Designation: B315 – 12

Standard Specification for Seamless Copper Alloy Pipe and Tube[1]

This standard is issued under the fixed designation B315; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification[2] establishes the requirements for seamless, copper alloy pipe and tube in nominal pipe sizes, both regular and extra strong, and seamless tube in straight lengths for general engineering purposes. Pipe and tube are produced in the copper alloy UNS Numbers: C61300, C61400, C63020, C65100, and C65500.

NOTE 1—Inquiry should be made of the manufacturer or supplier concerning the availability of product in a specific alloy.

1.2 Values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following safety 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 determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B846 Terminology for Copper and Copper Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[4]

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[4]

E243 Practice for Electromagnetic (Eddy Current) Examination of Copper and Copper-Alloy Tubes

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E478 Test Methods for Chemical Analysis of Copper Alloys

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *specially cleaned*—sufficiently free of oxides as to exhibit the golden color associated with the alloy.

4. Ordering Information

4.1 Include the following specified choices when placing orders for product under this specification, as applicable:

4.1.1 ASTM Designation and year of issue (for example B315 – XX),

4.1.2 Copper Alloy (Section 6, Table 1),

4.1.2.1 Whether the product of copper alloy C61300 is to be subsequently welded (see Table 1 and Footnote B),

4.1.3 Temper (Section 7),

4.1.4 *Dimensions, Diameter, and Wall Thickness:*

4.1.4.1 Pipe size regular (Table 3),

4.1.4.2 Pipe size, extra-strong (Table 3),

4.1.4.3 Tube diameter (Table 9),

4.1.4.4 Tube wall thickness (Table 6, Table 7, or Table 8),

4.1.4.5 Length (Table 10 or Table 11),

4.1.4.6 When copper alloy UNS No. C63020 is ordered under this specification, tube diameter, wall thickness, length, sizes, and tolerances shall be a part of the purchase order as agreed upon between the supplier and the purchaser.

4.1.5 Quantity or total length of each size,

4.1.6 Finish (11.2 and 11.3), and

[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 *ASME Boiler and Pressure Vessel Code* applications see related Specification SB315 in Section II of that Code.

[3] 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] The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Requirements

Copper Alloy UNS No.	C61300[A]	C61400	C63020[B]	C65100	C65500
	Composition, % Max (Unless Shown as a Range or Minimum)				
Copper[C]	remainder	remainder	74.5 min	remainder	remainder
Lead	0.01	0.01	0.03	0.05	0.05
Iron	2.0–3.0	1.5–3.5	4.0–5.5	0.8	0.8
Zinc	0.10	0.20	0.30	1.5	1.5
Aluminum	6.0–7.5	6.0–8.0	10.0–11.0	. . .	. . .
Manganese	0.20	1.0	1.5	0.7	0.50–1.3
Silicon	0.10	. . .	. . .	0.8–2.0	2.8–3.8
Tin	0.20–0.50	. . .	0.25	. . .	. . .
Nickel (including cobalt)	0.15	. . .	4.2–6.0	. . .	0.6
Phosphorus	0.015	0.015	. . .	. . .	. . .

[A] When the product is for subsequent welding applications and is so specified by the purchaser, chromium shall be 0.05 % max, cadmium 0.05 % max, zinc 0.05 % max, and zirconium 0.05 % max.
[B] Chromium shall be 0.05 max and cobalt 0.20 max.
[C] Including silver.

4.1.6.1 When product is to be subjected to welding or brazing, the purchase order or contract shall specify product to be "specially cleaned", and

4.1.7 Intended application.

4.2 The following options are available but may not be included unless specified at the time of order placement when required:

4.2.1 Heat identification or traceability details (5.1.2),

4.2.2 Certification (Section 19),

4.2.3 Test Report (Section 20),

4.2.4 If product is ordered for ASME Boiler and Pressure Vessel Code Application (see Section 19), and

4.2.5 If the product specification number must be marked on the shipping unit (21.2).

5. Materials and Manufacture

5.1 *Material:*

5.1.1 The material of manufacture shall be a cast billet, bar, tube, or so forth of copper alloy UNS No. C61300, C61400, C63020, C65100, or C65500 and of such purity and soundness as to be suitable for processing in to the products prescribed herein.

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

NOTE 2—Because of the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

5.2 *Manufacture:*

5.2.1 The product shall be produced by hot-working, cold-working, and annealing processes as to produce a uniform wrought structure in the finished product.

5.2.2 Unless otherwise specified, the product shall be finished by such cold working and annealing or heat treatment as necessary to meet the temper properties specified.

5.2.3 Copper alloy UNS No. C63020 tube shall be quench hardened and tempered (TQ30) as follows:

5.2.3.1 Heat to 1550 to 1650°F (843 to 899°C) for 2-h minimum and quench in water. Then, temper at 900 to 1000°F (482 to 538°C) for 2-h minimum and air cool to room temperature.

6. Chemical Composition

6.1 The material shall conform to the composition requirements in Table 1 for the copper alloy UNS No. Designation specified in the ordering information.

6.1.1 Results of analysis on a product (check) sample shall conform to the compositional requirements within the permitted analytical variance specified in Table 1.

6.2 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.

6.2.1 For alloys in which copper is listed as "remainder," copper is the difference between the sum of results of all elements determined and 100%.

6.2.1.1 When all the elements listed for an alloy in Table 1 are determined, the sum of the determined elements for the alloy shall be as shown in the following table:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C61300	99.8
C61400	99.5
C63020	99.5
C65100	99.5
C65500	99.5

7. Temper

7.1 The standard tempers for products described in this specification are listed as follows and in Table 2:

7.1.1 Alloys C61300 and C61400 are supplied in tempers M30 (hot-extruded), O30 (hot-extruded and annealed), and O61 (annealed).

7.1.2 Alloy C63020 is supplied in temper TQ30 (quench hardened and tempered).

7.1.3 Alloy C65100 is supplied in tempers O30 (extruded and annealed), O61 (annealed), and H50 (extruded and cold worked).

7.1.4 Alloy C65500 is supplied in tempers O30 (extruded and annealed) and O61 (annealed).

8. Mechanical Property Requirements

8.1 *Tensile Strength Requirements:*

TABLE 2 Tensile Requirements

Copper Alloy UNS No.	C61300 and C61400	C63020	C65100		C65500
Temper Designation	M30 (Extruded) or O61 (Annealed	TQ30 (Quench-Hardened and Tempered)	O30 (Extruded and Annealed) or O61 (Annealed)	H50 (Extruded and Cold-Worked)	O30 (Extruded and Annealed) and O61 (Annealed)
Tensile Strength, min, ksi[A] (Mpa)[B]	65 (447)	130 (896)	40 (275)	50 (345)	50 (345)
Yield Strength at 0.5 % extension under load, ksi[A] (MPa)[B]	28 (193) min	89 (621)[C]	10 (69) min	40 (275) min	15 to 29 (103 to 200)
Elongation in 2 in. or 50 mm, min %	30	6	35	7	35

[A] ksi = 1000 psi.
[B] See Appendix.
[C] Yield strength at 0.2 % offset, min, ksi[A] (Mpa)[B] .

8.1.1 Product furnished under this specification shall conform to the tensile, yield, and elongation requirements prescribed in Table 2, for the alloy specified in the ordering information, when tested in accordance with Test Methods E8/E8M.

8.1.1.1 Acceptance or rejection based on mechanical properties shall depend only upon tensile, yield, or elongation test results.

8.2 *Rockwell Hardness Requirement:*

8.2.1 Product furnished from Alloy C63020 in TQ30 temper shall have a minimum hardness of 26 on the Rockwell C scale when tested in accordance with Test Methods E18.

8.2.1.1 The approximate Rockwell hardness values given are for general information and assistance in testing and shall not be used as a basis for product rejection.

NOTE 3—The Rockwell hardness test offers a quick and convenient method of checking for general conformity to the specification requirements for temper, tensile strength and grain size.

9. Other Requirements

9.1 *Nondestructive Testing:*

9.1.1 Unless otherwise agreed upon between the supplier and the purchaser, the pipe or tube shall be tested for defects either in the final drawn, annealed, or specified temper or in the drawn temper before the final anneal. Unless otherwise specified, the manufacturer shall have the option of testing the pipe or tube by one of the following tests:

9.1.2 *Electromagnetic Examination (Eddy Current)*—Each tube or pipe in nominal sizes from ⅛ in. (3.2 mm) up to and including 2½ in. (63.5 mm), regular and extra-strong, shall be subjected to an eddy-current test. Tests shall follow the procedures of Practice E243 except for the determination of "end effect." The pipe or tube shall be passed through an eddy-current testing unit adjusted to detect an artificial defect of a size and shape defined as follows:

NOTE 4—End effect is that length of the pipe or tube that travels through the coil until the testing unit has stabilized and is able to detect flaws. The magnitude of the spike generated when an end passes through the test coils is such that it disrupts testing momentarily.

9.1.2.1 *Artificial Defects*—Round bottom-notch standards with a profile as defined in Practice E243, rounded to the nearest 0.001 in. (0.025 mm) shall be 10 % of the specified wall thickness. Notch-depth tolerances shall be ±0.0005 in. (0.013 mm). Alternatively, when a manufacturer uses speed-insensitive equipment that can select a maximum unbalance signal, a maximum unbalance signal of 0.3 % shall be used.

9.1.2.2 *Retesting*—Pipes or tubes that do not activate the signaling device of the eddy-current tester shall be considered as conforming to the requirements of this test. Lengths with discontinuities, indicated by the testing unit, at the option of the manufacturer, may be reexamined or retested to determine whether the discontinuity is cause for rejection. Signals that are found to have been caused by soil, moisture, or minor mechanical damage shall not be cause for rejection, provided the pipe or tube dimensions are still within the prescribed limits and the pipe or tube is suitable for its intended application.

9.1.3 *Pressure Tests*—Each pipe or tube selected in accordance with 13.1.3 shall withstand the pressure test of either 9.1.3.1 or 9.1.3.2.

9.1.3.1 *Hydrostatic Test*—Each pipe or tube shall withstand, without showing evidence of leakage, an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 7000 psi (48 mPa). The pipe or tube need not be tested at a hydrostatic pressure of over 1000 psi (6.9 MPa) unless so specified. At the option of the manufacturer, annealed pipe with wall thickness up to 0.083 in. (2.11 mm), inclusive, may be tested in the drawn condition, before annealing. Fiber stress shall be determined by the following equation for thin, hollow cylinders under tension:

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

where:

P = hydrostatic pressure, psi (MPa);
t = thickness of pipe or tube wall, in. (mm);
D = outside diameter of the pipe or tube, in. (mm); and
S = allowable fiber stress of the material, psi (MPa).

9.1.3.2 *Pneumatic Test*—Each pipe or tube shall be pressurized to a minimum of 60 psi (415 kPa), air for 5 s, without showing evidence of leakage. The test method used shall permit easy visual detection of any leakage, such as by submerging the tube under water or by pressure differential method.

10. Dimensions, Mass, and Permissible Variations

10.1 *General:*

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

10.1.2 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 may be cause for rejection.

10.1.3 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 5—Blank spaces in the tolerance tables indicate either that the product is not generally available or that no tolerances have been established.

10.2 *Dimensions*—Dimensions and theoretical weights of nominal pipe sizes shall be in accordance with Table 3.

10.3 *Wall Thickness Tolerances*—Wall thickness tolerances for pipe shall be in accordance with Tables 4 and 5. Wall thickness tolerances for tube shall be in accordance with Tables 6-8.

10.4 *Diameter Tolerances*—Diameter tolerances for pipe and tube shall be as follows:

10.4.1 *Diameter Tolerances for Pipe:*

Nominal Pipe Size, in. (mm)	Diameter Tolerance, in. (mm)
1½ (38.1) and under	+0.016 – 0.031 (+0.40 – 0.79)
Over 1½ (38.1)	±1 % of specified diameter

10.4.2 The dimensional limits of nominal pipe sizes are shown in Tables 4 and 5.

10.4.3 Diameter tolerances for tube shall be in accordance with Table 9.

10.5 *Length Tolerances:*

10.5.1 Length tolerances shall be in accordance with Table 10.

10.5.2 *Schedule of Tube Lengths*—Specific and stock lengths with ends shall be in accordance with Table 11.

10.6 *Squareness of Cut*—For pipe and tube in straight lengths, the departure from squareness of the end of any pipe or tube shall not exceed the following:

TABLE 3 Dimensions and Weights of Copper Alloy Pipe, Standard Pipe Sizes

Nominal or Standard Pipe Size, in.	Dimension, in. (mm)			Cross-Sectional Area of Bore, in.^{2} (cm^2)	Theoretical Weight, lb/ft (kg/m)		
					Copper Alloy UNS No.		
	Outside Diameter	Inside Diameter	Wall Thickness		C61300 and C61400	C65500	C65100
			Regular				
⅛	0.405 (10.3)	0.269 (6.83)	0.068 (1.73)	0.057 (0.367)	0.246 (0.366)	0.266 (0.395)	0.273 (0.406)
¼	0.540 (13.7)	0.364 (9.25)	0.088 (2.24)	0.104 (0.670)	0.427 (0.634)	0.462 (0.686	0.474 (0.704)
⅜	0.675 (17.1)	0.493 (12.5)	0.091 (2.31)	0.191 (1.23)	0.571 (0.849)	0.617 (0.917)	0.633 (0.941)
½	0.840 (21.3)	0.622 (15.8)	0.109 (2.77)	0.304 (1.96)	0.856 (1.27)	0.925 (1.37)	0.949 (1.41)
¾	1.050 (26.7)	0.824 (20.9)	0.113 (2.87)	0.533 (3.44)	1.14 (1.69)	1.23 (1.83)	1.26 (1.88)
1	1.315 (33.4)	1.049 (26.6)	0.133 (3.38)	0.864 (3.57)	1.69 (2.51)	1.83 (2.72)	1.87 (2.79)
1¼	1.660 (42.2)	1.380 (35.1)	0.140 (3.56)	1.496 (9.66)	2.29 (3.40)	2.47 (3.68)	2.53 (3.77)
1½	1.900 (48.3)	1.610 (40.9)	0.145 (3.68)	2.036 (13.1)	2.74 (4.07)	2.95 (4.40)	3.03 (4.51)
2	2.375 (60.3)	2.067 (52.5)	0.154 (3.91)	3.356 (21.7)	3.67 (5.45)	3.97 (5.91)	4.07 (6.06)
2½	2.875 (73.0)	2.469 (62.7)	0.203 (5.16)	4.788 (30.9)	5.83 (8.66)	6.30 (9.37)	6.46 (9.61)
3	3.500 (88.9)	3.068 (77.9)	0.216 (5.49)	7.393 (47.7)	7.62 (11.3)	8.24 (12.3)	8.45 (12.6)
3½	4.000 (102)†	3.548 (90.1)	0.226 (5.74)	9.887 (63.8)	9.16 (13.6)	9.90 (14.7)	10.2 (15.1)
4	4.500 (114)	4.026 (102)	0.237 (6.02)	12.730 (82.1)	10.9 (16.2)	11.7 (17.5)	12.0 (17.9)
5	5.562 (141)	5.046 (128)	0.258 (6.55)	19.998 (129)	14.7 (21.8)	15.9 (23.6)	16.3 (24.3)
6	6.625 (168)	6.065 (154)	0.280 (7.11)	28.890 (186)	19.1 (28.4)	20.6 (30.7)	21.2 (31.5)
8	8.625 (219)	7.981 (203)	0.322 (8.18)	50.030 (323)	28.7 (42.7)	31.0 (46.2)	31.9 (47.4)
10	10.750 (273)	10.020 (255)	0.365 (9.27)	78.8 (508)	40.8 (90.1)	44.1 (65.6)	45.2 (67.3)
12	12.750 (324)	12.000 (305)	0.375 (9.52)	113.0 (729)	49.9 (74.1)	53.9 (80.2)	55.3 (82.3)
			Extra Strong				
⅛	0.405 (10.3)	0.215 (5.46)	0.095 (2.41)	0.036 (0.232)	0.316 (0.470)	0.342 (0.508)	0.351 (0.522)
¼	0.540 (13.7)	0.302 (7.67)	0.119 (3.02)	0.072 (0.464)	0.538 (0.799)	0.582 (0.865)	0.597 (0.887)
⅜	0.675 (17.1)	0.423 (10.7)	0.126 (3.20)	0.141 (0.909)	0.743 (1.10)	0.803 (1.19)	0.824 (1.22)
½	0.840 (21.3)	0.546 (13.9)	0.147 (3.73)	0.234 (1.51)	1.10 (1.63)	1.183 (1.76)	1.214 (1.80)
¾	1.050 (26.7)	0.742 (18.8)	0.154 (3.91)	0.432 (2.79)	1.48 (2.20)	1.60 (2.39)	1.65 (2.45)
1	1.315 (33.4)	0.957 (24.3)	0.179 (4.55)	0.719 (4.64)	2.19 (3.25)	2.36 (3.52)	2.42 (3.61)
1¼	1.660 (42.2)	1.278 (32.5)	0.191 (4.85)	1.283 (8.28)	3.01 (4.47)	3.26 (4.85)	3.34 (4.97)
1½	1.900 (48.3)	1.500 (38.1)	0.200 (5.08)	1.767 (11.4)	3.65 (5.42)	3.95 (5.88)	4.05 (6.03)
2	2.375 (60.3)	1.939 (49.3)	0.218 (5.54)	2.953 (19.1)	5.05 (7.50)	5.46 (8.12)	5.60 (8.34)
2½	2.875 (73.0)	2.323 (59.0)	0.276 (7.01)	4.238 (27.3)	7.71 (11.4)	8.33 (12.4)	8.55 (12.7)
3	3.500 (88.9)	2.900 (73.7)	0.300 (7.62)	6.605 (42.6)	10.3 (15.3)	11.1 (16.6)	11.4 (17.0)
3½	4.000 (102)	3.364 (85.5)	0.318 (8.08)	8.888 (57.3)	12.6 (18.7)	13.6 (20.2)	13.9 (20.8)
4	4.500 (114)	3.826 (97.2)	0.337 (8.56)	11.497 (74.)	15.1 (22.4)	16.3 (24.2)	16.7 (24.9)
5	5.562 (141)	4.812 (122)	0.375 (9.53)	18.186 (117)	20.9 (31.1)	22.6 (33.6)	23.2 (34.5)
6	6.625 (168)	5.761 (146)	0.432 (10.9)	26.067 (168)	28.7 (42.6)	31.1 (46.2)	31.9 (47.4)
8	8.625 (219)	7.625 (194)	0.500 (12.7)	45.664 (295)	43.6 (64.8)	47.2 (70.2)	48.4 (72.0)
10	10.750 (273)	9.750 (248)	0.500 (12.7)	74.7 (482)	55.1 (81.9)	59.5 (88.5)	61.1 (90.9)

TABLE 4 Dimensional Limits for Standard Pipe Sizes
Copper Alloy UNS No. C61300 and C61400

Nominal or Standard Pipe Size	Outside Diameter, in. (mm)	Min	Max	Regular			Extra Strong		
				Wall Thickness, in. (mm)	Min	Max	Wall Thickness, in. (mm)	Min	Max
⅛	0.405 (10.3)	0.374 (9.50)	0.421 (10.7)	0.068 (1.73)	0.061 (1.55)	0.075 (1.91)	0.095 (2.41)	0.086 (2.18)	0.105 (2.67)
¼	0.540 (13.7)	0.509 (12.9)	0.556 (14.1)	0.088 (2.24)	0.079 (2.01)	0.097 (2.46)	0.119 (3.02)	0.107 (2.72)	0.131 (3.33)
⅜	0.675 (17.1)	0.644 (16.4)	0.691 (17.6)	0.091 (2.31)	0.082 (2.08)	0.100 (2.54)	0.126 (3.20)	0.113 (2.87)	0.139 (3.53)
½	0.840 (21.3)	0.809 (20.5)	0.856 (21.7)	0.109 (2.77)	0.098 (2.49)	0.120 (3.05)	0.147 (3.73)	0.132 (3.35)	0.162 (4.11)
¾	1.050 (26.7)	1.019 (25.9)	1.066 (27.1)	0.113 (2.87)	0.102 (2.59)	0.124 (3.15)	0.154 (3.91)	0.139 (3.53)	0.169 (4.29)
1	1.315 (33.4)	1.284 (32.6)	1.331 (33.8)	0.133 (3.38)	0.120 (3.05)	0.146 (3.71)	0.179 (4.55)	0.161 (4.09)	0.197 (5.00)
1¼	1.660 (42.2)	1.629 (41.4)	1.676 (42.6)	0.140 (3.56)	0.126 (3.20)	0.154 (3.91)	0.191 (4.85)	0.172 (4.37)	0.210 (5.33)
1½	1.900 (48.3)	1.869 (47.5)	1.916 (48.7)	0.145 (3.68)	0.131 (3.33)	0.160 (4.06)	0.200 (5.08)	0.180 (4.57)	0.220 (5.59)
2	2.375 (60.3)	2.351 (59.7)	2.399 (60.9)	0.154 (3.91)	0.139 (3.53)	0.169 (4.29)	0.218 (5.54)	0.196 (4.98)	0.240 (6.10)
2½	2.875 (73.0)	2.846 (72.3)	2.904 (73.8)	0.203 (5.16)	0.183 (4.65)	0.223 (5.66)	0.276 (7.01)	0.248 (6.30)	0.304 (7.72)
3	3.500 (88.9)	3.465 (88.0)	3.535 (89.8)	0.216 (5.49)	0.194 (4.93)	0.238 (6.05)	0.300 (7.62)	0.270 (6.86)	0.330 (8.38)
3½	4.000 (102)	3.960 (101)	4.040 (103)	0.226 (5.74)	0.203 (5.16)	0.249 (6.32)	0.318 (8.08)	0.286 (7.26)	0.350 (8.89)
4	4.500 (114)	4.455 (113)	4.545 (115)	0.237 (6.02)	0.213 (5.41)	0.261 (6.63)	0.337 (8.56)	0.303 (7.70)	0.371 (9.42)
5	5.562 (141)	5.506 (140)	5.618 (143)	0.258 (6.55)	0.232 (5.89)	0.284 (7.21)	0.375 (9.53)	0.338 (8.59)	0.413 (10.5)
6	6.625 (168)	6.559 (167)	6.691 (170)	0.280 (7.11)	0.252 (6.40)	0.308 (7.82)	0.432 (11.0)	0.389 (9.88)	0.475 (12.1)
8	8.625 (219)	8.539 (217)	8.711 (221)	0.322 (8.18)	0.290 (7.37)	0.354 (8.99)	0.500 (12.7)	0.450 (11.4)	0.550 (14.0)
10	10.750 (273)	10.643 (270)	10.858 (276)	0.365 (9.27)	0.329 (8.36)	0.402 (10.2)	0.500 (12.7)	0.450 (11.4)	0.550 (14.0)
12	12.750 (324)	12.623 (321)	12.878 (327)	0.375 (9.53)	0.338 (8.59)	0.413 (10.5)	. . .	. . .	. . .

TABLE 5 Dimensional Limits for Standard Pipe Sizes
Copper Alloy UNS No. C65100 and C65500

Nominal or Standard Pipe Size	Outside Diameter, in. (mm)	Min	Max	Regular			Extra Strong		
				Wall Thickness, in. (mm)	Min	Max	Wall Thickness, in. (mm)	Min	Max
⅛	0.405 (10.3)	0.374 (9.50)	0.421 (10.7)	0.068 (1.73)	0.065 (1.65)	0.083 (2.11)	0.095 (2.41)	0.090 (2.29)	0.123 (3.12)
¼	0.540 (13.7)	0.509 (12.9)	0.556 (14.1)	0.088 (2.24)	0.084 (2.13)	0.102 (2.59)	0.119 (3.02)	0.107 (2.72)	0.144 (3.66)
⅜	0.675 (17.1)	0.644 (16.4)	0.691 (17.6)	0.091 (2.31)	0.086 (2.18)	0.103 (2.62)	0.126 (3.20)	0.120 (3.05)	0.146 (3.71)
½	0.840 (21.3)	0.809 (20.5)	0.856 (21.7)	0.109 (2.77)	0.104 (2.64)	0.122 (3.10)	0.147 (3.73)	0.140 (3.56)	0.166 (4.22)
¾	1.050 (26.7)	1.019 (25.9)	1.066 (27.1)	0.113 (2.87)	0.107 (2.72)	0.124 (3.15)	0.154 (3.91)	0.146 (3.71)	0.171 (4.34)
1	1.315 (33.4)	1.284 (32.6)	1.331 (33.8)	0.133 (3.38)	0.126 (3.20)	0.145 (3.68)	0.179 (4.55)	0.170 (4.32)	0.196 (4.98)
1¼	1.660 (42.2)	1.629 (41.4)	1.676 (42.6)	0.140 (3.56)	0.133 (3.38)	0.151 (3.84)	0.191 (4.85)	0.181 (4.60)	0.207 (5.26)
1½	1.900 (48.3)	1.869 (47.5)	1.916 (48.7)	0.145 (3.68)	0.138 (3.51)	0.156 (3.96)	0.200 (5.08)	0.190 (4.83)	0.216 (5.49)
2	2.375 (60.3)	2.351 (59.7)	2.399 (60.9)	0.154 (3.91)	0.146 (3.71)	0.164 (4.17)	0.218 (5.54)	0.207 (5.26)	0.233 (5.92)
2½	2.875 (73.0)	2.846 (72.3)	2.904 (73.8)	0.203 (5.16)	0.193 (4.90)	0.217 (5.51)	0.276 (7.01)	0.262 (6.65)	0.295 (7.49)
3	3.500 (88.9)	3.465 (88.0)	3.535 (89.8)	0.216 (5.49)	0.205 (5.21)	0.230 (5.84)	0.300 (7.62)	0.285 (7.24)	0.321 (8.15)
3½	4.000 (102)	3.960 (101)	4.040 (103)	0.226 (5.74)	0.215 (5.46)	0.240 (6.10)	0.318 (8.08)	0.302 (7.67)	0.340 (8.64)
4	4.500 (114)	4.455 (113)	4.545 (115)	0.237 (6.02)	0.225 (5.72)	0.252 (6.40)	0.337 (8.56)	0.320 (8.13)	0.360 (9.14)
5	5.562 (141)	5.506 (140)	5.618 (143)	0.258 (6.55)	0.245 (6.22)	0.275 (6.99)	0.375 (9.53)	0.356 (9.04)	0.400 (10.2)
6	6.625 (168)	6.559 (167)	6.691 (170)	0.280 (7.11)	0.266 (6.76)	0.298 (7.57)	0.432 (11.0)	0.410 (10.4)	0.461 (11.7)
8	8.625 (219)	8.539 (217)	8.711 (221)	0.322 (8.18)	0.299 (7.59)	0.349 (8.86)	0.500 (12.7)	0.465 (11.8)	0.554 (13.8)
10	10.750 (273)	10.643 (270)	10.858 (276)	0.365 (9.27)	0.336 (8.53)	0.400 (10.2)	0.500 (12.7)	0.460 (11.7)	0.548 (13.9)
12	12.750 (324)	12.623 (321)	12.878 (327)	0.375 (9.53)	0.345 (8.76)	0.410 (10.4)	. . .	. . .	. . .

TABLE 6 Wall Thickness Tolerances for Copper Alloy UNS No. C61300 and C61400 Tube (Not Applicable to Pipe)

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. (mm)	Outside Diameter, in. (mm)		
	Over ⅝ 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 0.024 (0.610) to 0.034 (0.864), incl	0.003 (0.076)	0.004 (0.10)	0.004 (0.10)
Over 0.034 (0.864) to 0.057 (1.45), incl	0.0045 (0.11)	0.005 (0.13)	0.006 (0.15)
Over 0.057 (1.45) to 0.082 (2.08), incl	0.005 (0.13)	0.006 (0.15)	0.008 (0.20)
Over 0.082 (2.08) to 0.119 (3.02), incl	0.007 (0.18)	0.008 (0.20)	0.009 (0.23)
Over 0.119 (3.02) to 0.164 (4.17), incl	0.009 (0.23)	0.010 (0.25)	0.012 (0.30)

10.6.1 *Pipe:*

Outside Diameter	Tolerance
Up to ⅝ in. (15.9 mm), incl	0.010 in. (0.25 mm)
Over ⅝ in. (15.9 mm)	0.016 in./in. (0.016 mm/mm) of diameter

10.6.2 *Tube:*

Outside Diameter	Tolerance
Up to ⅝ in. (15.9 mm), incl	0.010 in. (0.25 mm)
Over ⅝ in. (15.9 mm)	0.016 in./in. (0.016 mm/mm) of diameter

10.7 The nominal density of materials used in the manufacture of products for this specification are shown in Table X2.1.

TABLE 7 Wall Thickness Tolerances for Copper Alloy UNS No. C65500 Tube (Not Applicable to Pipe)

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. (mm)	Outside Diameter,[A] in. (mm)						
	1/32 to 1/8 (0.792 to 3.18), incl	Over 1/8 to 5/8 (3.18 to 15.9), incl	Over 5/8 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 10 (173 to 251), incl
Up to 0.017 (0.432), incl	0.0025 (0.064)	0.0015 (0.038)	0.002 (0.051)	0.0025 (0.064)	. . .	. . .	. . .
Over 0.017 (0.432) to 0.024 (0.610), incl	0.004 (0.10)	0.0025 (0.064)	0.0025 (0.064)	0.003 (0.076)	. . .	. . .	. . .
Over 0.024 (0.610) to 0.034 (0.864), incl	0.004 (0.10)	0.003 (0.076)	0.003 (0.076)	0.004 (0.10)	0.005 (0.13)	. . .	. . .
Over 0.034 (0.864) to 0.057 (1.45), incl	0.004 (0.10)	0.001 (0.10)	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	. . .	0.0045 (0.11)	0.005 (0.13)	0.005 (0.13)	0.0075 (0.19)	0.010 (0.25)	0.013 (0.33)
Over 0.082 (2.08) to 0.119 (3.02), incl	. . .	0.005 (0.13)	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)	0.007 (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)	6[B]	6[B]	8[B]	8[B]
Over 0.379 (9.62)	. . .	. . .	. . .	6[B]	6[B]	8[B]	8[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 by more than 50 %.
[B] Percent of the specified wall thickness expressed to the nearest 0.001 in. (0.025 mm).

TABLE 8 Wall Thickness Tolerances for Copper Alloy UNS No. C65100 Tube (Not Applicable to Pipe)

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. (mm)	Outside Diameter,[A] in. (mm)						
	1/32 (0.792) to 1 1/8 (3.18), incl	Over 1/8 (3.18) to 5/8 (15.9), incl	Over 5/8 (15.9) to 1 (25.4), incl	Over 1 (25.4) to 2 (50.8), incl	Over 2 (50.8) to 4 (102), incl	Over 4 (102) to 7 (213), incl	Over 7 (213) to 10 (254), incl
Up to 0.017 (0.432), incl	0.002 (0.051)	0.001 (0.025)	0.0015 (0.038)	0.002 (0.051)	. . .	. . .	. . .
Over 0.017 (0.432) to 0.024 (0.610), incl	0.003 (0.076)	0.002 (0.051)	0.002 (0.051)	0.0025 (0.064)	. . .	. . .	. . .
Over 0.024 (0.610) to 0.034 (0.864), incl	0.003 (0.076)	0.0025 (0.064)	0.0025 (0.064)	0.003 (0.076)	0.004 (0.10)	. . .	. . .
Over 0.034 (0.864) to 0.057 (1.45), incl	0.003 (0.076)	0.003 (0.076)	0.0035 (0.089)	0.0035 (0.089)	0.005 (0.13)	0.007 (0.18)	. . .
Over 0.057 (1.45) to 0.082 (2.08), incl	. . .	0.0035 (0.089)	0.004 (0.10)	0.004 (0.10)	0.006 (0.15)	0.008 (0.20)	0.010 (0.26)
Over 0.082 (2.08) to 0.119 (3.02), incl	. . .	0.004 (0.10)	0.005 (0.13)	0.005 (0.13)	0.007 (0.18)	0.009 (0.23)	0.011 (0.28)
Over 0.119 (3.02) to 0.164 (4.17), incl	. . .	0.005 (0.13)	0.006 (0.15)	0.006 (0.15)	0.008 (0.20)	0.010 (0.25)	0.012 (0.30)
Over 0.164 (4.17) to 0.219 (5.56), incl	. . .	0.007 (0.18)	0.0075 (0.19)	0.008 (0.20)	0.010 (0.25)	0.012 (0.30)	0.014 (0.36)
Over 0.219 (5.56) to 0.283 (7.19), incl	. . .	. . .	0.009 (0.23)	0.010 (0.25)	0.012 (0.30)	0.014 (0.36)	0.016 (0.44)
Over 0.283 (7.19) to 0.379 (9.62), incl	. . .	. . .	0.012 (0.30)	5[B]	5[B]	6[B]	6[B]
Over 0.379 (9.62), incl	. . .	. . .	. . .	5[B]	5[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 by more than 50 %.
[B] Percent of the specified wall thickness expressed to the nearest 0.001 in. (0.025 mm).

11. Workmanship, Finish, and Appearance

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

11.2 Copper alloy UNS Nos. 65100 and 65500 may be supplied in the following finishes:

11.2.1 *Specially Cleaned*—Intended for brazing and welded operations.

11.2.2 Plain-pickled, or with dull iridescent film, on both the inside and outside surfaces

NOTE 6—Plain-pickled material normally has a brick red color with cuprous and silicon oxides still adherent.

11.3 Copper alloy UNS Nos. C61300 and C61400 shall be supplied with the normal as-extruded or annealed tarnish unless otherwise specified on the purchase order.

TABLE 9 Average Diameter Tolerances for Tube (Not Applicable to Pipe)

Copper Alloy UNS No.	Tolerance, ±in. (mm)[A]		
Specified Diameter, in. (mm)	C61300 and C61400	C65100	C65500
Up to 1/8 (3.18), incl	. . .	0.002 (0.051)[B]	0.003 (0.076)[B]
Up to 1/8 (3.18), incl	. . .	0.002 (0.051)[C]	0.025 (0.064)[C]
Over 1/8 (3.18) to 5/8 (15.9), incl	0.004 (0.10)	0.002 (0.051)	0.0025 (0.064)
Over 5/8 (15.9) to 1 (25.4), incl	0.005 (0.13)	0.0025 (0.064)	0.003 (0.076)
Over 1 (25.4) to 2 (50.8), incl	0.006 (0.15)	0.003 (0.076)	0.004 (0.10)
Over 2 (50.8) to 3 (76.2), incl	0.007 (0.18)	0.004 (0.10)	0.005 (0.13)
Over 3 (76.2) to 4 (102), incl	. . .	0.005 (0.13)	0.006 (0.15)
Over 4 (102) to 5 (127), incl	. . .	0.006 (0.15)	0.008 (0.20)
Over 5 (127) to 6 (152), incl	. . .	0.007 (0.18)	0.009 (0.23)
Over 6 (152) to 8 (203), incl	. . .	0.008 (0.20)	0.010 (0.25)
Over 8 (203) to 10 (254), incl	. . .	0.010 (0.25)	0.013 (0.33)

[A] Tolerance applies to inside or outside diameters, except as noted.
[B] On inside diameter.
[C] On outside diameter.

TABLE 10 Length Tolerances

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

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)	. . .
Over 6 in. (152 mm) to 2 ft (610 mm), incl	1/16 (1.6)	3/32 (2.4)	1/8 (3.2)
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)	1/4 (6.4)
Over 14 ft (4.27 m)	1/2 (13)	1/2 (13)	1/2 (13)
Specific lengths with ends	1 (25)	1 (25)	1 (25)
Stock lengths with or without ends	1[A] (25)	1[A] (25)	1[A] (25)

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

TABLE 11 Schedule of Tube Lengths (Specific and Stock) with Ends

Outside Dimensions, in. (mm)	Specific Length, ft (m)	Shortest Permissible Length,[A] % of Specific Length	Maximum Permissible Weight of Ends, % of Lot Weight
Up to 1 (25.4), incl	6 (1.83) to 20 (6.10), incl	70	20
Over 1 (25.4) to 2 (50.8), incl	6 (1.83) to 20 (6.10), incl	60	25
Over 2 (50.8) to 3 (76.2), incl	6 (1.83) to 20 (6.10), incl	55	30
Over 3 (76.2) to 4 (102), incl	6 (1.83) to 20 (6.10), incl	50	40

[A] Expressed to nearest 1/3 ft.

12. Sampling

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

12.1.1 *Lot Size*—For tube, the lot size shall be 10 000 lb (4550 kg) or fraction thereof. For pipe, the lot size shall be as follows:

Nominal Pipe Size, in (mm)	Lot Weight, lb. (kg)
Up to 4 (101.6), incl	10 000 (4 550) or fraction thereof
Over 4 (101.6)	40 000 (18 100) or fraction thereof

12.1.2 *Portion Size*—Sample pieces shall be taken for test purposes from each lot according to the following schedule. (Each sample shall be from a separate tube or pipe.)

Number of Pieces in Lot	Number of Sample Pieces to Be Taken
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of total number of pieces in the lot

12.1.3 *Chemical Analysis*—Samples for chemical analysis shall be taken in accordance with Practice E255. Drillings, millings, and so forth shall be taken in approximately equal weight from each of the sample pieces selected in accordance with 12.1.2 and combined into one composite sample. The minimum weight of the composite sample shall be 150 minimum.

12.1.3.1 Instead of sampling in accordance with Practice E255, the manufacturer shall have the option of determining conformance to chemical composition as follows: The manufacturer shall analyze samples taken at the time the castings are poured or from the semifinished product. When the chemical composition of the product is determined during the course of manufacture, sampling and analysis of the finished product shall not be required. The number of samples taken for determination of chemical compositions shall be as follows:

12.1.3.2 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.

12.1.3.3 When samples are taken from the semifinished product, a sample shall be taken to represent each 10 000 lb (4 550 kg), or fraction thereof for all tube and for pipe sizes up to 4 in. For pipe sizes over 4 in., a sample shall be taken to represent 40 000 lb (18 100 kg). In all instances, not more than one sample shall be required per piece.

12.1.4 *Pressure Tests*—See 13.1.3.

13. Number of Test and Retests

13.1 *Tests:*

13.1.1 *Chemical Analysis*—Chemical composition shall be determined as the per element mean of the results from at least two replicate analyses of the samples.

13.1.2 *Mechanical Tests*—For the mechanical tests, a specimen shall be taken from each of the pieces selected in accordance with 12.1. The required mechanical test shall be made on each of the specimens so selected.

13.1.2.1 If the percentage elongation of any tension test specimen is less than that specified and if 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 shall be allowed.

13.1.3 *Pressure Tests*—For the purpose of pressure testing only, a number of lengths of pipe or tube to be tested as described in 9.1.2 shall be randomly selected from the lot as follows:

Number of Pipes or Tubes	
Lot Size	Sample Size
1–8	5
9–50	7
51–150	20
151–280	32
281–500	50
501–1200	80
1201–3200	125

13.2 *Retests:*

13.2.1 When requested by the manufacturer or supplier, a retest shall be permitted when results of tests obtained by the purchaser fail to conform to the requirements of the product specification.

13.2.2 The retest shall be as directed in the product specification for the initial test, except the number of test specimens shall be twice that normally required for the specified test.

13.2.3 All test specimens shall conform to the product specification requirement(s) in retest. Failure to conform shall be cause for rejection.

14. Specimen Preparation:

14.1 *Chemical Analysis*—Preparation of the analytical test specimen is the responsibility of the reporting laboratory.

14.2 *Tensile Test:*

14.2.1 The test specimen shall be of the full section of the tube and shall conform to the requirements of the section titled Specimens for Pipe and Tube in Test Methods E8/E8M.

14.2.2 When the limitations of the testing equipment preclude the use of such a specimen, test specimens conforming to Type 1, Figure 13, Tension Test Specimens for Large-Diameter Tubular Products, of Test Methods E8/E8M may be used when a full-section specimen cannot be tested.

14.3 *Rockwell Hardness:*

14.3.1 The test specimen shall be of the size and shape to permit testing with the available test equipment.

14.3.2 The surface of the specimen shall be sufficiently flat and smooth to permit the accurate determination of hardness.

14.3.3 The test specimen shall be sufficiently free of scale and foreign material to permit the accurate determination of hardness.

14.3.4 Care shall be taken to avoid changing the material's condition through either cold working or heating, or both.

15. Test Methods

15.1 *Chemical Analysis*—In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser.

15.1.1 The following table lists published chemical test methods, some of which are considered by ASTM as no longer viable. These and others not listed may be used subject to agreement.

Test	Test Method
Copper	E478
Lead	E478
Iron	E478
Zinc	E478
Aluminum	E54
Manganese	E62
Silicon	E62
Tin	E478
Nickel (including cobalt)	E478
Phosphorus	E62
Electromagnetic (eddy current)	E243
Rockwell hardness	E18 and 14.3
Yield test	E8/E8M
Tension test	E8/E8M
Elongation	E8/E8M

15.2 *Tension Tests:*

15.2.1 When 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 prevail.

15.2.2 Tension test results on material covered by this specification are not seriously affected by variations in the speed of testing. A considerable range of testing speeds is permissible; however, the rate of stressing to obtain the yield strength should not exceed 100 ksi (690 mPa)/min. Above the yield strength, the movement per minute of the testing machine head under load should not exceed 0.5 in./in. (12 mm/mm) of gage length (or distance between grips for full-section specimens).

16. Significance of Numerical Limits

16.1 For the purpose of determining compliance with the specified limits of the properties listed in the following table and for dimensional tolerances, an observed or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29.

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand significant digit used in expressing the limiting value
Tensile strength/yield strength	nearest ksi (nearest 5 Mpa)
Elongation	nearest 1 %

17. Inspection

17.1 The manufacturer, or supplier, shall inspect and make tests necessary to verify that the furnished product conforms to the specification requirements.

17.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer, or supplier, and the purchaser as a part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector, representing the purchaser, that the product is being furnished in accordance with the specification shall be included in the agreement. All testing and inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

17.3 When mutually agreed upon, the manufacturer, or supplier, and the purchaser shall conduct the final inspection simultaneously.

18. Rejection and Rehearing

18.1 *Rejection:*

18.1.1 Product that fails to conform to the specification requirements, when tested by the purchaser or purchaser's agent, shall be subject to rejection.

18.1.2 Rejection shall be reported to the manufacturer or supplier promptly. In addition, a written notification of rejection shall follow.

18.1.3 In case of dissatisfaction with the results of the test upon which rejection is based, the manufacturer, or supplier, shall have the option to make claim for a rehearing.

18.2 *Rehearing*—As a result of product rejection, the manufacturer, or supplier, shall have the option to make claim for a retest to be conducted by the manufacturer, or supplier, and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or, alternately, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

19. Certification

19.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested or inspected, or both, as directed in this specification and the requirements have been met.

19.2 When identified in the ordering information that the product is purchased for ASME Boiler and Pressure Vessel Code applications, certification to this specification shall be mandatory.

20. Test Report

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

21. Packaging and Package Marking

21.1 *Packaging:*

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

21.2 *Package Marking:*

21.2.1 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.

22. Keywords

22.1 seamless copper alloy pipe; seamless copper alloy tube; UNS Alloy No. C61300; UNS Alloy No. C61400; UNS Alloy No. C63020; UNS Alloy No. C65100; UNS Alloy No. C65500

APPENDIXES

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties is shown in accordance with the International System of Units (SI). The derived SI unit for force is the Newton (N), which is defined as the force that when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). 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 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

X2. DENSITY OF COPPER ALLOYS

X2.1 The densities of the alloys covered by this specification are given in Table X2.1.

TABLE X2.1 Densities

Copper Alloy UNS Number	Density, lb/in.^{3} (g/cm^3)
C61300	0.285 (7.89)
C61400	0.285 (7.89)
C63020	0.269 (7.45)
C65100	0.316 (8.78)
C65500	0.308 (8.53)

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B315 – 06) that may impact the use of this standard. (Approved October 1, 2012.)

(1) General formatting changes were made to comply with the B05 Outline of Form Guidelines.