



Designation: B 135 – 96

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Seamless Brass Tube¹

This standard is issued under the fixed designation B 135; 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 (ε) 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 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. ²	Previously Used Designation ⁴	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

⁴ Alloy Designations of ASTM Specification B 135 – 63 which was published in the 1966 Book of ASTM Standards, Part 5.

NOTE 1—A complete metric companion to Specification B 135 has been developed—B 135M; therefore, no metric equivalents are presented in this specification.

1.2 **Warning**—Mercury is a definite health hazard in use and disposal. (See 10.1.)²

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

2.2 ASTM Standards:

B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing³

B 154 Test Method for Mercurous Nitrate Test for Copper and Copper Alloys³

¹ 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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² The UNS system for copper and copper alloys (see Practice E 527) 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.

³ Annual Book of ASTM Standards, Vol 02.01.

B 251 Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube³

B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast³

E 243 Practice for Electromagnetic (Eddy-Current) Testing of Seamless Copper and Copper-Alloy Tubes⁴

E 527 Practice for Numbering Metals and Alloys (UNS)⁵

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *capable of*—as used in this specification, the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements the material shall be subject to revision.

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 section 11.4),

4.1.6 Mercurous nitrate test, 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 B 251.

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

⁴ Annual Book of ASTM Standards, Vol 03.03.

⁵ Annual Book of ASTM Standards, Vol 01.01.



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	0.10 max	...	...	0.07	remainder
C27200	62.0–65.0	0.07 max	...	...	0.07	remainder
C27400	61.0–64.0	0.10 max	...	...	0.05	remainder
C28000	59.0–63.0	0.30 max	...	...	0.07	remainder
C33000	65.0–68.0	0.25 ^A –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

^A 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, it is permissible to furnish tube with a lead content less than 0.20 %.

of other elements. Limits for unnamed elements are to be established by agreement between manufacturer or supplier and purchaser.

6.2.1 For copper alloys in which zinc is specified as the remainder, either copper or zinc shall be permitted to be taken as the difference between the sum of all the elements analyzed and 100 %.

6.2.1.1 When all the elements in Table 1 are analyzed, their sum 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 harddrawn

TABLE 2 Mechanical Property Requirements of Drawn Temper Tube

Copper Alloy UNS No.	Temper Designation ^A		Outside Diameter, in. or Major Distance Between Outside Parallel Surfaces, in.	Wall Thickness, in	Tensile Strength ksi ^B	Rockwell Hardness ^C 30T
	Standard	Former				
C22000	H58	drawn (general purpose)	all	all	40 min	38 min
	H80	hard-drawn ^D	{ up to 1, incl over 1 to 2, incl over 2 to 4, incl }	{ 0.020 to 0.120, incl 0.035 to 0.180, incl 0.060 to 0.250, incl }	52 min	55 min
	{					
C23000	H55	light-drawn ^D	all	all	44–58	43–75
	H58	drawn (general purpose)	all	all	44 min	43 min
	H80	hard-drawn ^D	{ up to 1, incl over 1 to 2, incl over 2 to 4, incl }	{ 0.020 to 0.120, incl 0.035 to 0.180, 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
	H80	hard-drawn ^D	{ up to 1, incl over 1 to 2, incl over 2 to 4, incl }	{ 0.020 to 0.120, incl 0.035 to 0.180, incl 0.060 to 0.250, incl }	66 min	70 min
	{					
C28000 and C3700	H58	drawn (general purpose)	all	all	54 min	55 min
	H58	drawn (general purpose)	all	all	54 min	53 min
	{					
C44300	H80	hard-drawn ^D	all	all	66 min	70 min
	{					

^A Standard designations defined in Practice B 601.

^B ksi = 1000 psi.

^C 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 $\frac{5}{16}$ in. or over and to rectangular including square tubes having an inside major distance between parallel surfaces of $\frac{3}{16}$ 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 are permitted to be specified subject to agreement between the manufacturer and the purchaser.

^D Light-drawn and hard-drawn tempers are normally available in round-tube only.

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(H80) (see Table 2). 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) (Table 3).

NOTE 2—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 and a minimum yield strength of 12 ksi at 0.5 % extension under load, in which case the provisions for grain size and Rockwell hardness in 8.2 do not apply.

8. Mechanical Properties

8.1 Drawn Temper—Tube shall conform to the mechanical properties prescribed in Table 2. Tension tests are required for

tubes with a wall thickness under 0.020 in. and for round tubes having an inside diameter under $\frac{5}{16}$ in. and for rectangular including square tubes having a major distance between inside parallel surfaces under $\frac{3}{16}$ in. 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 Table 3.

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 B 153 an expansion of the outside diameter in the following amount:

Outside Diameter, in.	Expansion of Outside Diameter, %
$\frac{3}{4}$ and under	20
Over $\frac{3}{4}$	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.

TABLE 3 Mechanical Property Requirements of Annealed Temper Tube

Copper Alloy UNS No.	Temper Designation ^A		Wall Thickness, in.	Rockwell Hardness ^B		Average Grain Size, mm	
	Standard	Former		Scale	Max	Min	Max
C22000	O60	soft anneal	{ up to 0.045, incl over 0.045	30T F	30 70	0.025 0.025	0.060 0.060
	{ O50	light anneal	{ up to 0.045, incl over 0.045	30 T F	37 78	^C ^C	0.035 0.035
	O60	soft anneal	{ up to 0.045, incl over 0.045	30T F	36 75	0.025 0.025	0.060 0.060
	{ O50	light anneal	{ up to 0.045, incl over 0.045	30T F	39 85	^C ^C	0.035 0.035
C23000	{ O50	light anneal	{ up to 0.045, incl over 0.045	30T F	39 85	^C ^C	0.035 0.035
C26000, C33000, and C33200	O60	soft anneal	{ up to 0.030, incl over 0.030	30T F	40 80	0.025 0.025	0.060 0.060
C26000, C28000, C33000, C33200, and C37000	O50	light anneal	{ up to 0.030, incl over 0.030	30T F	60 90	^C ^C	0.035 0.035
C27000, C27200, and C27400	O60	soft anneal	{ up to 0.030, incl over 0.030	30T F	40 80	0.025 0.025	0.060 0.060
	{ O50	light anneal	{ up to 0.030, incl over 0.030	30T F	60 90	^C ^C	0.035 0.035
	O60	soft anneal	{ up to 0.030, incl over 0.030	30T F	40 80	0.025 0.025	0.060 0.060
	{ O50	light anneal	{ up to 0.030, incl over 0.030	30T F	60 90	^C ^C	0.035 0.035
C44300	{ O50	light anneal	{ up to 0.030, incl over 0.030	30T F	60 90	^C ^C	0.035 0.035

^A Standard designations defined in Practice B 601.

^B Rockwell hardness values shall apply only to tubes having a wall thickness of 0.015 in. or over and to round tubes having an inside diameter of $\frac{5}{16}$ in. or over and to rectangular including square tubes having an inside major distance between parallel surfaces of $\frac{3}{16}$ in. or over. For all other tube no Rockwell hardness values shall apply. Rockwell hardness tests 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 are permitted to be specified subject to agreement between the manufacturer and the purchaser.

^C Although no minimum grain size is specified, the product must nevertheless have a fully recrystallized grain structure.



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NOTE 3—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. in diameter in the annealed condition, a 4 in. in length shall be cut from the end of one of the lengths for a flattening test. This 4-in. test specimen shall be flattened so that a gage set at three times the wall thickness will pass over the tube freely throughout the flattened part. The tube so tested shall develop no cracks or flaws visible to the unaided eye (Note 3) as a result of this test. In making the flattening test the elements shall be slowly flattened by one stroke of the press.

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 and therefore equipment for the detection and removal of mercury vapor produced in volatilization is recommended. The use of rubber gloves in testing is advisable.

10.2 When specifically required, test specimens 6 in. in length of both annealed and drawn tempers shall withstand, after proper cleaning, an immersion for 30 min without cracking in the standard mercurous nitrate solution prescribed in Test Method B 154. 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 have the option of selecting 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 3⅞ in. in outside diameter shall be subjected to an eddy-current test. Testing shall follow the procedure of Practice E 243, 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. shall be 22 % of the nominal wall thickness. The notch-depth tolerance shall be ± 0.0005 in. Alternatively, at the option of the manufacturer who 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 are permitted to be used.

Standard Tube Size, inch	Maximum Percent Unbalance Signal Magnitude
Up to and including ⅜	0.2
½ to 2 incl	0.3
Over 2 to 3 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. Tubes with discontinuities indicated by the testing unit are permitted, at the option of the manufacturer, to be re-examined 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.

11.3 A pressure test is permitted to be specified for tube sizes over 3⅞ in. 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.

11.3.1 *Hydrostatic Test*—When specified, the tube shall stand, without showing evidence of leakage an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 7000 psi, determined by the following equation for thin hollow cylinders under tension:

$$P = 2St/(D - 0.8t) \quad (1)$$

where:

P = hydrostatic pressure, psi,

t = wall thickness of the material, in.,

D = outside diameter of the material, in., and

S = allowable stress of the material.

11.3.2 *Pneumatic Test*—When specified, the tube shall be subjected to an internal air pressure of 60 psig minimum for 5 s without showing evidence of leakage. The test method used shall permit easy detection of any leakage, such as having the material under water, or by the pressuredifferential method. Any evidence of leakage shall be cause for rejection.

12. Dimensions and Permissible Variations

12.1 The dimensions and tolerances for material covered by this specification shall be as prescribed in the current edition of Specification B 251, with particular reference to Section 5 and the following tables of that specification:

12.2 *Wall Thickness Tolerances*—See 5.2, Tables 1 and 6.

12.3 *Tolerances for Diameter or Distance Between Parallel Surfaces*—See 5.3, Tables 2 and 7.

12.4 *Length Tolerances*—See 5.5, Tables 3 and 4.

12.5 *Roundness*—See 5.4.

12.6 *Squareness of Cut*—See 5.6

12.7 *Straightness Tolerances*—For round tubes see 5.7.1, Table 5. For rectangular including square tubes see 5.7.2.

12.8 *Corner Radius for Rectangular Including Square Tubes*—See 5.8, Table 8.

12.9 *Twist Tolerances for Rectangular and Square Tubes*—See 5.9.

13. Sampling for Visual and Dimensional Examination

13.1 Minimum sampling for visual and dimensional examination shall be as follows when specified by the purchaser in the inquiry, contract or order, for agencies of the U.S. Government:

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Lot size (pieces per lot)
2 to 8

Sample size
Entire lot

9 to 90
91 to 150
151 to 280
281 to 500
501 to 1200
1201 to 3200
3201 to 10 000
10 001 to 35 000

8
12
19
21
27
35
38
46

13.2 In all cases, the acceptance number is zero and the rejection number is one. Rejected lots are permitted to be

screened and resubmitted for visual and dimensional examination. All defective items shall be replaced with acceptable items prior to lot acceptance.

14. Workmanship, Finish, and Appearance

14.1 Annealed tube shall be either bright annealed or acid cleaned after final annealing operations.

15. Keywords

15.1 brass tube; seamless brass tube; seamless tube

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order, for agencies of the U. S. Government. Supplementary requirement S5 shall apply only when specified.

S1. Referenced Documents

S1.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

S1.1.1 *Federal Standards:*⁶

Fed. Std. No. 102 Preservation, Packaging and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. No. 185 Identification Marking of Copper and Copper-Base Alloy Mill Products

S1.1.2 *Military Standard:*⁶

MIL-STD-129 Marking for Shipment and Storage

S1.1.3 *Military Specification:*⁶

MIL-C-3993 Packaging of Copper and Copper-Base Alloy Mill Products

S2. Quality Assurance

S2.1 *Responsibility for Inspection:*

S2.1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. Except as otherwise specified in the contract or purchase order, the manufacturer shall use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections or tests set forth when such inspections and tests are deemed necessary to assure that the material conforms to prescribed requirements.

S3. Identification Marking

S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification number and the alloy number shall be used.

S4. Preparation for Delivery

S4.1 *Preservation, Packaging, Packing:*

S4.1.1 *Military Agencies*—The material shall be separated by size, composition, grade or class and shall be preserved and packaged, Level A or C, packed, Level A, B, or C as specified in the contract or purchase order, in accordance with the requirements of MIL-C-3993.

S4.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S4.2 *Marking:*

S4.2.1 *Military Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with MIL-STD-129.

S4.2.2 *Civil Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with Fed. Std. No. 123.

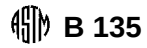
S5. Tubes for Voice and Pneumatic Service

S5.1 Tubes ordered to this supplement for voice and pneumatic service shall have dimensions, tolerances, and tempers as specified in Table S5.1. For these tubes, the mercurous nitrate test shall be required and nondestructive testing shall not be required. Copper plus sum of all named elements shall be 98.85 %.

TABLE S5.1 Tubes for Voice and Pneumatic Service

Size	Outside Diameter, in.	Inside Diameter, in.	Average Diameter Tolerance, in.	Wall Thickness, in.	Temper
A	2.000	...	+ 0.000 −0.004	0.049	H-80
B	2.000	...	+ 0.000 −0.004	0.109	H-58
C	...	2.000	+ 0.004 −0.000	0.049	H-80
D	2.250	...	+ 0.000 −0.004	0.065	H-80
E	...	2.250	+ 0.004 −0.000	0.049	H-80
F	3.000	...	+ 0.000 −0.004	0.049	H-80
G	3.000	...	+ 0.000 −0.004	0.109	H-58
H	...	3.000	+ 0.004 −0.000	0.049	H-80

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



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