



Standard Specification for Seamless Copper Alloy (UNS No. C69100) Pipe and Tube¹

This standard is issued under the fixed designation B 706; 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 alloy UNS No. C69100 seamless pipe in standard pipe sizes, both regular and extra strong, and seamless tube in straight lengths for general engineering purposes.

1.2 Values stated in inch-pound units are the standard. SI values given in parenthesis are provided for information only.

1.3 The following safety hazard caveat pertains only to the test method portion, Section 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:*²

B 193 Test Method for Resistivity of Electrical Conductor Materials

B 846 Terminology for Copper and Copper Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 20 Practice for Particle Size Analysis of Particulate Substances in the Range of 0.2 to 75 Micrometres by Optical Microscopy³

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes³

E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes

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

E 478 Test Methods for Chemical Analysis of Copper Alloys

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms related to copper and copper alloys, refer to Terminology **B 846**, unless otherwise stated.

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

4. Ordering Information

4.1 Orders for products shall include the following information:

4.1.1 ASTM designation and year of issue, that is, B 706–XX.

4.1.2 UNS designation, that is, C69100.

4.1.3 Temper (see Section 7).

4.1.4 Dimensions, diameter, and wall thickness.

4.1.5 How furnished: straight lengths or coils.

4.1.6 Finish.

4.1.7 Total length, or number of pieces, of each size.

4.1.8 Total weight, each size.

4.1.9 When product is purchased for agencies of the U.S. government.

4.2 The following options are available and shall be included in the contract or purchase order when required.

4.2.1 Heat identification or traceability details.

4.2.2 Electromagnetic (eddy-current) examination.

4.2.3 Expansion test.

4.2.4 Flattening test.

4.2.5 Certification.

4.2.6 Mill test report.

5. Materials and Manufacture

5.1 *Material:*

5.1.1 The material of manufacture shall be cast or extruded shells of Copper Alloy UNS No. C69100 of such purity and soundness as to be suitable for processing into the products prescribed herein.

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

NOTE 1—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.

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.

³ Withdrawn.



5.2 Manufacture:

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

5.2.2 The product shall be hot or cold worked to the finished size, and subsequently, annealed, when required, to meet the temper properties specified.

6. Chemical Composition

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

6.2 These composition limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer and purchaser.

6.3 For Alloy UNS C69100 where zinc is listed as “remainder,” zinc 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 % minimum.

7. Temper

7.1 The tempers for products described in this specification shall be in accordance with **Table 2**.

7.1.1 TB00 (soft-annealed),

7.1.2 TF00 (precipitation-hardened), and

7.1.3 HR50 (drawn stress relieved).

8. Physical Property Requirements

8.1 *Electrical Resistivity Requirement*—When specified in the contract or purchase order, the product furnished shall be capable of conforming to a specific resistant of $1.13 \mu\Omega/\text{mm}$ ($+ < 5 \%$) at 20°C when tested in accordance with Test Method **B 193**.

8.2 *Coefficient of Thermal Expansion*—When specified in the contract or purchase order, the product furnished shall be capable of conforming to a coefficient of linear expansion of 0.000 019 (or 19×10^{-6}) per $^\circ\text{C}$, in the range 20 to 200°C when tested in accordance with an appropriate test method.

9. Mechanical Property Requirements

9.1 Tensile Strength Requirements:

9.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in **Table 2** when tested in accordance with Test Methods **E 8**.

9.1.2 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

TABLE 1 Chemical Requirements

Element	Composition, % Max (Unless Shown as a Range or Minimum)
Copper (incl. Ag)	81.0–84.0
Lead	0.05
Iron	0.25
Zinc	remainder
Aluminum	0.7–1.2
Manganese	0.10 min
Silicon	0.8–1.3
Tin	0.10
Nickel (incl. Co)	0.8–1.4

TABLE 2 Tensile Requirements

Temper Designation	TB00 (Soft Annealed)	TF00 (Precipitation- Hardened)	HR50 (Drawn-Stress Relieved)
Tensile strength, min, ksi ^A (MPa ^B)	55 (380)	60 (420)	79 (550)
Yield strength at 0.5 % extension under load, ksi (MPa) ^A	16.5 (115)	31 (214)	48 (335)
Elongation in 2 in. or 50 mm, min, %	50	40	10

^A ksi = 100 psi.

^B See **Appendix X1**.

9.2 *Rockwell Hardness*—The approximate hardness value for alloy UNS C69100 lies within the range 69 to 76 Rockwell B, being for general information and assistance in testing, and shall not be used as a basis for product rejection.

NOTE 2—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.

10. Other Requirements

10.1 Nondestructive Testing:

10.1.1 Pipe or tube must be tested in the final heat-treated condition as supplied to the purchaser unless otherwise agreed upon between the manufacturer and purchaser. Unless otherwise specified, the manufacturer shall have the option of testing the pipe or tube by one of the following tests:

10.1.1.1 *Eddy-Current Test*—Each tube or pipe in standard sizes $\frac{1}{8}$ in. (3.18 mm) up to and including $2\frac{1}{2}$ in. (63.5 mm) regular and extra strong, shall be subject to an eddy-current test following the procedures of Practice **E 243** and using an end effect suppression device. The pipe or tube shall be passed through the eddy-current testing unit to provide information on the suitability of each piece for the intended application.

10.1.1.2 Notch-depth standards, rounded to the nearest 0.001 in. (0.025 mm), shall be 10 % of the nominal 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, such a signal of 0.3 % may be used.

10.1.1.3 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 tester may, at the option of the manufacturer, be reexamined or retested to determine whether the discontinuity is cause for rejection. Signals that are found to have been caused by minor mechanical damage, soil, or moisture shall not be cause for rejection provided the pipe or tube dimensions are still within the prescribed limits and the pipe or tube is suitable for its intended application.

10.1.2 *Hydrostatic Test*—Each length shall stand, without showing evidence of leakage, an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 7000 psi (48 MPa) determined by the following equation for thin hollow cylinders under internal pressure. The pipe or tube need not be tested at a hydrostatic pressure of over 1000 psi (6.9 MPa) unless so specified.

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



where:

P = hydrostatic pressure, psi (or MPa);

t = thickness of pipe or tube wall, in. (or mm);

D = nominal outside diameter of the pipe or tube, in. (or mm); and

S = allowable stress of the material, psi (or MPa).

11. Dimensions, Mass, and Permissible Variations

11.1 General:

11.1.1 The standard method of specifying wall thicknesses shall be in decimal fractions of an inch.

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

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

11.2 *Dimensions*—Nominal dimensions and nominal weights of standard pipe sizes shall be in accordance with Table 3.

11.3 *Wall Thickness Tolerances*—Wall thickness tolerances shall be in accordance with Table 4. Wall thickness tolerances for tube shall be in accordance with Table 5.

11.4 *Diameter Tolerances*—Diameter tolerances for pipe shall be as follows:

11.4.1 *Nominal Pipe Size 1½ in. (38 mm) and Under*—+0.016, −0.031 in. (+0.40, −0.79 mm).

11.4.2 *Nominal Pipe Size Over 1½ in. (38 mm)*—±1 % of specified diameter.

11.4.3 The dimensional limits of standard pipe sizes are shown in Table 4.

11.4.4 Diameter tolerances of tube shall be in accordance with Table 6.

11.5 Length Tolerances:

11.5.1 Length tolerances shall be in accordance with Table 7.

11.5.2 *Schedule of Tube Lengths*—Specific and stock lengths with ends shall be in accordance with Table 8.

11.6 *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:

11.6.1 Pipe:

Nominal Outside Diameter, in. (mm)	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 dia

11.6.2 Tube:

Specified Outside Diameter, in. (mm)	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 dia

11.7 The density of Copper Alloy UNS No. C69100 shall be taken to be 0.308 lb/in.³ (8.53 g/cm³).

12. Workmanship, Finish and Appearance

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

13. Sampling

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

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

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

Standard Pipe Size, in.	Nominal Dimension, in. (mm)			Cross-Sectional Area of Bore, in. ² (cm ²)	Nominal Weight, lb/ft (kg/m)
	Outside Diameter	Inside Diameter	Wall Thickness		
Regular					
1/8	0.405 (10.3)	0.269 (6.83)	0.068 (1.73)	0.057 (0.367)	0.266 (0.395)
1/4	0.540 (13.7)	0.364 (9.25)	0.088 (2.24)	0.104 (0.670)	0.462 (0.686)
3/8	0.675 (17.1)	0.493 (12.5)	0.091 (2.31)	0.191 (1.23)	0.617 (0.917)
1/2	0.840 (21.3)	0.622 (15.8)	0.109 (2.77)	0.304 (1.96)	0.925 (1.37)
3/4	1.050 (26.7)	0.824 (20.9)	0.113 (2.87)	0.533 (3.44)	1.23 (1.83)
1	1.315 (33.4)	1.049 (26.6)	0.133 (3.38)	0.864 (3.57)	1.83 (2.72)
1 1/4	1.660 (42.2)	1.380 (35.1)	0.140 (3.56)	1.496 (9.66)	2.47 (3.68)
1 1/2	1.900 (48.3)	1.610 (40.9)	0.145 (3.68)	2.036 (13.1)	2.95 (4.40)
2	2.375 (60.3)	2.067 (52.5)	0.154 (3.91)	3.356 (21.7)	3.97 (5.91)
2 1/2	2.875 (73.0)	2.469 (62.7)	0.203 (5.16)	4.788 (30.9)	6.30 (9.37)
3	3.500 (88.9)	3.068 (77.9)	0.216 (5.49)	7.393 (47.7)	8.24 (12.3)
Extra Strong					
1/8	0.405 (10.3)	0.215 (5.46)	0.095 (2.41)	0.036 (0.232)	0.342 (0.508)
1/4	0.540 (13.7)	0.302 (7.67)	0.119 (3.02)	0.072 (0.464)	0.582 (0.865)
3/8	0.675 (17.1)	0.423 (10.7)	0.126 (3.20)	0.141 (0.909)	0.803 (1.19)
1/2	0.840 (21.3)	0.546 (13.9)	0.147 (3.73)	0.234 (1.51)	1.183 (1.76)
3/4	1.050 (26.7)	0.742 (18.8)	0.154 (3.91)	0.432 (2.79)	1.60 (2.39)
1	1.315 (33.4)	0.957 (24.3)	0.179 (4.55)	0.719 (4.64)	2.36 (3.52)
1 1/4	1.660 (42.2)	1.278 (32.5)	0.191 (4.85)	1.283 (8.28)	3.26 (4.85)
1 1/2	1.900 (48.3)	1.500 (38.1)	0.200 (5.08)	1.767 (11.4)	3.95 (5.88)
2	2.375 (60.3)	1.939 (49.3)	0.218 (5.54)	2.953 (19.1)	5.46 (8.12)
2 1/2	2.875 (73.0)	2.323 (59.0)	0.276 (7.01)	4.238 (27.3)	8.33 (12.4)
3	3.500 (88.9)	2.900 (73.7)	0.300 (7.62)	6.605 (42.6)	11.1 (16.6)

^A Copper Alloy UNS No. C69100 is presently available only in standard pipe sizes up to 3 in.



TABLE 4 Dimensional Limits for Standard Pipe Sizes

Standard Pipe Size	Outside Diameter, in. (mm)			Wall Thickness, in. (mm)					
	Nominal	Min	Max	Regular			Extra Strong		
				Nominal	Min	Max	Nominal	Min	Max
1/8	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)
1/4	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)
3/8	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)
1/2	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)
3/4	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)
1 1/4	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)
1 1/2	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)
2 1/2	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)

TABLE 5 Wall Thickness Tolerances for Copper Alloy UNS No. C69100^A 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 5/8 to 1 (15.9 to 25.4) Incl	Over 1 to 2 (25.4 to 50.8) Incl	Over 2 to 3 (50.8 to 76.2) 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)

^A Copper Alloy UNS No. C69100 in tube sizes less than 1/8 in. shall be furnished in diameter and wall thickness tolerances agreed to between purchaser and supplier.

TABLE 6 Average Diameter Tolerances for Tube (Not Applicable to Pipe)

Specified Diameter, in. (mm)	Tolerance $\pm$ in. (mm) ^A
Over 1/8 (3.18) to 5/8 (15.9) incl	0.004 (0.10)
Over 5/8 (15.9) to 1 (25.4) incl	0.005 (0.13)
Over 1 (25.4) to 2 (50.8) incl	0.006 (0.15)
Over 2 (50.8) to 3 (76.2) incl	0.007 (0.18)

^A Tolerance applies to inside or outside diameters.

Standard Pipe Size, in. (mm)	Lot Weight, lb (kg)
Up to 4 in. (102 mm) incl.	10 000 lbs (4550 kg) or fraction thereof
Over 4 in. (102 mm)	40 000 lbs (18 000 kg) or fraction thereof

13.1.2 *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
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of total number of pieces in lot

13.2 Chemical Analysis:

13.2.1 The sample for chemical analysis shall be taken in accordance with Practice E 255 for product in its final form

TABLE 7 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 3 in. (76.2 mm) Incl
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)
Over 2 ft (610 mm) to 6 ft (1.83 m) incl	3/32 (2.4)	1/8 (3.2)
Over 6 ft (1.83 m) to 14 ft (4.27 m) incl	1/4 (6.4)	1/4 (6.4)
Over 14 ft (4.27 m)	1/2 (13)	1/2 (13)
Specific lengths with ends	1 (25)	1 (25)
Stock lengths with or without ends	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 8 Schedule of Tube Lengths (Specific and Stock) with Ends

Outside Dimensions, in. (mm)	Nominal Length, ft (m)	Shortest Permissible Length, ^A % of Nominal 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

^A Expressed to nearest 1/8 ft.

from the pieces selected in 13.1.2 and combined into one composite sample. The minimum weight of this composite sample shall be 150 g.

13.2.2 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 semifinished product. When the manufacturer determines chemical composition of the material during the course of manufacture, sampling of the finished product is not



required. The number of samples taken for determination of chemical composition shall be as follows:

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

13.2.2.2 When samples are taken from semifinished product, a sample shall be taken to represent each 10 000 lbs (4550 kg), or fraction thereof, except that not more than one sample shall be required.

13.2.2.3 Only one sample need be taken from the semifinished product of one cast bar of a single melt charge continuously processed.

13.3 *Samples of All Other Tests*—Samples of all other tests shall be taken from the sample portions selected in 13.1.2 and be of a convenient size to accommodate the test and comply with the requirements of the appropriate product specification and test method.

14. Number of Tests and Retests

14.1 Tests:

14.1.1 *Chemical Analysis*—Chemical composition shall be determined as the per element mean of results from at least two replicate analyses of the sample(s).

14.1.2 *Other Tests*—Tensile and electrical resistivity results shall be reported as the average of the results obtained from at least two test specimens, each taken from a separate test piece where possible.

14.2 Retests:

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

14.2.2 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.

14.2.3 Test results for all specimens shall conform to the product specification requirement(s) in retest and failure to comply shall be cause for lot rejection.

15. Specimen Preparation

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

15.2 *Tensile Test*—The test specimen shall be of the full section of the tube and shall conform to the requirements of specimens for pipe and tube 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 of Test Methods E 8 may be used when a full-section specimen cannot be tested.

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

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

15.3.2 The specimen shall be free of scale and foreign matter and care shall be taken to avoid any change in condition, that is, heating or cold working.

15.4 *Electrical Resistivity*—Test specimens are to be full size where practical and shall be the full cross section of the material it represents.

15.4.1 When the test specimen is cut from material in bulk, care shall be taken that the properties are not appreciably altered in the preparation. Plastic deformation may work harden a material and tend to raise the resistivity, while heating tends to anneal the material with a consequent reduction in resistivity.

15.4.2 When necessary, products are to be rolled or cold drawn to a wire 0.080 in. (1.2 mm) in diameter and at least 160 in. (4064 mm) in length. Since Copper Alloy UNS C69100 is heat treatable, such postdrawing or rolling heat treatment shall be agreed between the manufacturer and purchaser.

15.5 Should any test specimen show defective machining or develop flaws, it may be discarded and another specimen substituted.

16. Test Methods

16.1 Chemical Analysis:

16.1.1 The chemical composition of Copper Alloy UNS C69100 shall be determined, in the case of disagreement, by the methods defined in Specifications E 54 and E 478.

16.1.2 The test method(s) to be followed for the determination of element(s) resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

16.2 Other Tests:

16.2.1 The product furnished shall conform to all other requirements when subjected to test in accordance with the appropriate test method in the following table:

Test	Method
Tensile strength	E 8
Eddy current	E 243

16.2.1.1 Yield strength shall be determined by the extension-under-load method of Test Methods E 8.

16.2.1.2 Whenever tension and yield strength test results are obtained from both full-size and machined test specimens and they differ, the results from the full-size specimens shall prevail.

16.2.1.3 Tension test results on Copper Alloy UNS C69100 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 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. (0.5 mm/mm) of gage length (or distance between grips for full-section specimens).

17. Significance of Numerical Limits

17.1 For the purpose of determining compliance with the specified limits of requirements of the properties listed in the following table, an observed value of a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E 20:



Property	Rounded Unit for Observed or Calculated Value
Chemical composition	Nearest unit in the last
Hardness	right-hand significant digit
Linear dimensions	used in expressing the
Tolerances	limiting value
Tensile strength	Nearest ksi
Yield strength	
Elongation	Nearest 1 %

18. Inspection

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

18.2 Source inspection of the product by the purchaser may be agreed upon by the manufacturer or supplier, and the purchaser as 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 tests and the inspection shall be conducted so as not to interfere unnecessarily with the operations of the works.

18.3 The manufacturer or supplier and the purchaser may conduct the final inspection simultaneously by mutual agreement.

19. Rejection and Rehearing

19.1 *Rejection:*

19.1.1 Product that fails to conform to the specification requirements when inspected or tested by the purchaser, or purchaser's agent, may be rejected.

19.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly and in writing.

19.1.3 In case of dissatisfaction with the results of the test upon which rejection is based, the manufacturer, or supplier, may make claim for a rehearing.

19.2 *Rehearing*—As a result of product rejection, the manufacturer, or supplier, may 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, alternatively, upon agreement by both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

20. Certification

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

21. Test Report

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

22. Product Marking

22.1 Product conforming to this specification shall be marked, using indelible ink, along its length at repetitive intervals not exceeding 18 in. (460 mm). The repeating legend shall contain the manufacturer's name or trademark, the tube's outside diameter and wall thickness, this specification number, the cast number and country of origin. Other information, such as purchaser's order number and so forth, shall be added as required, but a maximum length of 36 in. (910 mm) shall not be exceeded.

23. Packaging and Package Marking

23.1 *Packaging*—The product shall be separated by size and composition, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to afford protection from normal hazards of transportation.

23.2 *Package Marking*—Each shipment unit shall be marked legibly 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.

24. Keywords

24.1 extra-strong; pipe; regular; seamless; standard pipe series; tube; UNS No. C69100

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 1 kg gives it an acceleration of one metre per second squared ($N = \text{kg} \cdot \text{m/s}^2$). 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 $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2 .



SUMMARY OF CHANGES

The following is a summary of changes incorporated since B 706 – 88 was discontinued in 1993.

(I) A complete revision in line with the ASTM “Outline of Form for Specification,” revised April 1994.

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