

Designation: B 251 – 02^{€1}

Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube¹

This standard is issued under the fixed designation B 251; 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 (€) 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 NOTE—Referenced Documents were editorially corrected in November 2003.

1. Scope*

1.1 This specification covers a group of general requirements common to several wrought product specifications. Unless otherwise specified in the purchase order, or in an individual specification, these general requirements shall apply to copper and copper-alloy tube supplied under Specifications B 68, B 75, B 135, B 466/B 466M, and B 743.

NOTE 1—A complete metric companion to Specification B 251 has been developed—B 251M; therefore, no metric equivalents are presented in this specification.

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 68 Specification for Seamless Copper Tube, Bright Annealed²
- B 75 Specification for Seamless Copper Tube²
- B 135 Specification for Seamless Brass Tube²
- B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing²
- B 154 Test Method for Mercurous Nitrate Test for Copper and Copper Alloys²
- B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes²
- B 193 Test Method for Resistivity of Electrical Conductor Materials³
- B 428 Test Method for Angle of Twist in Rectangular and Square Copper and Copper Alloy Tube²
- B 466/B 466M Specification for Seamless Copper-Nickel Pipe and Tube²

B 643 Specification for Copper-Beryllium Alloy Seamless Tube²

B 743 Specification for Seamless Copper Tube in Coils²

E 3 Guide for Preparation of Metallographic Specimens⁴

E 8 Test Methods for Tension Testing of Metallic Materials⁴

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁴

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 Gravimetry⁶

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)⁶

E 112 Test Methods for Determining Average Grain Size⁴

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E 478 Test Methods for Chemical Analysis of Copper Alloys⁷

3. Terminology

3.1 Definitions:

3.1.1 *average diameter (for round tubes only)*—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.

3.1.2 *coil*—a 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.

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

3.1.2.2 *double layer flat*—a 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 pancake coil” or “double layer spirally wound coil.”)

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.

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

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

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

⁶ *Annual Book of ASTM Standards*, Vol 03.06.

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

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



3.1.2.3 *level or traverse wound*—a 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.”)

3.1.2.4 *level or traverse wound on a reel or spool*—a coil in which the turns are positioned into layers on a reel or spool parallel to the axis of the reel or spool such that successive turns in a given layer are next to one another.

3.1.2.5 *single layer flat*—a coil in which the product is spirally wound into a single disk-like layer. (Sometimes called “pancake coil” or “single layer spirally wound coil.”)

3.1.2.6 *stagger wound*—a coil in which the turns are positioned into layers approximately parallel to the axis of the coil, but not necessarily with the fixed regularity of a level or traverse wound coil.

3.1.3 *lengths*—straight pieces of the product.

3.1.3.1 *ends*—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.

3.1.3.2 *mill*—straight lengths, including ends, that are conveniently manufactured in the mills. Full-length pieces are usually 10, 12, or 20 ft and subject to established length tolerances.

3.1.3.3 *multiple*—straight lengths of integral multiples of a base length, with suitable allowance for cutting, if and when specified.

3.1.3.4 *random*—run of mill lengths without any indicated preferred length.

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

3.1.3.6 *specific with ends*—specific lengths, including ends.

3.1.3.7 *standard*—uniform lengths recommended in a Simplified Practice Recommendation or established as a Commercial Standard.

3.1.3.8 *stock*—straight lengths that are mill cut and stored in advance of orders. They are usually 10, 12, or 20 ft and subject to established length tolerances.

3.1.3.9 *stock with ends*—stock lengths, including ends.

3.1.4 *reel or spool*—a cylindrical device that has a rim at each end and an axial hole for a shaft or spindle, and on which the product is wound to facilitate handling and shipping.

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

3.1.5.1 *tube, automotive and general service*—a seamless copper tube of small diameter conforming to a standard series of sizes commercially known as Automotive and General Service Tube.

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

4. Materials and Manufacture

4.1 The material shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed in the applicable product specification listed in Section 1.

4.2 The material shall be produced by either hot or cold working operations, or both. It shall be finished, unless otherwise specified, by such cold working and annealing or heat treatment as necessary to meet the properties specified.

5. Dimensions and Permissible Variations

5.1 General:

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

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

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

5.1.4 When round 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 Table 1 by more than 50 %.

NOTE 2—Blank spaces in the tolerance tables indicate either that the

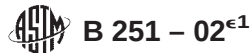
TABLE 1 Wall Thickness Tolerances for Copper and Copper-Alloy Tube
(Applicable to Specifications B 68, B 75, B 135, and B 743)

NOTE 1—*Maximum Deviation at 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.	Outside Diameter, in. ^A						
	⅛ ₃₂ to ⅛ ₈ , incl	Over ⅛ ₈ to ⅝ ₈ , incl	Over ⅝ ₈ to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl	Over 4 to 7, incl	Over 7 to 10, incl
Up to 0.017, incl	0.002	0.001	0.0015	0.002	...	...	...
Over 0.017–0.024, incl	0.003	0.002	0.002	0.0025	...	...	...
Over 0.024–0.034, incl	0.003	0.0025	0.0025	0.003	0.004	...	...
Over 0.034–0.057, incl	0.003	0.003	0.0035	0.0035	0.005	0.007	...
Over 0.057–0.082, incl	...	0.0035	0.004	0.004	0.006	0.008	0.010
Over 0.082–0.119, incl	...	0.004	0.005	0.005	0.007	0.009	0.011
Over 0.119–0.164, incl	...	0.005	0.006	0.006	0.008	0.010	0.012
Over 0.164–0.219, incl	...	0.007	0.009	0.009	0.011	0.012	0.014
Over 0.219–0.283, incl	...	...	0.011	0.012	0.014	0.015	0.016
Over 0.283–0.379, incl	...	...	0.014	6 ^B %	6 ^B %	7 ^B %	7 ^B %
Over 0.379	...	...	...	6 ^B %	6 ^B %	7 ^B %	7 ^B %

^A When round 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 the table by more than 50 percent.

^B Percent of specified wall expressed to the nearest 0.001 in.



material is not generally available or that no tolerances have been established.

5.2 Wall Thickness Tolerances for Copper and Copper-Alloy Tube—Wall thickness tolerances applicable to Specifications B 68, B 75, B 135, and B 743 for round tubes only shall be in accordance with Table 1. Wall thickness tolerances for rectangular including square tube applicable to B 75 and B 135 shall be in accordance with Table 2.

5.3 Diameter or Distance between Parallel Surfaces, Tolerances for Copper and Copper-Alloy Tube—Diameter tolerances applicable to Specifications B 68, B 75, B 135, and B 743 for round tubes only shall be in accordance with Table 3. Tolerances on distance between parallel surfaces for rectangular including square tube applicable to Specifications B 75 and B 135 shall be in accordance with Table 4.

5.4 Roundness (Applicable to Specifications B 75, B 135, and B 466/B 466M)—For drawn unannealed tube in straight lengths, the roundness tolerances shall be as follows:

t/D (Ratio of Wall Thickness to Outside Diameter)	Roundness Tolerance as Percent of Outside Diameter (Expressed to the Nearest 0.001 in.)
0.01–0.03, incl	1.5
Over 0.03–0.05, incl	1.0
Over 0.05–0.10, incl	0.8 or 0.002 in. whichever is greater
Over 0.10	0.7 or 0.002 in. whichever is greater

5.4.1 Compliance with the roundness tolerances shall be determined by taking measurements on the outside diameter only, irrespective of the manner in which the tube dimensions are specified. The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube. The major and minor diameters are the diameters of two concentric circles just enclosing the outside surface of the tube at the cross section.

5.4.2 No tolerances have been established for as-extruded tube, redraw tube, annealed tube, any tube furnished in coils or drawn tube whose wall thickness is under 0.016 in.

5.5 Length Tolerances:

5.5.1 Straight Lengths—Length tolerances, straight lengths, applicable to Specifications B 68, B 75, B 135, and B 466/B 466M shall be in accordance with Table 5.

5.5.2 Schedule of Tube Lengths—Specific and stock lengths of tube with ends, applicable to Specifications B 68, B 75,

TABLE 3 Average Diameter Tolerances for Copper and Copper-Alloy Tube^A

(Applicable to Specifications B 68, B 75, B 135, and B 743)

Specified Diameter, in.	Tolerance, Plus and Minus, in.
Up to $\frac{1}{8}$, incl	0.002
Over $\frac{1}{8}$ – $\frac{5}{8}$, incl	0.002
Over $\frac{5}{8}$ –1, incl	0.0025
Over 1–2, incl	0.003
Over 2–3, incl	0.004
Over 3–4, incl	0.005
Over 4–5, incl	0.006
Over 5–6, incl	0.007
Over 6–8, incl	0.008
Over 8–10, incl	0.010

^A Applicable to inside or outside diameter.

B 135, and B 466/B 466M, shall be in accordance with Table 6. Tube in straight lengths shall be furnished in stock lengths with ends, unless the order requires specific lengths or specific lengths with ends.

5.6 Squareness of Cut (Applicable to Specifications B 68, B 75, B 135, and B 466/B 466M)—For tube in straight lengths, the departure from squareness of the end of any tube shall not exceed the following:

5.6.1 Round Tube:

Specified Outside Diameter, in.	Tolerance
Up to $\frac{1}{8}$, incl	0.010 in.
Over $\frac{1}{8}$	0.016 in./in. of diameter

5.6.2 Rectangular and Square Tube:

Specified Distance Between Major Outside Parallel Surfaces, in.	Tolerance
Up to $\frac{1}{8}$, incl	0.016 in.
Over $\frac{1}{8}$	0.025 in./in. of distance between out- side parallel surfaces

5.7 Straightness Tolerances:

5.7.1 Round Tubes—For round tubes of any drawn temper, $\frac{1}{4}$ to $3\frac{1}{2}$ in. in outside diameter, inclusive, but not redraw tube, extruded tube, or any annealed tube, the straightness tolerances applicable to Specifications B 75, B 135, and B 466/B 466M shall be in accordance with Table 7.

TABLE 2 Wall Thickness Tolerances for Copper and Copper-Alloy Rectangular and Square Tube
(Applicable to Specifications B 75, B 135, and B 743)

NOTE 1—Maximum deviation at 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.	Distance Between Outside Parallel Surface, in. ^A						
	$\frac{1}{32}$ to $\frac{1}{8}$, incl	Over $\frac{1}{8}$ to $\frac{5}{8}$, incl	Over $\frac{5}{8}$ to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl	Over 4 to 7, incl	Over 7 to 10, incl
Up to 0.017, incl	0.002	0.002	0.0025	0.003	...	...	...
Over 0.017–0.024, incl	0.003	0.0025	0.003	0.0035	...	...	...
Over 0.024–0.034, incl	0.0035	0.0035	0.0035	0.004	0.006	...	...
Over 0.034–0.057, incl	0.004	0.004	0.0045	0.005	0.007	0.009	...
Over 0.057–0.082, incl	...	0.005	0.006	0.007	0.008	0.010	0.012
Over 0.082–0.119, incl	...	0.007	0.008	0.009	0.010	0.012	0.014
Over 0.119–0.164, incl	...	0.009	0.010	0.011	0.012	0.014	0.016
Over 0.164–0.219, incl	...	0.011	0.012	0.013	0.015	0.017	0.019
Over 0.219–0.283, incl	...	...	0.015	0.016	0.018	0.020	0.022

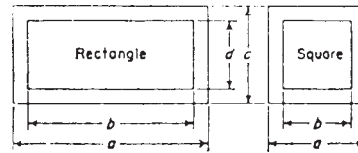
^A In the case of rectangular tube the major dimension determines the thickness tolerance applicable to all walls.



TABLE 4 Tolerances on Distance Between Parallel Surfaces for Copper and Copper-Alloy Rectangular and Square Tube
(Applicable to Specifications B 75, B 135, and B 743)

NOTE 1—The following tolerances are plus and minus; if tolerances all plus or all minus are desired, double the values given.

Dimension <i>a</i> or <i>b</i> (see sketches), in.	Tolerances, in.
Up to ⅛, incl	0.003
Over ⅛–⅝, incl	0.004
Over ⅝–1, incl	0.005
Over 1–2, incl	0.006
Over 2–3, incl	0.007
Over 3–4, incl	0.008
Over 4–5, incl	0.009
Over 5–6, incl	0.010
Over 6–8, incl	0.011
Over 8–10, incl	0.012



Nominal dimension *a* determines tolerance applicable to both *a* and *c*.
Nominal dimension *b* determines tolerance applicable to both *b* and *d*.

TABLE 5 Length Tolerances for Copper and Copper-Alloy Tube, Straight Lengths
(Applicable to Specifications B 68, B 75, B 135, and B 466/B 466M)

NOTE 1—Tolerances are all plus; if all minus tolerances are desired, use the same values; if tolerances plus and minus are desired, halve the values given.

Length	Tolerances, in. Applicable Only to Full-Length Pieces		
	For Major Outside Dimensions Up to 1 in., incl	For Major Outside Dimensions Over 1 to 4 in., incl	For Major Outside Dimensions Over 4 in.
Specific lengths:			
Up to 6 in., incl	⅓ ₃₂	⅓ ₁₆	...
Over 6 in.–2 ft, incl	⅓ ₁₆	⅓ ₃₂	⅓ ₈
Over 2–6 ft, incl	⅓ ₃₂	⅓ ₈	⅓ ₄
Over 6–14 ft, incl	⅓ ₄	⅓ ₄	⅓ ₄
Over 14 ft	⅓ ₂	⅓ ₂	⅓ ₂
Specific lengths with ends	1	1	1
Stock lengths with or without ends	1 ^A	1 ^A	1 ^A

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

TABLE 6 Schedule of Tube Lengths (Specific and Stock) with Ends for Copper and Copper-Alloy Tube
(Applicable to Specifications B 68, B 75, B 135 and B 466/B 466M)

Major Outside Dimensions, in.	Specific Length, ft	Shortest Permissible Length, ^A Percent of Specific Length	Maximum Permissible Weight of Ends, Percent of Lot Weight
Up to 1, incl	6–20, incl	70	20
Over 1–2, incl	6–20, incl	60	25
Over 2–3, incl	6–20, incl	55	30
Over 3–4, incl	6–20, incl	50	40

^A Expressed to the nearest ½ ft.

5.7.2 Rectangular and Square Tubes—For rectangular and square tubes of any drawn temper, the straightness tolerance applicable to Specifications B 75 and B 135 shall be ½ in. maximum curvature (depth of arc) in any 6-ft portion of the total length. (Not applicable to extruded tube, redraw tube, or any annealed tube.)

5.8 Corner Radius, Rectangular and Square Tubes—The permissible radii for commercially square corners applicable to Specifications B 75 and B 135 shall be in accordance with Table 8.

TABLE 7 Straightness Tolerances for Copper and Copper-Alloy Tube^A in Any Drawn Temper
(Applicable to Specifications B 75, B 135, B 466/B 466M and B 643)

NOTE 1—Applies to round tube in any drawn temper from ¼ (6.35) to 3½ in. (88.9 mm), incl, in outside diameter.

Length, ft ^B	Maximum Curvature (Depth of Arc), in.
Over 3–6, incl	⅓ ₁₆
Over 6–8, incl	⅓ ₁₆
Over 8–10, incl	⅓ ₂

^A Not applicable to pipe, redraw tube, extruded tube or any annealed tube.

^B For lengths greater than 10 ft the maximum curvature shall not exceed ½ in. in any 10-ft portion of the total length.

TABLE 8 Permissible Radii for Commercially Square Corners for Copper and Copper-Alloy Rectangular and Square Tube
(Applicable to Specifications B 75, B 135, and B 743)

Wall Thickness, in.	Maximum Radii, in.	
	Outside Corners	Inside Corners
Up to 0.058, incl	⅓ ₆₄	⅓ ₃₂
Over 0.058–0.120, incl	⅓ ₁₆	⅓ ₃₂
Over 0.120–0.250, incl	⅓ ₃₂	⅓ ₃₂
Over 0.250	none established	none established

5.9 Twist Tolerances, Rectangular and Square Tubes—The maximum twist about the longitudinal axis of drawn temper rectangular and square tubes applicable to Specifications B 75 and B 135 shall not exceed 1°/ft of length, measured to the nearest degree, and the total angle of twist shall not exceed 20° when measured in accordance with Test Method B 428. The requirement is not applicable to tubes in the annealed temper or to tubes whose specified major dimension is less than ½ in.

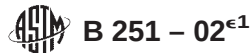
6. Workmanship, Finish, and Appearance

6.1 The material shall be free of defects of a nature that interfere with normal commercial applications. It shall be well cleaned and free of dirt.

7. Sampling

7.1 *Sampling*—The lot, size, portion size, and selection of sample pieces shall be as follows:

7.1.1 *Lot Size*—For tube, the lot size shall be 10 000 lb or fraction thereof.



7.1.2 Portion Size—Sample pieces shall be taken for test purposes from each lot according to the following schedule:

Number of Pieces in Lot	Number of Sample Pieces to be Taken ^A
1–50	1
51–200	2
201–1500	3
Over 1500	0.2 % of total number of pieces in the lot, but not to exceed 10 sample pieces

^A Each sample piece shall be taken from a separate tube.

8. Number of Tests and Retests

8.1 Chemical Analysis—Samples for chemical analysis shall be taken in accordance with Practice E 255. Drillings, millings, etc., shall be taken in approximately equal weight from each of the sample pieces selected in accordance with 7.1.2 and combined into one composite sample. The minimum weight of the composite sample that is to be divided into three equal parts shall be 150 g.

8.1.1 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of determining conformance to chemical composition as follows: Conformance shall be determined by the manufacturer by analyzing samples taken at the time the castings are poured or samples taken from the semi-finished product. If the manufacturer determines the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product. The number of samples taken for determination of chemical composition shall be as follows:

8.1.1.1 When samples are taken at the time the castings are poured, at least one sample shall be taken for each group of castings poured simultaneously from the same source of molten metal.

8.1.1.2 When samples are taken from the semi-finished product, a sample shall be taken to represent each 10 000 lb or fraction thereof, except that not more than one sample shall be required per piece.

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

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

8.2 Other Tests—For other tests, unless otherwise provided in the product specification, test specimens shall be taken from two of the sample pieces selected in accordance with 7.1.2.

8.2.1 In the case of tube furnished in coils, a length sufficient for all necessary tests shall be cut from each coil selected for purpose of tests. The remaining portion of these coils shall be included in the shipment, and the permissible variations in length on such coils shall be waived.

8.3 Retests:

8.3.1 If any test specimen shows defective machining or develops flaws, it shall be discarded and another specimen substituted.

8.3.2 If the percentage elongation of any tension test specimen is less than that specified and any part of the fracture is outside the middle two thirds of the gage length or in a punched or scribed mark within the reduced section, a retest on an

additional specimen either from the same sample piece or from a new sample piece shall be allowed.

8.3.3 If the results of the test on one of the specimens fail to meet the specified requirements, two additional specimens shall be taken from different sample pieces and tested. The results of the test on both of these specimens shall meet the specified requirements. Failure of more than one specimen to meet the specified requirements for a particular property shall be cause for rejection of the entire lot.

8.3.4 If the chemical analysis fails to conform to the specified limits, analysis shall be made on a new composite sample prepared from additional pieces selected in accordance with 7.1.2. The results of this retest shall comply with the specified requirements.

9. Test Specimens

9.1 Tension test specimens shall be of the full section of the tube and shall conform to the requirements of Test specimens section of Test Methods E 8, unless the limitations of the testing machine preclude the use of such a specimen. Test specimens conforming to Type No. 1 of Fig. 13, Tension Test Specimens for Large-Diameter Tubular Products, of Test Methods E 8 shall be used when a full-section specimen cannot be tested.

9.2 Whenever tension test results are obtained from both full size and from machined test specimens and they differ, the results obtained from full-size test specimens shall be used to determine conformance to the specification requirements.

9.3 Tension test results on material covered by this specification are not seriously affected by variations in speed of testing. A considerable range of testing speed is permissible; however, the rate of stressing to the yield strength shall not exceed 100 ksi/min. Above the yield strength the movement per minute of the testing machine head under load shall not exceed 0.5 in/in. of gage length (or distance between grips for full-section specimens).

9.4 The surface of the test specimen for microscopical examination shall approximate a radial longitudinal section of round tube and a longitudinal section of rectangular and square tube perpendicular to, and bisecting, the major dimensional surface.

10. Test Methods

10.1 The properties enumerated in the specifications listed in Section 1 shall, in case of disagreement, be determined in accordance with the following applicable test methods:

Test	ASTM Designation
Chemical analysis	B 170, ^A E 53, E 62, E 478
Tension	E 8
Rockwell hardness	E 18 ^B
Grain size	E 3, E 112
Expansion (pin test)	B 153
Mercurous nitrate test	B 154
Electrical resistivity	B 193

^A Reference to Specification B 170 is to the suggested chemical methods in the annex thereof. When Committee E01 has tested and published methods for assaying the low-level impurities in copper, the Specification B 170 annex will be eliminated.

^B The value for the Rockwell Hardness number of each specimen shall be established by taking the arithmetical average of at least three readings.

B 251 – 02^{e1}

11. Significance of Numerical Limits

11.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E 29:

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand place of figures of the specified limit
Hardness	nearest ksi
Electrical resistivity	nearest ksi
Tensile strength	nearest 1 %
Yield strength	
Elongation	
Grain size:	
Up to 0.055 mm, incl	nearest multiple of 0.005 mm
Over 0.055 to 0.160 mm, incl	nearest 0.01 mm

12. Inspection

12.1 The manufacturer shall afford the inspector representing the purchaser, all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with the specified requirements.

13. Rejection and Rehearing

13.1 Material that fails to conform to the requirements of this specification shall be subject to rejection. Rejection shall be reported to the manufacturer or supplier promptly and in

writing. In case of dissatisfaction with the results of the test, the manufacturer or supplier shall have the option to make claim for a rehearing.

14. Certification

14.1 When specified on the purchase order the manufacturer shall furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification and has met the requirements.

14.2 When material is specified to meet the requirements of *ASME Boiler and Pressure Vessel Code*, the certification requirements are mandatory.

15. Packaging and Package Marking

15.1 The material shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from the normal hazards of transportation.

15.2 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight and name of supplier. The specification number shall be shown, when specified.

16. Mill Test Report

16.1 When specified on the purchase order, the manufacturer shall furnish to the purchaser a test report showing results of tests required by the specification.

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.

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*:⁸

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*:⁸

MIL-STD-129 Marking for Shipment and Storage

S1.1.3 *Military Specification*:⁸

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

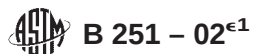
S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification number and the alloy number shall be used.

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

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, ATTN: NPODS.



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.

APPENDIX

(Nonmandatory Information)

X1. STANDARD DENSITIES

X1.1 For purposes of calculating weights, cross sections, etc., the densities of the copper and copper alloys covered by the specifications listed in Section 1 shall be taken as in Table X1.1.

TABLE X1.1 Densities

ASTM Designation	Material	Copper or Copper Alloy UNS No.	Density, lb/in. ³
B 68	copper	C10100	0.323
B 75	copper	C10200	0.323
B 743	copper	C10300	0.323
		C10800	0.323
		C12000	0.323
		C12200	0.323
(B 75 only)		C14200	0.323
B 135	brass	C22000	0.318
		C23000	0.316
		C26000	0.308
		C27000	0.306
		C27200	0.305
		C28000	0.303
		C33000	0.307
		C33200	0.308
		C37000	0.304
		C44300	0.308
B 466	copper nickel	C70400	0.323
		C70600	0.323
		C71000	0.323
		C71500	0.323
		C72200	0.323

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 251 – 97) that may impact the use of this standard.

(1) Section 13 was modified to replace non-mandatory language with mandatory language.



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