



Designation: B1003 – 16 (Reapproved 2023)

Standard Specification for Seamless Copper Tube for Linesets¹

This standard is issued under the fixed designation B1003; 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 seamless copper tube for linesets intended for use in air conditioning units. The pressure rating established is 700 psi at 250 °F and incorporates fully annealed and brazed copper tubing.

1.2 The tube shall be produced from the following copper alloy:

Copper UNS No.	Previously Used Designation	Description
C12200	DHP	Phosphorus deoxidized, high residual phosphorus

1.3 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 The following safety hazard caveat pertains only to the test methods described in this specification:

1.4.1 *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 and health 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

B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

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 Oct. 15, 2023. Published October 2023. Originally approved in 2016. Last previous edition approved in 2016 as B1003 – 16. DOI: 10.1520/B1003-16R23.

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.

- [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](#)
- [B846 Terminology for Copper and Copper Alloys](#)
- [B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies](#)
- [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 \(Withdrawn 2022\)³](#)
- [E62 Test Methods for Chemical Analysis of Copper and Copper Alloys \(Photometric Methods\) \(Withdrawn 2010\)³](#)
- [E112 Test Methods for Determining Average Grain Size](#)
- [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](#)
- 2.2 *ASME Standard:*⁴
- [B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings](#)

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 *insulating material, n*—any material used to impart insulating properties to the copper coil provided the material does not cause corrosion of the copper.

3.2.2 *lineset, n*—a set of two (2) coils consisting of a suction line and a liquid line.

3.2.2.1 *liquid line, n*—a specified length of coiled tube with or without a sleeved insulating material.

3.2.2.2 *suction line, n*—a specified length of coiled tube with a sleeved insulating material.

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.

3.2.3 *R-value, n*—the quantity determined by the temperature difference, at steady state, between two defined surfaces of a material or construction that induces a unit heat flow rate through a unit area.

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 (for example, B1003 – 16),
- 4.1.2 Copper UNS No. (or other internationally recognized copper alloy designation) – not necessary unless a specific copper is desired,
- 4.1.3 Dimensions; diameter,
- 4.1.4 Standard Size (Table 1),
- 4.1.5 Length,
- 4.1.6 Quantity (total pieces of each size and type),
- 4.1.7 Insulation Type (Section 5),
- 4.1.8 Insulation Thickness or R-Value, or both (Section 5),
- 4.1.9 End Bend/Fittings/Refrigerant Charge (Section 5), and
- 4.1.10 If product is purchased for agencies of the U.S. Government (Section 11).

4.2 The following options are available but may not be included unless specified at the time of order placement:

- 4.2.1 Expansion test (10.1),
- 4.2.2 Cleanness test (Sections 10.2 and 17.2.5),
- 4.2.3 Microscopical Examination for Hydrogen Embrittlement, Procedure B (10.3.2),
- 4.2.4 Certification (Section 21),
- 4.2.5 Test report (Section 22),
- 4.2.6 Tensile test (9.1),
- 4.2.7 If the specification number must be shown in the package marking (23.1.1), and
- 4.2.8 Tubing with pressure ratings other than 700 psi.

5. Materials and Manufacture

5.1 *Materials:*

5.1.1 The material of manufacture shall be billets, bars, or tube and shall be of such soundness as to be suitable for processing into the tubular products described.

5.1.2 The material of insulation shall be agreed upon between the purchaser and manufacturer. The thickness or R-Values, or both, shall also be agreed upon by the purchaser

and manufacturer. The insulating material shall be chemically compatible with copper and shall not cause corrosion of the copper.

5.2 *Manufacture:*

5.2.1 The tube shall be manufactured by such hot- or cold-working processes as to produce a uniform wrought structure in the finished product.

5.2.2 The tube shall be cold drawn to the finished diameter and wall thickness and subsequently bright annealed. The tube can be in the form of a level-wound coil, bunch coil, straight length, or other form depending upon the manufacturer’s processing capabilities.

5.2.3 After annealing, the insulating material shall be applied to the suction line and the liquid line as specified. Re-coiling of the insulated tube may be performed upon the specified lengths, as required.

5.2.4 Bends, fittings, and refrigerant charges may be applied to the material after application of the insulating material.

6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements in Table 2.

6.1.1 These composition limits do not preclude the presence of other elements. By agreement between the supplier and purchaser, limits may be established and analysis required for unnamed elements.

7. Temper

7.1 Tubes produced under this specification shall be furnished in O60 (soft annealed) as defined in Classification B601.

8. Grain Size

8.1 Tubes shall have a recrystallized grain size of 0.030 mm minimum and 0.070 mm maximum when determined in accordance with Test Methods E112.

9. Mechanical Property Requirements

9.1 *Tensile Requirements*—The tube shall conform to the tensile requirements prescribed in Table 3.

9.1.1 Tensile requirements shall be made prior to re-coiling.

9.1.2 Tensile tests need not be performed except when specified in the contract or purchase order.

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

9.2 *Straightening*—It shall not be prohibited to use light straightening for tube.

10. Performance Requirements

10.1 *Expansion Test:*

TABLE 1 Standard Dimensions and Tolerances in Diameter for Coils

Standard Size, in.	Outside Diameter, in. (mm)	Tolerances	
		Average, ^A Outside Diameter, Plus and Minus, in. (mm)	
1/4	0.250 (6.35)	0.002 (0.051)	
5/16	0.312 (7.92)	0.002 (0.051)	
3/8	0.375 (9.53)	0.002 (0.051)	
1/2	0.500 (12.7)	0.002 (0.051)	
5/8	0.625 (15.9)	0.002 (0.051)	
3/4	0.750 (19.1)	0.0025 (0.064)	
7/8	0.875 (22.2)	0.003 (0.076)	
1 1/8	1.125 (28.6)	0.0035 (0.089)	

^A The average outside diameter of a tube is the average of the maximum and minimum outside diameters as determined at any one cross section of the tube.

TABLE 2 Chemical Composition—Weight %

Element	Copper UNS No. C12200
Copper, ^A min	99.9
Phosphorus	0.015–0.040

^A Copper + silver.

TABLE 3 Mechanical Property Requirements of Annealed-Temper Tube (Inch-Pound Values)

Temper Designation		Outside Diameter, or Major Distance Between Outside Parallel Surfaces, in.	Average Grain Size, mm	Tensile Strength, ksi ^A (MPa)	Elongation in 2 in. min %
Code	Name				
O60	soft anneal	all	0.030 min–0.070 max	30 min (207 min)	40

^A ksi = 1000 psi.

10.1.1 Tube shall be capable of being expanded in accordance with Test Method **B153** to the following extent:

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

10.1.2 Expansion tests need not be performed except when specified in the contract or purchase order.

10.2 *Cleanliness of Interior Surface:*

10.2.1 Tube shall have the capability of meeting an internal cleanliness test described in **17.2.5**.

10.2.2 Cleanliness tests need not be performed except when specified in the contract or purchase order.

10.2.3 After evaporation of the cleaning solvent, the residue weight from the tube shall not exceed 0.0035 g/ft² (0.038 g/m²) of the interior surface.

10.3 *Microscopical Examination for Susceptibility to Hydrogen Embrittlement:*

10.3.1 Tubes shall be essentially free of cuprous oxide as determined by Procedure A of Test Methods **B577**.

10.3.2 Tubes furnished in all coppers shall be capable of passing the embrittlement test specified in Procedure B of Test Methods **B577**. Hydrogen Embrittlement testing need not be performed except when specified in the contract or purchase order. In case of a dispute, Procedure C of Test Methods **B577** shall be used as the referee method.

10.4 *Pressure Ratings:*

10.4.1 Tubing shall be capable of handling pressures up to 700 psi according to the tests described in **17.3**.

10.4.2 Upon agreement between supplier and purchaser, tubing with pressure ratings other than 700 psi may be produced. Proof of the design shall be determined in accordance with the procedures described in **17.3**.

11. Other Requirements

11.1 *Nondestructive Testing Requirements:*

11.1.1 *Electromagnetic (Eddy-Current) Examination:*

11.1.1.1 Each length of tube shall be subjected to examination.

11.1.1.2 Tubes that do not actuate the signaling device on the testing unit, after having been adjusted to provide information on the suitability of the tube for the intended application, shall conform to the requirements of this test. Testing shall be in accordance with Practice **E243** and **17.2.4**.

11.1.1.3 Any tube which actuates the signaling device on the testing unit is to be removed or scrapped from the finished linesets. Marked defects are not allowed.

11.1.2 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.

12. Dimensions, Mass, and Permissible Variations

12.1 The standard dimensions for the various nominal sizes are given in **Table 1**.

12.2 *Outer Diameter*—The tolerances for diameter shall conform to the requirements specified in **Table 1**.

12.3 *Lengths and Tolerances:*

12.3.1 *Standard Lengths and Tolerances*—The length tolerances for coils shall be +12 in. (305 mm) and –0 in.

12.4 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 shall be subject to rejection.

12.5 Tubes supplied with end bend shall be in accordance with requirements established by agreement between the manufacturer or supplier and the purchaser.

12.6 Tubes supplied with end fitting or connector, or both, shall be in accordance with requirements established by agreement between the manufacturer or supplier and the purchaser.

12.7 Tube supplied with refrigerant charges shall be in accordance with the requirements established by agreement between the manufacturer or supplier and the purchaser.

13. Workmanship, Finish, and Appearance

13.1 The finished tube shall be smooth, free of internal and external mechanical imperfections, and shall have a clean, bright appearance at the time of manufacture. Blemishes of a nature that do not interfere with the intended application are acceptable.

13.2 The insulating material shall be smooth and free from tears or splits, or both, porous areas, weak sections, bubbles, foreign matter, or other defects which directly affect serviceability.

13.2.1 Insulation shall have no more than one mend joint, using suitable tape or other joining methods.

14. Sampling

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

14.1.1 *Lot Size*—An inspection lot shall be 10 000 lb (5000 kg), or less, of the same alloy, temper, and nominal dimensions, subject to inspection at one time. Alternatively, a lot shall be the product of one cast bar from a single melt charge, or one continuous casting run whose weight does not exceed 40 000 lb (20 000 kg) that has been continuously processed and subject to inspection at one time.