



Designation: **B360—09 B360 – 15**

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

This standard is issued under the fixed designation B360; 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 hard-drawn, seamless capillary tube made from Copper Alloy UNS 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 *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 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:*<sup>2</sup>

[B251](#) Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube

[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

~~[B950](#) Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys~~

[E8E8/E8M](#) Test Methods for Tension Testing of Metallic Materials

[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[E62](#) Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)<sup>3</sup>

[E255](#) Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

#### 2.2 *ASHRAE Standard:*

[No. 28](#) Method for Testing Capillary Tubes<sup>4</sup>

### 3. General Requirements

3.1 The following sections of Specification [B251](#) are a part of this specification.

3.1.1 Terminology,

3.1.2 Workmanship, Finish and Appearance,

3.1.3 Significance of Numerical Limits,

3.1.4 Inspection,

3.1.5 Rejection and Reheating,

<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.

Current edition approved ~~Oct. 1, 2009~~ July 1, 2015. Published ~~November 2009~~ July 2015. Originally approved in 1960. Last previous edition approved in ~~2004~~ 2009 as [B360 – 01](#)/[B360 – 09](#). DOI: [10.1520/B0360-09](#)/[10.1520/B0360-15](#).

<sup>2</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>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](#).

<sup>4</sup> Available from the American Society of Heating, Refrigeration, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, [http://www.ashrae.org](#).

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

- 3.1.6 Certification,
- 3.1.7 Test Reports, and
- 3.1.8 Package and Package ~~Marking, and~~ Marking.

3.2 In addition, when a section with a title identical with those referenced in 3.1, above, appears in this specification, it contains additional requirements which supplement those appearing in Specification B251.

#### 4. Terminology

- 4.1 For the definitions of terms related to copper and copper alloys, refer to Terminology B846.

#### 5. Ordering Information

- 5.1 The contract or purchase order for product under this specification shall include the following information, as applicable:
  - 5.1.1 ASTM designation and year of issue (for example, B360 – XX),
  - 5.1.2 Copper Alloy UNS No. (for example, C10800, Section 7<sub>2</sub> and Table 1),
  - 5.1.3 Dimensions: inside and outside diameter (Table 2),
  - 5.1.4 Air Flow requirements (ft<sup>3</sup>/min), /min or cfm), (see 10.3), if required.

NOTE 1—Product is specified to air flow requirements for capillary applications.

- 5.1.5 Quantity, total length, number of pieces or total weight of each size,
- 5.1.6 Length per piece of each size, and

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

- 5.2.1 Heat Identification or traceability details,
- 5.2.2 Embrittlement test, (see 10.1),
- 5.2.3 Certification, (see 3.1.6), and
- 5.2.4 Mill test report (see 3.1.7).

#### 6. Material and Manufacture

##### 6.1 Material:

6.1.1 The material of manufacture shall be from a cast and extruded tube of Copper Alloy UNS No. C10800 (oxygen free, low phosphorus), C12000 (phosphorus deoxidized, low residual phosphorus), or C12200 (phosphorus deoxidized, high residual phosphorus) of such purity and soundness as to be suitable for processing in to the product prescribed herein.

6.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 2—Due to the discontinuous nature of processing castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

##### 6.2 Manufacture:

6.2.1 The product shall be manufactured by cold drawing processes as to produce a uniform wrought structure in the finished product.

6.2.2 The tube shall be finished by degreasing or other cleaning operations to meet the stringent requirements for cleanness of the inner diameter.

6.2.3 The outside and inside of both ends of straight lengths shall be made free of burrs that could restrict flow, by burr-free cutting, brushing, or chamfering.

6.2.4 The maximum allowable residue as determined by the cleanness test described in 16.4 shall not exceed the value given in Table 2 for the tube size tested.

#### 7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements in Table 1 for the Copper UNS Alloy No. designation specified in the ordering information.

7.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance specified in Table 1.

**TABLE 1 Chemical Requirements**

Element, Percent	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.

**TABLE 2 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) = (π)(ID)<sup>2</sup>/4 where: π = 3.1416 and ID = inside diameter.

7.2 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 un-named elements.

## 8. Temper

8.1 The tubes shall be furnished in the H80<sup>5</sup> (hard drawn) condition.

## 9. Mechanical Property Requirements

### 9.1 Tensile Strength:

9.1.1 The tubes shall have a tensile strength of 45 ksi (310 MPa) minimum.

## 10. Other Requirements

### 10.1 Embrittlement Requirement:

10.1.1 Samples of product produced from Coppers UNS Nos. C10800 and C12000 shall be capable of passing the embrittlement test of Procedure B of Test Methods B577. The actual performance of this test is not mandatory under the terms of this specification unless specified in the ordering information. In case of a dispute, a referee method in accordance with Procedure C shall be employed.

### 10.2 Cleanness Requirement:

10.2.1 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 16.4 (Refer to Table 2)

### 10.3 Air Flow Requirement:

10.3.1 When specified, the tubes shall conform to the air flow requirements, in ft<sup>3</sup>/min [cfm] stipulated at the time of order placement, when tested in accordance with the test in 16.5.

## 11. Dimensions, Mass, and Permissible Variations

### 11.1 Outside Diameter Tolerance ± Tolerance:

11.1.1 The average outside diameter tolerance shall be ±0.002 in. (0.051 mm).

### 11.2 Inside Diameter Tolerance:

<sup>5</sup> Refer to Practice Classification B601 for definition of temper designations.