



# Standard Specification for Hard-Drawn Copper Capillary Tube for Restrictor Applications<sup>1</sup>

This standard is issued under the fixed designation B 360; 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 seamless capillary tube made from Copper Alloy UNS<sup>2</sup> Nos. C10800, C12000, or C12200.

1.2 This tube is commonly supplied in straight lengths intended for restrictor applications such as metering lines for liquids and gases where close control over smoothness and diameter of the bore is required to insure uniform flow characteristics between tubes.

1.3 The values stated in inch pound units are the standard. Metric values in parentheses are for information only.

1.4 The following safety hazard caveat pertains only to the test method described in Section 19.3.3 (Cleanness Test) 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 251 Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube<sup>3</sup>

B 577 Test Methods for Hydrogen Embrittlement of Copper<sup>3</sup>

B 601 Practice for Temper Designation for Copper and Copper Alloys—Wrought and Cast<sup>3</sup>

E 3 Practice for Preparation of Metallographic Specimens<sup>4</sup>

E 8 Test Methods for Tension Testing of Metallic Specimens<sup>4</sup>

E 53 Test Method for Chemical Analysis of Copper<sup>5</sup>

E 62 Test Methods for Chemical Analysis of Copper and

Copper Alloys (Photometric Methods)<sup>5</sup>

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition<sup>5</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>6</sup>

2.2 ASHRAE Standard:

No. 28-88 Method for Testing Capillary Tubes<sup>7</sup>

## 3. Terminology

### 3.1 Definition:

3.1.1 *tube, capillary, n*—a tube of small inside diameter with an inside surface of highest quality and conforming to close-diameter tolerances.

3.1.2 The tube is subject to special tests to insure precision and uniformity of bore and is specially cleaned and packed.

## 4. Ordering Information

4.1 The contract or purchase order for product under this specification should include the following information:

4.1.1 ASTM designation and year of issue (for example, B360 – XX),

4.1.2 Copper Alloy UNS No. (for example, C10800, Section 15 and 3),

4.1.3 Dimensions: inside and outside diameter (Table 1),

4.1.4 Air Flow requirements,

4.1.5 Quantity, total length, number of pieces or total weight of each size,

4.1.6 Length per piece of each size, and

4.1.7 When material is purchased for agencies of the U.S. Government.

4.2 The following options are available and should be specified in the contract or purchase order when required:

4.2.1 Heat Identification or traceability details,

4.2.2 Embrittlement test,

4.2.3 Certification, and

4.2.4 Mill test report.

## 5. Material and Manufacture

### 5.1 Material:

<sup>6</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>7</sup> Available from the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-5 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> Refer to Practice E 527 for an explanation of the Unified Numbering System (UNS).

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 03.05.

**TABLE 1 Standard Dimensions and Residue Limits of Interior Surfaces for Capillary Tubes**

Outside Diameter, in. (mm)	Inside Diameter, in. (mm)	Mean Wall Thickness, in. (mm)	Cross-Sectional Area of Tube Bore, in. <sup>2</sup> (mm <sup>2</sup> ) <sup>A</sup>	Weight, lb/ft (kg/m)	Maximum Allowable Residue, g/linear ft (g/linear m)
0.072 (1.83)	0.026 (0.660)	0.023 (0.584)	0.0005309 (0.343)	0.01373 (0.0204)	0.00020 (0.000656)
0.072 (1.83)	0.028 (0.711)	0.022 (0.558)	0.0006158 (0.397)	0.01340 (0.0199)	0.00021 (0.000689)
0.081 (2.06)	0.031 (0.787)	0.025 (0.635)	0.0007548 (0.487)	0.01705 (0.0254)	0.00023 (0.000754)
0.081 (2.06)	0.033 (0.838)	0.024 (0.606)	0.0008553 (0.552)	0.01666 (0.0248)	0.00025 (0.000820)
0.087 (2.21)	0.036 (0.914)	0.0255 (0.648)	0.001018 (0.657)	0.01910 (0.0284)	0.00027 (0.000886)
0.087 (2.21)	0.039 (0.991)	0.024 (0.606)	0.001195 (0.771)	0.01842 (0.0239)	0.00029 (0.000951)
0.093 (2.36)	0.042 (1.07)	0.0255 (0.648)	0.001385 (0.893)	0.02096 (0.0312)	0.00032 (0.00105)
0.097 (2.47)	0.046 (1.17)	0.025 (0.648)	0.001662 (1.07)	0.02221 (0.0331)	0.00035 (0.00115)
0.099 (2.51)	0.049 (1.24)	0.025 (0.635)	0.001886 (1.22)	0.02253 (0.0335)	0.00037 (0.00121)
0.106 (2.69)	0.054 (1.37)	0.026 (0.660)	0.002290 (1.48)	0.02533 (0.0377)	0.00041 (0.00134)
0.112 (2.84)	0.059 (1.50)	0.0265 (0.673)	0.002734 (1.76)	0.02760 (0.0411)	0.00044 (0.00144)
0.125 (3.18)	0.064 (1.63)	0.0305 (0.775)	0.003217 (2.07)	0.03511 (0.0522)	0.00048 (0.00157)
0.125 (3.18)	0.070 (1.78)	0.0275 (0.698)	0.003848 (2.48)	0.03266 (0.0486)	0.00053 (0.00174)
0.125 (3.18)	0.075 (1.91)	0.025 (0.635)	0.004418 (2.85)	0.03054 (0.0454)	0.00057 (0.00187)
0.145 (3.68)	0.080 (2.03)	0.0325 (0.826)	0.005027 (3.24)	0.04453 (0.0663)	0.00060 (0.00197)
0.145 (3.68)	0.085 (2.16)	0.030 (0.762)	0.005674 (3.66)	0.04202 (0.0625)	0.00064 (0.00210)
0.145 (3.68)	0.090 (2.29)	0.0275 (0.698)	0.006362 (4.10)	0.03936 (0.0586)	0.00068 (0.00223)
0.160 (4.06)	0.100 (2.54)	0.030 (0.762)	0.007854 (5.07)	0.04750 (0.0707)	0.00075 (0.00246)
0.160 (4.06)	0.110 (2.79)	0.025 (0.635)	0.009503 (6.13)	0.04111 (0.0611)	0.00083 (0.00272)
0.188 (4.78)	0.120 (3.03)	0.034 (0.864)	0.01131 (7.29)	0.06377 (0.0949)	0.00090 (0.00295)
0.188 (4.78)	0.130 (3.30)	0.029 (0.737)	0.01327 (8.56)	0.05616 (0.0836)	0.00098 (0.00321)
0.200 (5.08)	0.145 (3.68)	0.0275 (0.698)	0.01651 (10.7)	0.05779 (0.0860)	0.00109 (0.00358)
0.220 (5.59)	0.160 (4.06)	0.030 (0.762)	0.02011 (13.0)	0.06943 (0.103)	0.00121 (0.00397)
0.240 (6.10)	0.175 (4.45)	0.0325 (0.826)	0.02405 (15.5)	0.08107 (0.121)	0.00132 (0.00433)

<sup>A</sup> Cross-section area of tube bore in.<sup>2</sup> = (P i)(ID)<sup>2</sup>/4 where: π = 3.1416 and ID = inside diameter.

5.1.1 The tube shall be from Copper UNS No. C10800 (oxygen free, low phosphorus), C12000 (phosphorus deoxidized, low residual phosphorus) or C12200 (phosphorus deoxidized, high residual phosphorus).

5.1.2 When heat identification or traceability is required, the details desired shall be specified in the contract or purchase order.

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

## 5.2 Manufacture:

5.2.1 The tube shall be produced with a continuous periphery in all stages of operation and finished by cold drawing and cleaning.

5.2.2 Process design and equipment shall be such as is required to meet the stringent requirements of the bore.

5.2.3 The tube bore shall be finished so as to be clean and smooth.

5.2.4 The outside and inside of both ends of straight lengths shall be deburred.

## 6. Chemical Composition

6.1 The product shall conform to the specified Copper UNS No. designation as follows:

Element, Percent	Copper UNS No.		
	C10800	C12000	C12200
Copper	99.95 <sup>A</sup>	99.90 <sup>B</sup>	99.9 <sup>B</sup>
Phosphorus	0.005–0.012	0.004–0.012	0.015–0.040

<sup>A</sup> Copper + Silver + Phosphorus.

<sup>B</sup> Silver is counted as Copper.

6.1.1 These compositional limits do not preclude the presence of other elements. Limits may be established and analysis required for un-named elements by agreement between the manufacturer and purchaser.

## 7. Temper

7.1 The tubes shall be furnished in the H80<sup>8</sup> (hard drawn) condition.

## 8. Mechanical Property Requirements

### 8.1 Tensile Strength:

8.1.1 The tubes shall have a tensile strength of 45 ksi (MPa 395) minimum.

## 9. Hydrogen Embrittlement

9.1 The material shall conform with the requirements of Procedure B of Test Methods B 577.

9.1.1 This test is not required unless specified in the contract or purchase order.

## 10. Cleanness Requirement

10.1 The residue attributable to the tubes shall not exceed 0.0002 g/in.<sup>2</sup> (0.310 g/m<sup>2</sup>) of internal surface of the tube when subjected to test as directed in 19.3.3 (Refer to Table 1).

## 11. Air Flow Requirement

11.1 The tubes shall conform with the air flow requirements stipulated at the time of order placement.

<sup>8</sup> Refer to Practice B 601 for definition of temper designations.