



Designation: B 743 – 00

Standard Specification for Seamless Copper Tube in Coils¹

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1. Scope *

1.1 This specification establishes the requirements for seamless copper tube in coils, suitable for use in refrigeration and air conditioning or other uses, such as oil lines, gasoline lines, and so forth.

1.2 *Units*—The values stated in inch-pound units are 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 tube shall be produced of the following coppers. Unless otherwise specified, tubes made from any one of these coppers may be supplied:

Copper Alloy UNS No.	Previously Used Designation	Type of Copper
C10200	OF	Oxygen-free without residual deoxidants ^A
C10300	...	Oxygen-free, extra low phosphorus ^A
C10800	...	Oxygen-free, low phosphorus ^A
C12000	DLP	Phosphorized, low residual phosphorus
C12200	DHP	Phosphorized, high residual phosphorus

^A See Classification B 224.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information only.

1.5 The following safety hazards caveat pertains to the test method portion, Section 19, 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 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing²
- B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes²

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.

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² *Annual Book of ASTM Standards*, Vol 02.01.

- B 193 Test Method for Resistivity of Electrical Conductor Materials³
- B 224 Classification of Coppers²
- B 251 Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube²
- B 577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper²
- B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast²
- E 2 Methods of Preparation of Micrographs of Metals and Alloys (Including Recommended Practice for Photography as Applied to Metallography)⁴
- E 3 Practice for Preparation of Metallographic Specimens⁵
- E 8 Test Methods of Tension Testing of Metallic Materials⁶
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁵
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵
- E 53 Test Methods for Determination of Copper in Unalloyed Copper by Gravimetry⁷
- E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)⁷
- E 112 Test Methods for Determining Average Grain Size⁵
- E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes⁸
- E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition⁹
- E 846 Terminology for Copper and Copper Alloys²

3. General Requirements

3.1 The following sections of Specification B 251 constitute a part of this specification:

- 3.1.1 Sampling,
- 3.1.2 Number of tests and retests,
- 3.1.3 Dimensions and permissible variations,
- 3.1.4 Test specimens, and

³ *Annual Book of ASTM Standards*, Vol 02.03.

⁴ Discontinued. See 1982 *Annual Book of ASTM Standards*, Vol 03.01.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

⁶ *Annual Book of ASTM Standards*, Vol 03.01.

⁷ *Annual Book of ASTM Standards*, Vol 03.05.

⁸ *Annual Book of ASTM Standards*, Vol 03.03.

⁹ *Annual Book of ASTM Standards*, Vol 14.04.

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

3.1.5 Significance of numerical limits.

3.2 In addition, when a section with a title identical to those referenced in 2.1 appears in this specification, it contains additional information which supplements those appearing in Specification B 251. In case of conflict, this specification shall prevail.

4. Terminology

4.1 *Definitions*—For the definitions of terms related to copper and copper alloys, refer to Terminology B 846.

4.1.1 *coil, n*—length of the product wound into a series of connected turns. The unqualified term “coil” as applied to tube usually refers to a bunched coil.

4.1.1.1 *bunched, adj*—coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.

4.1.1.2 *level or traverse wound, adj*—coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another (sometimes called “helical coil”).

4.1.1.3 *single layer flat, adj*—coil in which the product is spirally wound into a single disk-like layer (sometimes called “pan-cake coil” or “single layer spirally wound coil”).

4.1.1.4 *double layer flat, adj*—coil in which the product is spirally wound into two connected disk-like layers such that one layer is on top of the other (sometimes called “double layer pan-cake coil” or “double layer spirally wound coil”).

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1 *unaided eye, n*—visual inspection, without the use of special equipment or enhancement excepting the use of corrective lenses.

5. Ordering Information

5.1 Orders for materials under this specification shall include the following information:

5.1.1 ASTM designation and year of issue,

5.1.2 Copper UNS No. (for example, C12200), if required (see 1.4 and 7.1),

5.1.3 Temper (see Section 8).

5.1.4 Dimensions, diameter, and wall thickness. Dimensional tolerances, if other than those included in this specification, are required,

5.1.5 Length (see 16.1),

5.1.6 Type of coil (see 4.1),

5.1.7 Total quantity of each item,

5.2 The following options are available and shall be specified at the time of placing the order, when required:

5.2.1 Embrittlement test (see 13.3.1),

5.2.2 Refrigeration or air-conditioning grade (see 17.3),

5.2.3 If coil ends are to be sealed (see 13.4.1.1),

5.2.4 Eddy-current test (see 13.1.1),

5.2.5 Expansion test (see 12.1.1),

5.2.6 Electrical resistivity requirement (see 10.1),

5.2.7 Certification (see Section 23),

5.2.8 Mill test report.

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be cast billet, bar, tube, and so forth of Copper Alloys Nos. C10200, C10300, C10800, C12000, or C12200 and of such purity and soundness as to be suitable for processing in to the product prescribed herein.

6.2 *Manufacture:*

6.2.1 The tube shall be manufactured by such hot and cold working processes needed to produce a homogenous, uniform wrought structure in the finished product.

6.2.1.1 It shall be cold-drawn to the finish size and wall thickness.

6.2.1.2 When the cold-drawn temper is required, the final drawing operation shall be such as to meet the specified temper.

6.2.1.3 When the annealed temper is required, the tube shall be annealed after the final cold draw.

7. Chemical Composition

7.1 The material shall conform to the compositional requirements listed in Table 1 for the copper specified in the ordering information.

8. Temper

8.1 *H (Drawn) Temper*—The temper of drawn tube shall be designated as H58 (drawn, general purpose).

8.2 *O (Annealed) Temper*—The temper of annealed tube shall be designated as 050 (light anneal) and 060 (soft anneal) (see Table 2). Tempers are defined in Practice B 601.

9. Grain Size of Annealed Tempers

9.1 Samples of annealed temper tubes shall be examined at a magnification of 75 diameters. The microstructure shall show complete recrystallization and shall have an average grain size within the limits specified in Table 3, when tested in accordance with Test Method E 112.

10. Physical Property Requirements

10.1 *Electrical Resistivity*—When specified in the contract or purchase-order, tube ordered for electrical conductor application produced from Copper UNS No. C10200, C10300, or C12000 shall have an electrical mass resistivity, $\Omega \cdot \text{g}/\text{m}^2$, not to

TABLE 1 Chemical Requirements

Element	Composition, %				
	Copper Alloy UNS No.				
	C10200 ^A	C10300	C10800	C12000	C12200
Copper, ^B min	99.95	99.90	99.9
Copper + phosphorus, min	...	99.95	99.95
Phosphorus	...	0.001–0.005	0.005–0.012	0.004–0.012	0.015–0.040

^AOxygen in C10200 shall be 10 ppm max.

^BSilver counting as copper.

TABLE 2 Mechanical Property Requirements of Drawn-Temper and Annealed-Temper Tube

Temper Designation	Wall Thickness, in. (mm)	Rockwell Hardness		Tensile Strength Min, ksi ^A (Mpa)	Yield Strength ^B Min, ksi ^A (Mpa)	Elongation in 2 in., min %
		Scale	Value			
H58	Less than 0.020	N/A	N/A	36 (250)	30 (205)	N/A
	0.020 and over	30T ^C	30 min	36 (250)	30 (205)	N/A
O50	Less than 0.015	N/A	N/A	30 (205)	9 (62)	40
	0.015 to 0.035 (0.381 to 0.889)	15T ^C	65 max	30 (205)	9 (62)	40
	Over .035 (0.889)	F ^C	55 max	30 (205)	9 (62)	40
O60	Less than 0.015	N/A	N/A	30 (205)	6 (40)	40
	0.015 to 0.035 (0.381 to 0.889)	15T ^C	60 max	30 (205)	6 (40)	40
	Over 0.35 (0.889)	F ^C	50 max	30 (205)	6 (40)	40

^Aksi = 1000 psi.

^BYield strength to be determined at 0.5 % extension under load.

^CRockwell hardness values apply to tubes having an inside diameter of 5/16 in. (7.92 mm) or over, and Rockwell hardness test shall be made on the inside surface of the tube. When suitable equipment is not available for determining the specific Rockwell hardness, other Rockwell scales and values may be specified subject to agreement between the purchaser and supplier.

TABLE 3 Grain Size of Annealed Tempers

Temper	Average Grain Size, mm
O60	0.040 min
O50	0.040 max

exceed the limits in Table 4 for the specified copper and temper when tested in accordance with Test Method B 193.

11. Mechanical Property Requirements

11.1 *Tensile and Yield Strength*—The product shall conform to the requirements in Table 2 for the specified temper.

11.2 Rockwell Hardness:

11.2.1 For product of the H58 temper and Rockwell hardness values are given for reference purposes only.

11.2.2 For product of the O (annealed) temper, the product shall conform to the Rockwell hardness values contained in Table 2.

12. Performance Requirements

12.1 Expansion Requirement:

12.1.1 When specified in the contract or purchase order, specimens of the annealed product shall be capable of being expanded in accordance with Test Method B 153 with an expansion of the outside diameter in the following percentage:

Outside Diameter, in. (mm)	Expansion of Outside Diameter, %
0.750 (19.1) and under	40
Over 0.750 (19.1)	30

12.1.2 The expanded tube shall show no cracking or rupture visible to the unaided eye.

TABLE 4 Copper UNS No.

NOTE 1—Refer to Appendix X1 for the International Annealed Copper Standard (IACS) electrical conductivity equivalents.

Temper	C10200	C10300	C12000
O50, O60	0.153 28	0.156 14	0.170 31
H58	0.15737	0.159 40	0.174 18

13. Other Requirements

13.1 Nondestructive Examination for Defects:

13.1.1 Upon agreement between the manufacturer and the purchaser, each tube shall be subjected to an eddy-current test.

13.1.2 Tubes shall be tested normally in the drawn temper; however, they may be tested in the annealed temper at the option of the manufacturer.

13.1.3 Testing shall follow the procedures of Practice E 243 except for the determination of “end effect.”

NOTE 1—End effect is that length of the tube, which travels through the coil until the testing unit, has stabilized and is able to detect flaws. The magnitude of the spike, generated when an end passes through the test coils is such that it disrupts testing momentarily.

13.1.4 Unless otherwise agreed upon between the manufacturer, or supplier, and the purchaser, the manufacturer shall have the option of calibrating the test equipment using either notches or drilled holes. If agreement cannot be reached, drilled holes shall be used.

13.1.4.1 Notch-depth standards rounded to the nearest 0.001 in. (0.025 mm) shall be 22 % of the nominal bottom-wall thickness.

13.1.4.2 Drilled-hole standards shall be 0.025 in. (0.635 mm) diameter for tubes up to and including 3/4 in. (19.05 mm) specified diameter and 0.31 in. (0.785 mm) diameter for tubes over 3/4 in. (19.05 mm) specified diameter.

13.1.5 Tubes that do not actuate the signaling device on the eddy-current tester shall be considered in conformance with the requirements of this test.

13.1.6 Tubes, rejected for irrelevant signals because of moisture, soil, and like effects, may be reconditioned and retested.

13.1.7 Tubes that are reconditioned and retested (see 13.1.6) shall be considered in conformance with the requirements of this specification, if they do not cause output signals beyond the acceptable limits.

13.1.8 Eddy-current discontinuities will be identified on coils in excess of 200 ft (61 m) in length for subsequent removal by the purchaser.