



Designation: B819 – 00 (Reapproved 2006)

# Standard Specification for Seamless Copper Tube for Medical Gas Systems<sup>1</sup>

This standard is issued under the fixed designation B819; 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.

## 1. Scope\*

1.1 This specification establishes the requirements for two wall thickness schedules of specially cleaned, straight lengths of seamless copper tube, identified as Types K and L, suitable for medical gas systems. The tube shall be installed in conformance with the requirements of the National Fire Protection Association (NFPA) Standard 99, Gas and Vacuum Systems (NFPA) Standard 99C, Standard for Hypobaric Facilities (NFPA) Standard 99B, and Canadian Standards Association (CSA) Standard Z 305.1/Z 7396.1, Nonflammable Medical Gas Piping Systems.

NOTE 1—Types K and L tube are defined in Specification B88.

NOTE 2—Drawn temper tube is suitable for use with capillary (solder joint) fittings for brazing.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.3 The following safety hazard caveat pertains only to the test method portion of Section 12 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.*<sup>2</sup>

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

B88 Specification for Seamless Copper Water Tube

B251 Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube  
B280 Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service  
B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast  
B846 Terminology for Copper and Copper Alloys  
E8 Test Methods for Tension Testing of Metallic Materials  
E18 Test Methods for Rockwell Hardness 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)  
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 Other Standards:

National Fire Protection Association (NFPA) 99, Gas and Vacuum Systems (NFPA) 99C and Standard for Hypobaric Facilities (NFPA) 99B<sup>4</sup>  
Compressed Gas Association (CGA) G-4.1, Cleaning Equipment for Oxygen Service<sup>5</sup>  
Canadian Standards Association (CSA) Z 305.1/Z 7396.1, Nonflammable Medical Gas Piping Systems<sup>6</sup>

## 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 *lengths*—straight pieces of the product.

<sup>1</sup> 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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<sup>2</sup> The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard system accomplished by the addition of a prefix “C” and a suffix “00”. The suffix can be used to accommodate composition variation of the base alloy.

<sup>3</sup> 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.

<sup>4</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101.

<sup>5</sup> Available from Compressed Gas Association (CGA), 1725 Jefferson Davis Hwy., Suite 1004, Arlington, VA 22202-4102.

<sup>6</sup> Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W1R3, Canada.

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

3.2.2 *standard*—uniform lengths established as commercial standards.

3.2.3 *tube, copper water*—a seamless copper tube conforming to the particular dimensions commercially known as Copper Water Tube and designated as Types K and L (see Table 1).

3.2.4 *tube, seamless*—a tube produced with a continuous periphery in all stages of the operations.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Specification B819-00.

4.1.2 Nominal or standard size (Column 1 of Table 1) and whether Type K or L (Sections 3 and 10),

4.1.3 Temper (Sections 7 and 8),

4.1.4 Length (see 10.5),

4.1.5 Quantity (pieces) of each size and type,

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

4.2.1 Whether tension test determinations are required (Section 8),

4.2.2 Whether the tube shall be charged with dry, oil-free nitrogen during capping, closing, or plugging (see 11.8),

4.2.3 Certification, if required (see Section 20), and

4.2.4 Mill Test Report, if required, (see Section 21).

4.2.5 In addition, when material is purchased for agencies of the U.S. government, it shall conform to the Supplementary Requirements as defined herein when specified in the contract or purchase order.

5. Materials and Manufacture

5.1 *Material*—The materials of manufacture shall be a cast billet of Copper Alloy UNS C12200 of such purity and soundness as to be suitable for processing into the products prescribed herein.

5.2 *Manufacture*—The product shall be manufactured by such hot working necessary to convert the billet to a tubular shape and cold worked to the finished size.

6. Chemical Composition

6.1 The material shall conform to the following chemical requirements of Copper UNS No. C12200:

Copper (incl silver), %	99.9 minimum
Phosphorous, %	0.015 to 0.040

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

7. Temper

7.1 Seamless copper tube for medical gas systems shall be furnished in the H58 (Drawn General Purpose) temper, as defined in Practice B601.

TABLE 2 Mechanical Properties

Temper Designation		Form	Rockwell Hardness <sup>A</sup>		Tensile Strength	
Standard	Former		Scale	Value	min, ksi <sup>B</sup>	(MPa) <sup>C</sup>
H58	drawn general purpose	straight lengths	30T	30 min	36	(250)

<sup>A</sup> Rockwell hardness tests shall be made on the inside surfaces of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values may be specified subject to between the purchaser and the supplier.

<sup>B</sup> ksi = 1000 psi.

<sup>C</sup> MPa = pascal × 10<sup>6</sup>.

8. Mechanical Properties

8.1 The tube shall conform to the mechanical property requirements specified in Table 2 when tested in accordance with Test Methods E18 and E8, respectively. Tension test determinations need not be made except when indicated by the

TABLE 1 Dimensions, Mass, and Tolerances in Diameter and Wall Thickness for Nominal or Standard Copper Water Tube Sizes. (All tolerances are plus and minus except as otherwise indicated)

Nominal or Standard Size, in.	Outside Diameter, in. (mm)		Average Outside Diameter <sup>A</sup> Tolerances, in. (mm)		Wall Thickness and Tolerances, in.								Theoretical Mass, lb/ft (kg/m)			
					Type K				Type L							
					Wall Thickness		Wall Tolerance		Thickness		Tolerance		Type K		Type L	
1/4	0.375	(9.52)	0.001	(0.025)	0.035	(0.889)	0.0035	(0.089)	0.030	(0.762)	0.003	(0.076)	0.145	(0.216)	0.126	(0.187)
3/8	0.500	(12.7)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.035	(0.889)	0.004	(0.10)	0.269	(0.400)	0.198	(0.295)
1/2	0.625	(15.9)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.040	(1.02)	0.004	(0.10)	0.344	(0.512)	0.285	(0.424)
5/8	0.750	(19.1)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.042	(1.07)	0.004	(0.10)	0.418	(0.622)	0.362	(0.539)
3/4	0.875	(22.3)	0.001	(0.025)	0.065	(1.65)	0.006	(0.15)	0.045	(1.14)	0.004	(0.10)	0.641	(0.954)	0.455	(0.677)
1	1.125	(28.6)	0.0015	(0.038)	0.065	(1.65)	0.006	(0.15)	0.050	(1.27)	0.005	(0.13)	0.839	(1.25)	0.655	(0.975)
1 1/4	1.375	(34.9)	0.0015	(0.038)	0.065	(1.65)	0.006	(0.15)	0.055	(1.40)	0.006	(0.15)	1.040	(1.55)	0.884	(1.32)
1 1/2	1.625	(41.3)	0.002	(0.051)	0.072	(1.83)	0.007	(0.18)	0.060	(1.52)	0.006	(0.15)	1.360	(2.02)	1.140	(1.70)
2	2.125	(54.0)	0.002	(0.051)	0.083	(2.11)	0.008	(0.20)	0.070	(1.78)	0.007	(0.18)	2.060	(3.07)	1.750	(2.60)
2 1/2	2.625	(66.7)	0.002	(0.051)	0.095	(2.41)	0.010	(0.25)	0.080	(2.03)	0.008	(0.20)	2.930	(4.36)	2.480	(3.69)
3	3.125	(79.4)	0.002	(0.510)	0.109	(2.77)	0.011	(0.28)	0.090	(2.29)	0.009	(0.23)	4.000	(5.95)	3.330	(4.96)
3 1/2	3.625	(92.1)	0.002	(0.051)	0.120	(3.05)	0.012	(0.30)	0.100	(2.54)	0.010	(0.25)	5.120	(7.62)	4.290	(6.38)
4	4.125	(105)	0.002	(0.051)	0.134	(3.40)	0.013	(0.33)	0.110	(2.79)	0.011	(0.28)	6.510	(9.69)	5.380	(8.01)
5	5.125	(130)	0.002	(0.051)	0.160	(4.06)	0.016	(0.41)	0.125	(3.18)	0.012	(0.30)	9.670	(14.4)	7.610	(11.3)
6	6.125	(156)	0.002	(0.051)	0.192	(4.88)	0.019	(0.48)	0.140	(3.56)	0.014	(0.36)	13.900	(20.7)	10.200	(15.2)
8	8.125	(206)	+0.002	(0.051)	0.271	(6.88)	0.027	(0.69)	0.200	(5.08)	0.020	(0.51)	25.900	(38.5)	19.300	(28.7)
			-0.006	(0.150)												

<sup>A</sup> The average outside diameter of a tube is the average of the maximum and minimum outside diameter, as determined at any one cross section of the tube.

purchaser at the time of placing the order. A convenient method of indicating that these tests are to be made is to state that “Test Procedure T” is required (see 4.2.1). Where agreement on the Rockwell hardness tests cannot be reached, the tensile strength requirements of Table 2 shall be the basis for acceptance or rejection.

## 9. Nondestructive Testing

9.1 Each tube up to and including 3-in. (76.2-mm) standard size, 3/8-in. (79.4-mm) outside diameter, shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice E243, except for the determination of “end effect.” Tubes shall be passed through an eddy-current test unit adjusted to provide information on the suitability of the tube for the intended application.

9.1.1 Either notch depth or drilled hole standards shall be used.

9.1.1.1 Notch-depth standards, rounded to the nearest 0.001 in. (0.025 mm) shall be 22 % of the wall thickness. The notch-depth tolerance shall be plus and minus 0.0005 in. (0.013 mm). Alternatively at the option of the manufacturer using speed-insensitive eddy-current units that are equipped so that a fraction of the maximum imbalance signal can be selected, the following percent maximum imbalance signals may be used:

Standard Tube Size, in.	Maximum Percent Imbalance Signal Magnitude
Up to 3/8, incl	0.2
1/2 to 2, incl	0.3
Over 2 to 3, incl	0.4

9.1.1.2 Drilled holes shall be drilled radially through the wall using a suitable drill jig that has a bushing to guide the drill, care being taken to avoid distortion of the tube while drilling. The diameter of the drilled hole shall be in accordance with the following and shall not vary by more than +0.001 in. (+0.026 mm), -0.000 in. (-0.000 mm) of the hole diameter specified.

Tube Outside Diameter, in.	Diameter of Drilled Holes, in.	Drill Number
1/4 to 3/4, incl	0.025	72
Over 3/4 to 1, incl	0.031	68
Over 1 to 1 1/4, incl	0.036	64
Over 1 1/4 to 1 1/2, incl	0.042	58
Over 1 1/2 to 1 3/4, incl	0.046	58
Over 1 3/4 to 2, incl	0.052	55

9.1.2 Tubes that do not activate the signalling device of the eddy-current testers shall be considered as conforming to the requirements of this test. Tubes with discontinuities indicated by the testing unit may at the option of the manufacturer be reexamined or retested to determine whether the discontinuity is cause for rejection. Signals that are found to have been caused by minor mechanical damage, soil or moisture, shall not be cause for rejection of the tubes provided the tube dimensions are still within prescribed limits and the tube is suitable for its intended application.

9.2 Tube made to this specification shall be capable of withstanding the pressure test of 9.2.1 or 9.2.2. Should subsequent testing by the purchaser establish that the material does not meet these requirements, the material may be rejected.

9.2.1 The tube shall stand without showing evidence of leakage, and an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 6000 psi (41 MPa) calculated from the following equation for thin hollow cylinders under tension:

$$P = \frac{2St}{D - 0.8t} \quad (1)$$

where:

- $P$  = hydrostatic pressure, psi (MPa);
- $S$  = allowable stress of the material, psi (MPa);
- $t$  = wall thickness, in. (mm); and
- $D$  = outside diameter of the tube, in. (mm).

9.2.2 The tube shall stand an internal air pressure of 60 psig (415 kPa) for 5 s without showing evidence of leakage. The test method used shall permit easy visual detection of any leakage, such as by having the tube under water or by the pressure differential method.

## 10. Dimensions, Mass and Permissible Variations

10.1 For the purpose of determining conformance with the dimensional requirements specified in this specification, any measured value outside the specified limiting values for any dimensions may be cause for rejection.

10.2 *Standard Dimensions, Wall Thickness, and Diameter Tolerances* shall be in accordance with Table 1.

10.3 *Theoretical Weights* for purposes of calculating weights, cross sections, and so forth, the density of the copper shall be taken as 0.323 lb/in.<sup>3</sup> (8.94 g/cm<sup>3</sup>).

10.4 *Roundness Tolerance* shall be as specified in Table 3. The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube.

10.5 *Standard Lengths and Tolerances*—The standard length and tolerances shall be as specified in Table 4.

10.6 *Squareness of Cut*—The departure from squareness of the end of any tube shall not exceed more than 0.010 in. (0.25 mm) for tube up to and including 1/2-in. (12.7-mm) standard size; and not more than 0.016 in./in. (0.40 mm/mm) of outside diameter for tube larger than 1/2-in. (12.7-mm) standard size.

## 11. Tube Cleaned for Medical Gas Systems

11.1 Tube for medical gas systems shall be cleaned to meet the requirements of Section 12. The following are recommended practices for cleaning, but the producer is not limited to these procedures.

NOTE 3—Some cleaning techniques are found in CGA G-4.1.

11.2 *Alkaline Washing*—Washing in a solution of approximately 4 oz of commercial alkaline cleaner per gallon (30 g/L)

**TABLE 3 Roundness Tolerance**

t/D (Ratio of Wall Thickness to Outside Diameter)	Roundness Tolerance % of Outside Diameter (Expressed to Nearest 0.001 in. or 0.010 mm)
0.01 to 0.03, incl	1.5
Over 0.03 to 0.05, incl	1.0
Over 0.05 to 0.10, incl	0.8