



Standard Specification for Copper-Beryllium Seamless Tube (UNS Nos. C17500 and C17510)¹

This standard is issued under the fixed designation B 937; 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.

1. Scope

1.1 This specification establishes the requirements for copper-beryllium alloy seamless tube in straight lengths. Copper-cobalt-beryllium alloy UNS No. C17500 and copper-nickel-beryllium alloy UNS No. C17510 will be the alloys furnished whenever this specification is specified.

1.2 *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, which are provided for information only and are not considered standard.

1.3 The following safety hazard caveat pertains only to the test method(s) described in 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 to determine the applicability of regulatory limitations prior to use.*

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:*²

- B 193 Test Method for Resistivity of Electrical Conductor Materials
- B 194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
- B 251 Specification for General Requirements for Wrought Seamless Copper and Copper Alloy Tube
- B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
- B 846 Terminology for Copper and Copper Alloys
- E 8 Test Methods for Tension Testing of Metallic Materials

- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
- E 255 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determinations of Chemical Compositions
- E 1004 Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method

3. General Requirements

3.1 The following sections of Specification B 251 (as noted) constitute a part of this specification:

- 3.1.1 Workmanship, Finish, and Appearance,
- 3.1.2 Number of Tests and Retests,
- 3.1.3 Significance of Numerical Limits,
- 3.1.4 Inspection,
- 3.1.5 Rejection and Rehearing,
- 3.1.6 Certification,
- 3.1.7 Mill Test Report, and
- 3.1.8 Packaging and Package Marking.

4. Terminology

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

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1 *average diameter (for round tubes only), n*—the average of the maximum and minimum outside diameters, or maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

4.2.2 *lengths, n*—straight pieces of the product

4.2.2.1 *ends, n*—straight pieces, shorter than the nominal length, left over after cutting the product into mill lengths, stock lengths, or specific lengths. They are subject to minimum length and maximum weight requirements.

4.2.2.2 *specific, adj*—straight lengths that are uniform in length, as specified, and subject to established length tolerances.

4.2.2.3 *specific with ends, adj*—specific lengths, including ends.

4.2.2.4 *stock, n*—straight lengths that are mill cut and stored in advance of orders. They are usually 8, 10, 12, or 20 ft (2.44, 3.05, 3.66, or 6.10 m) and subject to established length tolerances.

4.2.2.5 *stock with ends, adj*—stock lengths, including ends.

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 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.

4.2.3 *tube, n*—a hollow product of round or any other cross section having a continuous periphery.

4.2.3.1 *tube, seamless, adj*—a tube produced with a continuous periphery in all stages of the operations.

5. Ordering Information

5.1 Include the following information when placing orders for product under this specification, as applicable:

- 5.1.1 Quantity, number of pieces or pounds,
- 5.1.2 Copper Alloy UNS No. designation (see 1.1),
- 5.1.3 Temper (see section 8)
- 5.1.4 Dimensions, including length if applicable. For tube or pipe specify either OD/ID, OD/wall, or ID/wall.
- 5.1.5 How furnished: stock lengths with or without ends, specific lengths with or without ends,
- 5.1.6 ASTM designation and year of issue,
- 5.1.7 Special tests or exceptions, if any,
- 5.1.8 Hardness tests, if required,
- 5.1.9 Special tests such as tension test, if required,
- 5.1.10 Special marking or packaging, if required,
- 5.1.11 Inspection, if required (see Specification B 251),
- 5.1.12 Certification, if required (see Specification B 251),
- 5.1.13 Mill test report, if required (see Specification B 251).

5.2 When material is purchased for agencies of the U.S. government, this shall be specified in the contract or purchase order, and the material shall conform to the Supplementary Requirements as defined in the current issue of Specification B 251.

6. Materials and Manufacture

6.1 Materials:

6.1.1 The material of manufacture shall be UNS Alloy No. C17500 or C17510, cast and worked into tubular form, and of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.1.2 The tube shall have heat traceable identity.

6.2 Manufacture:

6.2.1 The product shall be manufactured by a combination of hot working or cold working, or both; annealing; or precipitation heat treatment, or both, as to produce a uniform wrought structure in the finished product, to meet the temper specified.

7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements in Table 1 for the copper alloy designated in the

ordering information.

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 unnamed elements

7.3 For alloys in which copper is listed as “Remainder,” copper is the difference between the sum of results of all elements determined and 100 %. When all elements in Table 1 are determined, the sum of results shall be 99.5 % min.

8. Temper

8.1 Tempers, as described in Classification B 601, available under this specification are: TB00 (solution treated (A)), TF00 (precipitation hardened (AT)), TD04 (solution heat-treated and cold worked: hard (H)), and TH04 (hard and precipitation heat-treated (HT)). These products meet property requirements in Table 2.

9. Precipitation Heat Treatment

9.1 When material is purchased in the TB00 (A) or the TD04 (H) tempers, the precipitation heat treatment is performed by the purchaser.

9.2 Conformance to the TF00 (AT) and TH04 (HT) specification limits shown in Table 2, for products supplied in the TB00 (A) or the TD04 (H) tempers, shall be determined by testing test specimens heat-treated at a uniform temperature of 850 to 900°F for the times shown in Table 3.

9.3 End products may be heat-treated at other times and temperatures for specific applications. These special combinations of properties such as increased ductility, dimensional accuracy, and endurance strength may be obtained by special precipitation-hardening heat treatments. The mechanical requirements of Table 2 do not apply to such special heat treatment. Specific test requirements as needed shall be agreed upon between the manufacturer or the supplier and the purchaser of the end product.

9.4 TF00 (AT) and TH04 (HT) tempers as standard mill-hardened products has been precipitation heat-treated and tested by the manufacturer. An appropriate time and temperature has been used to produce properties within the specification limits shown in Table 2. Table 3 does not apply. Further thermal treatment of these tempers is not normally required.

9.5 Material may be supplied with nonstandard properties. Table 2 values would not apply. Specific test requirements as needed shall be agreed upon between the manufacturer or supplier and the purchaser of these end products.

10. Physical Property Requirements

10.1 *Electrical Conductivity*—Product furnished to this specification shall conform to the electrical conductivity requirement given in Table 2 for the applicable temper, when tested in accordance with Practice E 1004 or by converting from resistivity measured in accordance with Test Method B 193.

11. Mechanical Property Requirements

11.1 Mechanical property requirements are specified in Table 2.

TABLE 1 Chemical Composition

Element	Concentration, %	
	Copper Alloy UNS No. C17500	Copper Alloy UNS No. C17510
Beryllium	0.4-0.7	0.2-0.6
Cobalt	2.4-2.7	0.03 max
Nickel	...	1.4-2.2
Iron, max	0.10	0.10
Aluminum, max	0.20	0.20
Silicon, max	0.20	0.20
Copper	Remainder	Remainder

TABLE 2 Tensile Strength and Rockwell Hardness Requirements^A

Standard	Temper Designation		As Supplied		
	Former		Tensile Strength Ksi ^B (MPa ^C)	Rockwell Hardness, B Scale	Electrical Conductivity IACS min, %
TB00	Solution heat-treated (A)		35-55 (240-380)	50 max	20
TD04	Solution heat-treated and cold-worked hard (H)		65-80 (450-550)	60-80	20
After Precipitation Heat Treatment					
TF00	Precipitation hardened (AT)		100-130 (690-895) ^D	92-100	45
TH04	Hard and precipitation heat-treated (HT)		110-140 (760-965) ^D	95-102	48

^A These values apply to mill products. See Section 10 for exceptions in end products.

^B ksi = 1000 psi.

^C See Appendix.

^D The upper limits in the tensile strength column are for design guidance only.

TABLE 3 Precipitation Heat-Treatment Time for Acceptance Tests

Standard	Temper Designation		Copper Alloy UNS No. 17500 At 900°F (482°C), h	Copper Alloy UNS No. C17510 At 850°F (454°C) ^A to 900°F (482°C) ^A , h
	Former			
TB00	Solution heat-treated (A)		3	3
TD04	Solution heat-treated and cold-worked: hard (H)		2	2

^A Specific temperature used must conform with supplier's certification.

11.2 *Rockwell Hardness*—Rockwell hardness is the product acceptance criteria, when tested in accordance with Test Methods E 18 for product larger than 3/8 in. (9.5 mm) in nominal diameter or distance between parallel surfaces, and other shapes having a nominal cross sectional area larger than 0.141 in.² (91 mm²).

11.2.1 The referee product rejection criteria shall be tensile results, when tested in accordance with Test Methods E 8.

11.3 *Tension Test*—The tension test will be used for qualification of all material when specifically required by the purchaser, as in some government requirements.

12. Purchases for the U.S. Government

12.1 When specified in the contract or purchase order, product purchased for agencies of the U.S. government shall conform to the special government regulations specified in the Supplemental Requirements section of Specification B 251.

13. Dimensions, Mass, and Permissible Variation

13.1 The standard method of specifying wall thickness shall be in decimal fractions of an inch.

13.1.1 For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified values for any dimension may be cause for rejection.

13.1.2 Tolerances on a given tube may be specified with respect to any two, but not all three, of the following: outside diameter, inside diameter, wall thickness

NOTE 1—Blank spaces in the tolerance tables indicate either that the material is not generally available or no tolerances have been established.

13.2 Wall-Thickness Tolerances—Wall-thickness tolerances shall be in accordance with Table 4 and Table 5.

13.3 Diameter Tolerances—Diameter Tolerances shall be in accordance with Table 6.

13.4 Length Tolerances—Length tolerances shall be in accordance with Table 7

13.5 Squareness—For tube in straight lengths, the departure from squareness of the end shall not exceed the following:

Diameter, in. (mm)	Specified Outside
	Tolerance, in./in. (mm/mm)
3/4 (19.1) and over	0.062

TABLE 4 Wall-Thickness Tolerances—TB00 (A) and TF00 (AT) Tempers^A

NOTE 1—*Maximum Deviation of Any Point*—The following tolerances are plus and minus: if tolerances all plus or all minus are desired double the values given.

Wall Thickness, in. (mm)	Outside Diameter, in. (mm)			
	5/8 to 1 (15.9 to 25.4)	Over 1 to 2 (25.4 to 50.8)	Over 2 to 4 (50.8 to 102)	Over 4 (102)
Over 0.125 (3.2) to 0.250 (6.5) incl	±0.014 (0.36)	±0.017 (0.43)	±0.020 (0.51)	±0.030 (0.76)
Over 0.250 (6.5) to 0.500 (12.7) incl	±0.017 (0.43)	±0.023 (0.58)	±0.032 (0.81)	±0.053 (1.35)
Over 0.500 (12.7) to 1.000 (25.4) incl	...	±0.030 (0.76)	±0.053 (1.35)	±0.083 (2.11)
Over 1.000 (25.4)	±0.068 (1.73)	±0.098 (2.49)

^A When tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in this table more than 50 %.

TABLE 5 Wall-Thickness Tolerances—TD04 (H) and TH04 (HT) Tempers^A

NOTE 1—*Maximum Deviation of Any Point*—The following tolerances are plus and minus; if tolerances all plus or all minus are desired double the values given.

Wall Thickness, in. (mm)	Outside Diameter, in. (mm)				
	Over ½ to 1 (15.9 to 25.4) Incl	Over 1 to 2 (25.4 to 50.8) Incl	Over 2 to 4 (50.8 to 102) Incl	Over 4 to 7 (102 to 173) Incl	Over 7 to 12 (173 to 305) Incl
Over 0.034 (0.864), to 0.057 (1.45) incl	0.0045 (0.11)	0.0045 (0.11)	0.0065 (0.17)	0.009 (0.23)	...
Over 0.057 (1.45) to 0.082 (2.08) incl	0.005 (.13)	0.005 (.13)	0.0075 (0.19)	0.010 (.25)	0.013 (0.33)
Over 0.082 (2.08) to 0.119 (3.02) incl	0.0065 (0.17)	0.0065 (0.17)	0.009 (0.23)	0.011 (0.28)	0.014 (0.36)
Over 0.119 (3.02) to 0.164 (4.17) incl	0.007 (0.18)	0.0075 (0.19)	0.010 (0.25)	0.013 (0.33)	0.015 (0.38)
Over 0.164 (4.17) to 0.219 (5.56) incl	0.009 (0.23)	0.010 (0.25)	0.012 (0.30)	0.015 (0.38)	0.018 (0.46)
Over 0.219 (5.56) to 0.283 (7.19) incl	0.012 (0.30)	0.013 (0.33)	0.015 (0.38)	0.018 (0.46)	0.020 (0.51)
Over 0.283 (7.19) to 0.379 (9.62) incl	0.014 (0.36)	0.015 (0.38)	0.018 (0.46)	6% ^B	6% ^B
Over 0.379 (9.62)	...	6% ^B	6% ^B	6% ^B	6% ^B

^A When tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in this table more than 50 %.

^B Percent of the specified wall thickness expressed to the nearest 0.001 in. (0.025 mm).

TABLE 6 Average Diameter Tolerances^A

Specified Diameter, in. (mm)	Tolerance, Plus and Minus, in. (mm) ^B	Tolerance, Plus and Minus, in. (mm) ^B
	Cold-Worked Tube	Hot-Worked Tube
Over ½ (12.7) to ¾ (19.1), incl	0.003 (0.08)	0.020 (0.51)
Over ¾ ((19.1) to 1 (25.4), incl	0.006 (0.15)	0.020 (0.51)
Over 1 (25.4) to 2 (50.8), incl	0.008 (0.20)	0.030 (0.76)
Over 2 (50.8) to 3 (76.2), incl	0.010 (0.25)	0.040 (1.02)
Over 3 (76.2) to 4 (102), incl	0.012 (0.30)	0.050 (1.27)
Over 4 (102) to 5 (127), incl	0.016 (0.41)	0.060 (1.52)
Over 5 (127) to 6 (152), incl	0.018 (0.46)	0.060 (1.52)
Over 6 (152) to 8 (203), incl	0.020 (0.51)	0.060 (1.52)
Over 8 (203) to 12 (305), incl	0.030 (0.76)	0.060 (1.52)

^A When tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in this table more than 50 %.

^B Tolerance applies to inside or outside diameter.

13.6 Straightness—Refer to Table 7 of Specification B 251.

14. Workmanship, Finish and Appearance

14.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

15. Sampling

15.1 Refer to sampling section in Specification B 251.

15.2 *Sampling*—Sample pieces shall be taken from a heat and lot of material processed simultaneously in the same equipment, as follows:

15.2.1 *Heat*—A heat shall be the result of castings poured simultaneously from the same source of molten metal

15.2.2 *Lot*—The lot shall be a heat, or fraction thereof.

16. Specimen Preparation

16.1 *Chemical Analysis*—Sample preparation shall be in accordance with Practice E 255.

16.1.1 Analytical specimen preparation shall be the responsibility of the reporting laboratory.

16.2 *Tension Tests*—Sample preparation shall be in accordance with Specification B 251.

16.3 *Rockwell Hardness*—The test specimens shall be of a size and shape to permit testing by the available test equipment and shall permit testing in a plane parallel to the direction of deformation given to the product.

16.3.1 The surface of the test specimens shall be sufficiently smooth and even to permit the accurate determination of hardness.

16.3.2 Each specimen shall be free of scale and foreign matter and care shall be taken to avoid change in condition, that is, heating or cold working

17. Test Methods

17.1 *Chemical Analyses*—The chemical composition shall, in cases of disagreement, be determined in accordance with the applicable method in Annex A1 of Specification B 194.

17.2 *Tension Tests*—Tension tests, when required, shall be made according to Test Methods E 8.

18. Test Report

18.1 When specified in the contract or purchase order, a report of test results shall be furnished.

19. Keywords

19.1 beryllium copper tube; UNS No. C17500; UNS No. C17510

TABLE 7 Length Tolerances—All Tempers^A

Length	Tolerances, in. (mm)		Applicable Only to Full-Length Pieces	
	Outside Diameters Up to 1 in. (25.4 mm) incl		Outside Diameters Over 1 in. (25.4 mm) to 4 in. (102 mm) Incl	Outside Diameters Over 4 in. (102 mm)
Specific lengths:				
Up to 6 in. (152 mm), incl	1/32 (0.79)		1/16 (1.6)	1/8 (3.2)
Over 6 in. (152 mm) to 2 ft (610 mm), incl	1/16 (1.6)		3/32 (2.4)	1/4 (6.4)
Over 2 ft (610 mm) to 6 ft (1.83 m), incl	3/32 (2.4)		1/8 (3.2)	1/4 (6.4)
Over 6 ft (1.83 m) to 14 ft (4.27 m), incl	1/4 (6.4)		1/4 (6.4)	1/2 (13)
Over 14 ft (4.27 m)	1/2 (13)		1/2 (13)	1 (25)
Specific lengths with ends	1 (25)		1 (25)	1 ^A (25)
Stock lengths with or without ends	1 ^A (25)		^A (25)	

^A As stock lengths are cut and placed in stock in advance of orders, departure from this tolerance is not practicable.

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the Newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = \text{kg}\cdot\text{m}/\text{s}^2$). The derived SI unit for pressure or

stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$ the metric equivalents are expressed as megapascal (Mpa), which is the same as MN/m^2 and N/mm^2 .

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