



Designation: B135/B135M – 17

# Standard Specification for Seamless Brass Tube<sup>1</sup>

This standard is issued under the fixed designation B135/B135M; 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 U.S. Department of Defense.*

## 1. Scope\*

1.1 This specification covers seamless round and rectangular including square copper alloy tube in straight lengths. Ten alloys are specified having the following nominal compositions:

Copper Alloy UNS No. <sup>2</sup>	Previously Used Designation <sup>4</sup>	Nominal Composition, %			
		Copper	Zinc	Lead	Tin
C22000	7	90.0	10.0	...	...
C23000	1	85.0	15.0	...	...
C26000	2	70.0	30.0	...	...
C27000	9	65.0	35.0	...	...
C27200	8	63.0	37.0	...	...
C27400	...	62.5	37.5	...	...
C28000	5	60.0	40.0	...	...
C33000	3	66.0	33.5	0.5	...
C33200	4	66.0	32.4	1.6	...
C37000	6	60.0	39.0	1.0	...
C44300	...	71.5	27.5	...	1.00

<sup>4</sup> Alloy Designations of Specification B135 – 63, which was published in the 1966 Book of ASTM Standards, Part 5.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 **Warning**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Safety Data Sheet (SDS) for additional information. Users should be aware that

<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 designation system accomplished by the addition of a prefix “C” and a suffix “00.” The suffix can be used to accommodate composition variations of the base alloy.

selling mercury and/or mercury containing products into your state or country may be prohibited by law. (See 10.1.)<sup>2</sup>

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, health, and environmental 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:<sup>3</sup>

- B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
- B154 Test Method for Mercurous Nitrate Test for Copper Alloys
- B251/B251M Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
- B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
- B846 Terminology for Copper and Copper Alloys
- B858 Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys
- B968/B968M Test Method for Flattening of Copper and Copper-Alloy Pipe and Tube
- E243 Practice for Electromagnetic (Eddy Current) Examination of Copper and Copper-Alloy Tubes
- E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

## 3. Terminology

3.1 For terms related to copper and copper alloys, refer to Terminology B846.

<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.

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

#### 4. Ordering Information

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

- 4.1.1 Alloy (Section 1),
- 4.1.2 Temper (Section 7),
- 4.1.3 Whether tension tests are required (for drawn tempers only (see 8.1)),
- 4.1.4 Dimensions: diameter or distance between parallel surfaces and wall thickness (see 11.2 and 11.3),
- 4.1.5 Length (see 12.4),
- 4.1.6 Stress Corrosion Resistance Testing, if required (Section 10),
- 4.1.7 Total length of each size,
- 4.1.8 Hydrostatic pressure test, when specified, and
- 4.1.9 Pneumatic test, when specified.

#### 5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification B251/B251M.

5.2 The following sections of Specification B251/B251M constitute a part of this specification:

- 5.2.1 Terminology
- 5.2.2 Materials and Manufacture
- 5.2.3 Dimensions and Permissible Variations
- 5.2.4 Sampling
- 5.2.5 Number of Tests and Retests
- 5.2.6 Specimen Preparation
- 5.2.7 Certification
- 5.2.8 Test Reports

5.3 In addition, when a section with a title identical to that referenced in 5.1, above, appears in this specification, it contains additional requirements which supplement those appearing in Specification B251/B251M.

#### 6. Chemical Composition

6.1 The material shall conform to the chemical requirements specified in Table 1.

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

6.2.1 For alloys in which zinc is listed as “remainder,” either copper or zinc may be taken as the difference between the sum of results of all other elements determined and 100 %. When all elements in Table 1 are determined, the sum of the results shall be as shown in the following table:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C22000	99.8
C23000	99.8
C26000	99.7
C27000	99.7
C27200	99.7
C27400	99.7
C28000	99.7
C33000	99.6
C33200	99.6
C37000	99.6
C44300	99.6

#### 7. Temper

7.1 *Drawn Tempers, H*—The tempers of drawn tube shall be designated as light-drawn (H55), drawn (H58), and hard-drawn (H80) (see Tables 2 and 3). Light-drawn (bending) temper is used only when a tube of some stiffness but yet capable of being bent is needed. Drawn temper is for general purposes and is most commonly used where there is no specific requirement for high strength on the one hand or for bending qualities on the other. Hard-drawn temper is used only where there is need for a tube as strong as is commercially feasible for the sizes indicated. For any combination of diameter and wall thickness not covered under hard-drawn temper, the values given for drawn temper shall be used. Rectangular including square tubes shall normally be supplied only in drawn (general-purpose) temper. When there is a need for light-drawn or hard-drawn tempers these are to be supplied as agreed upon between the manufacturer and the purchaser.

7.2 *Annealed Tempers, O*—The tempers of annealed tube shall be designated as light anneal (O50) and soft anneal (O60) (Tables 4 and 5).

NOTE 1—Tube of Copper Alloy UNS No. C23000, when specified to meet the requirements of the ASME Boiler and Pressure Vessel Code, shall have in the annealed condition a minimum tensile strength of 40 ksi [275 MPa] and a minimum yield strength of 12 ksi [80 MPa] at 0.5 % extension under load, in which case the provisions for grain size and Rockwell hardness in 8.2 do not apply.

**TABLE 1 Chemical Requirements**

Copper Alloy UNS No.	Composition, %					
	Copper	Lead	Arsenic	Tin	Iron, max	Zinc
C22000	89.0–91.0	0.05 max	...	...	0.05	remainder
C23000	84.0–86.0	0.05 max	...	...	0.05	remainder
C26000	68.5–71.5	0.07 max	...	...	0.05	remainder
C27000	63.0–68.5	0.09 max	...	...	0.07	remainder
C27200	62.0–65.0	0.07 max	...	...	0.07	remainder
C27400	61.0–64.0	0.09 max	...	...	0.05	remainder
C28000	59.0–63.0	0.09 max	...	...	0.07	remainder
C33000	65.0–68.0	0.25 <sup>A</sup> –0.7	...	...	0.07	remainder
C33200	65.0–68.0	1.5–2.5	...	...	0.07	remainder
C37000	59.0–62.0	0.9–1.4	...	...	0.15	remainder
C44300	70.0–73.0	0.07 max	0.02–0.06	0.9–1.2	0.06	remainder

<sup>A</sup> In the case of Copper Alloy UNS No. C33000 on tube sizes greater than 5 in. in outside diameter, or distance between outside parallel surfaces, the lead content shall be 0.7 % maximum, no minimum is specified.



TABLE 2 Mechanical Property Requirements of Drawn Temper Tube—Inch-Pound Values

Copper Alloy UNS No.	Temper Designation <sup>A</sup>		Outside Diameter, in. or Major Distance Between Outside Parallel Surfaces, in.	Wall Thickness, in.	Tensile Strength ksi <sup>B</sup>	Rockwell Hardness <sup>C</sup> 30T
	Standard	Former				
C22000	H58	drawn (general purpose)	all	all	40 min	38 min
C22000	H80	hard drawn <sup>D</sup>	up to 1, incl	0.020 to 0.120, incl	52 min	55 min
C22000	H80	hard drawn <sup>D</sup>	over 1 to 2, incl	0.035 to 0.180, incl	52 min	55 min
C22000	H80	hard drawn <sup>D</sup>	over 2 to 4, incl	0.060 to 0.250, incl	52 min	55 min
C23000	H55	light drawn <sup>D</sup>	all	all	44–58	43–75
C23000	H58	drawn (general purpose)	all	all	44 min	43 min
C23000	H80	hard drawn <sup>D</sup>	up to 1, incl	0.020 to 0.120, incl	57 min	65 min
C23000	H80	hard drawn <sup>D</sup>	over 1 to 2, incl	0.035 to 0.180, incl	57 min	65 min
C23000	H80	hard drawn <sup>D</sup>	over 2 to 4, incl	0.060 to 0.250, incl	57 min	65 min
C26000, C27000, C27200, C27400, C33000, and C33200	H58	drawn (general purpose)	all	all	54 min	53 min
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>D</sup>	up to 1, incl	0.020 to 0.120, incl	66 min	70 min
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>D</sup>	over 1 to 2, incl	0.035 to 0.180, incl	66 min	70 min
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>D</sup>	over 2 to 4, incl	0.060 to 0.250, incl	66 min	70 min
C28000 and C37000	H58	drawn (general purpose)	all	all	54 min	55 min
C44300	H58	drawn (general purpose)	all	all	54 min	53 min
C44300	H80	hard drawn <sup>D</sup>	all	all	66 min	70 min

<sup>A</sup> Standard designations defined in Classification B601.

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

<sup>C</sup> Rockwell hardness values shall apply only to tubes having a wall thickness of 0.012 in. or over and to round tubes having an inside diameter of 5/16 in. or over and to rectangular including square tubes having an inside major distance between parallel surfaces of 3/16 in. or over. Rockwell hardness shall be made on the inside surface of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values shall be specified subject to agreement between the manufacturer and the purchaser.

<sup>D</sup> Light-drawn and hard-drawn tempers are available in round-tube only.

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8. Mechanical Properties

8.1 *Drawn Temper*—Tube shall conform to the mechanical properties prescribed in Tables 2 and 3. Tension tests are required for tubes with a wall thickness under 0.020 in. [50 mm] and for round tubes having an inside diameter under 5/16 in. [8.0 mm] and for rectangular including square tubes having a major distance between inside parallel surfaces under 3/16 in. [5.0 mm]. The tension test for other sizes of tubes need not be made except when indicated by the purchaser at the time of placing the order. A convenient method of indicating that the tension test is required is to specify that “Test procedure ‘T’ is required” (see 4.1.3). When agreement on the Rockwell hardness tests cannot be reached, the tensile strength requirements of Table 2 shall be the basis for acceptance or rejection.

8.2 *Annealed Temper*—Tube shall conform to the grain size and Rockwell hardness limits prescribed in Tables 4 and 5.

9. Expansion Test for Round Tube

9.1 Tube ordered in the annealed (O) condition, selected for test, shall be capable of withstanding in accordance with Test Method B153 an expansion of the outside diameter in the following amount:

Outside Diameter, in.	Expansion of Outside Diameter, %
3/4 and under	20
Over 3/4	15

The expanded tube shall show no cracking or rupture visible to the unaided eye. Tube ordered in the drawn (H) condition is not subject to this test.

NOTE 2—The term “unaided eye,” as used herein, permits the use of corrective spectacles necessary to obtain normal vision.

9.2 As an alternative to the expansion test for tube over 4 in. [100 mm] in diameter in the annealed condition shall be Test Method B968/B968M.

9.3 Drawn temper tube shall not be required to withstand these tests.

10. Mercurous Nitrate Test

10.1 **Warning**—Mercury is a definite health hazard. Use equipment for the detection and removal of mercury vapor. Wear rubber gloves when conducting the test.

10.2 When specifically required, test specimens 6 in. [150 mm] in length of both annealed and drawn tempers shall withstand, after proper cleaning, an immersion for 30 min



TABLE 3 Mechanical Property Requirements of Drawn Temper Tube—SI Values

Copper Alloy UNS No.	Temper Designation <sup>A</sup>		Outside Diameter, mm or Major Distance Between Outside Parallel Surfaces, mm	Wall Thickness, mm	Tensile Strength, MPa	Rockwell Hardness <sup>B</sup> 30T
	Standard	Former				
C22000	H58	drawn (general purpose)	all	all	275 min	38 min
C22000	H80	hard drawn <sup>C</sup>	up to 25, incl	0.050 to 3.0, incl	360 min	55 min
C22000	H80	hard drawn <sup>C</sup>	over 25 to 40, incl	0.090 to 5.50, incl	360 min	55 min
C22000	H80	hard drawn <sup>C</sup>	over 50 to 100, incl	1.5 to 6.0, incl	360 min	55 min
C23000	H55	light drawn <sup>C</sup>	all	all	305–400	43–75
C23000	H58	drawn (general purpose)	all	all	305 min	43 min
C23000	H80	hard drawn <sup>C</sup>	up to 25, incl	0.050 to 3.0, incl	395 min	65 min
C23000	H80	hard drawn <sup>C</sup>	over 25 to 50, incl	0.090 to 5.0, incl	395 min	65 min
C23000	H80	hard drawn <sup>C</sup>	over 50 to 100, incl	1.5 to 6.0, incl	395 min	65 min
C26000, C27000, C27200, C27400, C33000, and C33200	H58	drawn (general purpose)	all	all	370 min	53 mm
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>C</sup>	up to 25, incl	0.050 to 3.0, incl	455 min	70 min
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>C</sup>	over 25 to 50, incl	0.090 to 5.0, incl	455 min	70 min
C26000, C27000, C27200, C27400, C33000, and C33200	H80	hard drawn <sup>C</sup>	over 50 to 100, incl	1.5 to 6.0, incl	455 min	70 min
C28000 and C37000	H58	drawn (general purpose)	all	all	370 min	55 min
C44300	H58	drawn (general purpose)	all	all	370 min	53 min
C44300	H80	hard drawn <sup>C</sup>	all	all	455 min	70 min

<sup>A</sup> Standard designations defined in Classification B601.

<sup>B</sup> Rockwell hardness values shall apply only to tubes having a wall thickness of 0.30 mm or over and to round tubes having an inside diameter of 8.0 mm or over and to rectangular including square tubes having an inside major distance between parallel surfaces of 5.0 mm or over. Rockwell hardness shall be made on the inside surface of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values shall be specified.

<sup>C</sup> Light-drawn and hard-drawn tempers are available in round tube only.

without cracking in the standard mercurous nitrate solution prescribed in Test Method B154. Immediately after removal from the solution, the specimen shall be wiped free of excess mercury and examined for cracks.

## 11. Nondestructive Testing

11.1 Unless nondestructive testing has been waived, tubes shall be subjected to a nondestructive test. The manufacturer shall select the nondestructive test that is most suitable for the tube size and the application.

11.1.1 Eddy-current testing is the standard nondestructive test, and all tubes of appropriate size shall be eddy-current tested in accordance with 11.2.

11.1.2 Tubes that are not of a size suitable for eddy-current test capabilities shall be tested by the hydrostatic test as described in 11.3.1, or by the pneumatic test as described in 11.3.2.

11.2 *Eddy-Current Test*—Each tube up to 3½ in. [79 mm] in outside diameter shall be subjected to an eddy-current test. Testing shall follow the procedure of Practice E243, except the determination of “end effect” is not required. Tubes shall be passed through an eddy-current test unit adjusted to provide information on the suitability of the tube for the intended application.

11.2.1 Notch-depth standards rounded to the nearest 0.001 in. [0.03 mm] shall be 22 % of the nominal wall thickness. The notch-depth tolerance shall be ±0.0005 in.

[±0.01 mm]. Alternatively, if the manufacturer uses speed-insensitive eddy-current units that are equipped so that a fraction of the maximum unbalance signal is able to be selected, the following percent maximum unbalance signals shall be used.

Standard Tube Size, in. [mm]	Maximum Percent Unbalance Signal Magnitude
Up to and including ¾ [12 mm]	0.2
½ to 2 incl [15 to 54 mm incl]	0.3
Over 2 to 3 incl [54 to 79 mm incl]	0.4

11.2.2 Tubes that do not actuate the signalling device of the eddy-current testers shall be considered as conforming to the requirements of this test. If reexamined or retested, tubes with 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.

11.3 A pressure test shall be specified for tube sizes over 3½ in. [79 mm] in outside diameter or tube of dimensions beyond the capabilities of the eddy-current test apparatus or as an alternative to the eddy-current test. The purchaser shall have the option to specify either a hydrostatic test in 11.3.1 or the pneumatic test in 11.3.2. When, in the case where subsequent testing by the purchaser establishes that the material does not meet these requirements, then the tubes shall be subject to rejection.