product test specimens when flattened and

bent in accordance with the test method described in **16.2.5**, shall show no evidence of cracks, lack of penetration in the weld, or overlaps resulting from flash removal visible to the unaided eye which are considered unacceptable for the intended application.

10. Other Requirements

10.1 *Electromagnetic (Eddy-Current) Test:*

10.1.1 Each straight length tube, up to and including 3 1/8 in. (79.4 mm) outside diameter, shall be passed through an eddy-current testing unit adjusted to provide information on the suitability of the tube for the intended application.

10.1.2 Tubes that do not actuate the signaling device of the eddy-current testing unit shall be considered as conforming to the requirements of the test. Testing shall follow the procedures of Practice **E243**, except for the determination of “end effect.”

10.1.3 Testing of coiled lengths shall be subject to negotiation between the manufacturer and the purchaser.

10.1.4 For tubes greater than 3 1/8 in. (79.4 mm) in outside diameter, the manufacturer and purchaser shall agree on whatever nondestructive testing is required.

10.2 *Cleaness Test:*

10.2.1 When specified in the contract or purchase order, a cleanliness test described in **16.2.7** shall be performed.

10.2.1.1 After evaporation of the cleaning solvent, the residue weight shall not exceed 0.0035 g/ft² (0.038 g/m²). The maximum amount of residue in grams per tube shall not exceed the limits in **Tables 3 and 4**.

10.3 *Purchases for Agencies of the U.S. Government*—When specified in the contract or purchase order, product purchased for agencies of the U.S. government shall conform to the requirements stipulated in the Supplementary Requirements.

TABLE 3 Interior Surface Residue Limits of Soft Coiled Lengths^A

Standard Size, in.	Wall Thickness, in. (mm)	Residue Limit ^B per 50 ft (15.2 m) coil, g
	Copper UNS Nos. C10100, C10200, C12000, and C12200	Copper UNS Nos. C10100, C10200, C12000, and C12200
1/8	0.030 (0.762)	0.0030
3/16	0.030 (0.762)	0.0058
1/4	0.030 (0.762)	0.0087
5/16	0.032 (0.813)	0.0114
3/8	0.032 (0.813)	0.0143
1/2	0.032 (0.813)	0.0200
5/8	0.035 (0.889)	0.0254
3/4	0.035 (0.889)	0.0312
7/8	0.042 (1.07)	0.0305
1	0.045 (1.14)	0.0360
1 1/8	0.050 (1.27)	0.0470
1 1/4	0.055 (1.40)	0.0580
1 3/8	0.060 (1.52)	0.0690

^A See also **Table 5**.

^B Residue limit 0.0035 g/ft² (0.038 g/m²) inside area. The internal surface area per foot or tube is determined by the equation (3.1416 × inside diameter × 144)/1728.

TABLE 2 Mechanical Property Requirements

Copper UNS Nos. C10100, C10200, C12000, and C12200				
Form	Temper	Tensile Strength, Min		Elongation in 2 in. (50 mm), Min, %
		ksi ^A	MPa ^B	
Coiled lengths	O60	30	205	40
Straight lengths	H58	36	250	...

^A ksi = 1000 psi.

^B See **Appendix X1**.