



Designation: **B42—15a B42 – 20**

Standard Specification for Seamless Copper Pipe, Standard Sizes¹

This standard is issued under the fixed designation B42; 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 specification² establishes the requirements for seamless copper pipe in all nominal or standard pipe sizes, both regular and extra-strong, suitable for use in plumbing, boiler feed lines, and for similar purposes.³

1.2 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.3 The following safety hazard caveat pertains only to the test methods described in this specification.

1.3.1 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*⁴

[B153 Test Method for Expansion \(Pin Test\) of Copper and Copper-Alloy Pipe and Tubing](#)

[B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes](#)

[B577 Test Methods for Detection of Cuprous Oxide \(Hydrogen Embrittlement Susceptibility\) in Copper](#)

[B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast](#)

[B846 Terminology for Copper and Copper Alloys](#)

[B968/B968M Test Method for Flattening of Copper and Copper-Alloy Pipe and Tube](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry](#)

[E62 Test Methods for Chemical Analysis of Copper and Copper Alloys \(Photometric Methods\) \(Withdrawn 2010\)](#)⁵

[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](#)

[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

2.2 *ASME Code:*⁶

[ASME Boiler and Pressure Vessel Code](#)

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 SB-42 in Section II of that Code.

³ The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix “C” and a suffix “00.” The suffix can be used to accommodate composition variations of the base alloy.

⁴ 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.

⁵ The last approved version of this historical standard is referenced on www.astm.org.

⁶ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms related to copper and copper alloys, refer to Terminology **B846**.

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~~; issue;
- 4.1.2 Copper UNS No. designation, if required, (see Chemical Composition ~~section~~); section);
- 4.1.3 Temper (see Temper section and Table ~~2~~); 2);
- 4.1.4 Pipe size, regular or ~~extra-strong~~; extra-strong (see Dimensions section and Table ~~3~~); 3);
- 4.1.5 Length (see **10.3**) if different than ~~standard~~; standard; and
- 4.1.6 ~~Total length of each size~~; Quantity—total weight, or total length or number of pieces of each size.

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

- 4.2.1 If product is ordered for ASME Boiler and Pressure Vessel Code Application (See Certification ~~Section~~); Section);
- 4.2.2 If product is required for bending (see **6.2**) and the temper to be ~~furnished~~; furnished;
- 4.2.3 Certification, if required (see Certification ~~section~~); section);
- 4.2.4 Test report, if required (see Test Report ~~section~~); section);
- 4.2.5 Hydrostatic test, if required (see Nondestructive Testing ~~section~~); section);
- 4.2.5.1 If hydrostatic test pressure above 1000 psi is ~~required~~; required;
- 4.2.6 Pneumatic test, if required (see Nondestructive Testing ~~section~~); section);
- 4.2.7 If product is purchased for agencies of the U.S. Government (see the Other Requirements section of this ~~specification~~; specification); and
- 4.2.8 If specification number is required to be shown on each shipping unit (see Packaging and Package Marking ~~section~~); section).

5. Chemical Composition

5.1 The material shall conform to the following chemical requirements:

Copper (incl silver), min, %	99.9
Phosphorus, max, %	0.04

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

5.2 The pipe shall be produced from one of the following coppers, and unless otherwise specified, ~~anyone~~ any one of them is permitted to be furnished:

Copper UNS No.	Previously Used Designation	Type of Copper
C10200	OF	Oxygen-free without residual deoxidants
C10300		Oxygen-free, extra-low phosphorus
C10800		Oxygen-free, low phosphorus
C12000	DLP	Phosphorized, low residual phosphorus
C12200	DHP	Phosphorized, high residual phosphorus

5.3 When the copper UNS No. designation is specified, the material shall conform to the chemical requirements specified in **Table 1**.

5.4 These composition limits do not preclude the presence of other elements. By agreement between manufacturer or supplier and purchaser, limits may be established and analysis required for unnamed elements.

TABLE 1 Chemical Requirements

Copper UNS No.	Copper (incl Silver), min, %	Phosphorus, %
C10200 ^A	99.95	...
C10300	99.95 ^B	0.001 to 0.005
C10800	99.95 ^B	0.005 to 0.012
C12000	99.90	0.004 to 0.012
C12200	99.9	0.015 to 0.040

^A Oxygen in C10200 shall be 10 ppm max.

^B Copper + silver + phosphorus.

6. Temper

6.1 The standard tempers as prescribed in Classification **B601**, for products described in this specification are:

6.1.1 Annealed O61,

6.1.2 Light Drawn **H55H55**, and

6.1.3 Hard Drawn **H80H80**.

6.2 When pipe is required for bending, it shall be so specified in the purchase order, and the pipe shall be furnished in the temper agreed upon between the manufacturer or supplier and the purchaser.

7. Mechanical Property Requirements

7.1 *Tensile Strength Requirements:*

7.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in **Table 2**, when tested in accordance with Test Methods **E8/E8M**.

8. Performance Requirements

8.1 *Expansion Test:*

8.1.1 Pipe ordered in the annealed (O61) temper, selected for test, shall withstand an expansion of 25 % of the outside diameter when expanded in accordance with Test Method **B153**. The expanded pipe shall show no cracking or rupture visible to the unaided eye. Pipe ordered in the drawn tempers H55 or H80 are not subject to this test.

NOTE 1—The term “unaided eye,” as used herein, permits the use of corrective spectacles necessary to obtain normal vision.

8.2 *Flattening Test:*

8.2.1 As an alternative to the expansion test for pipe over ~~4 in.~~ **4 in.** (102 mm) in diameter in the annealed temper, a flattening test in accordance with Test Method **B968/B968M** shall be performed.

8.3 *Microscopical Examination:*

8.3.1 The pipe shall be made from copper that is free of cuprous oxide as determined by microscopical examination in accordance with Method A of Test Methods **B577** at a 75× magnification.

8.3.2 When Copper UNS No. C12200 is supplied, microscopical examination for cuprous oxide is not required.

9. Other Requirements

9.1 *Nondestructive Testing:*

9.1.1 The material shall be tested in the final size but is permitted to be tested before the final anneal or heat treatment, when these thermal treatments are required, unless otherwise agreed upon by the manufacturer or supplier and purchaser.

9.2 *Eddy-Current Test*—Each piece of material from ~~1/8 in.~~ **1/8 in.** up to and including ~~2 1/2 in.~~ **2 1/2 in.** nominal outside diameter, or within the capabilities of the eddy-current tester, shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice **E243**, except for determination of “end effect.” The material shall be passed through an eddy-current testing unit adjusted to provide information on the suitability of the material for the intended application.

9.2.1 Notch-depth standards rounded to the nearest 0.001 in. (0.025 mm) shall be 10 % of the nominal wall thickness. The notch depth tolerance shall be ±0.0005 in. (0.013 mm). Alternatively, when a manufacturer uses speed-insensitive equipment that allows the selection of a maximum imbalance signal, a maximum imbalance signal of 0.3 % is permitted to be used.

9.2.2 Material that does not actuate the signaling device of the eddy-current test shall be considered as conforming to the requirements of this test. Material with discontinuities indicated by the testing unit is permitted to be ~~reexamined~~ **re-examined** or retested, at the option of the manufacturer, to determine whether the discontinuity is cause for rejection. Signals that are found to have been caused by minor mechanical damage, soil, or moisture shall not be cause for rejection of the material provided the dimensions of the material are still within prescribed limits and the material is suitable for its intended application.

TABLE 2 Tensile Requirements

Temper Designation		Pipe Size Nominal or Standard, in.	Tensile Strength,	Yield Strength, ^C
Code	Name		min, ksi ^A (MPa) ^B	min. ksi ^A (MPa) ^B
O61	annealed	all	30 (205)	9 (60) ^D
H80	hard drawn	1/8 –2, incl	45 (310)	40 (275)
H80	hard drawn	over 2	38 (260)	32 (220)
H55	light drawn	2–12, incl	36 (250)	30 (205)

^A ksi = 1000 psi.

^B See **Appendix X1**.

^C At 0.5 % extension under load.

^D Light-straightening operation is permitted.

9.3 *Hydrostatic Test*—When specified, the material shall stand, without showing evidence of leakage, an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 6000 psi (41 MPa), determined by the following equation for thin hollow cylinders under tension. The material need not be tested at a hydrostatic pressure of over 1000 psi (6.9 MPa) unless so specified.

$$P = 2St/(D - 0.8t) \tag{1}$$

where:

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

9.4 *Pneumatic Test*—When specified, the material shall be subjected to an internal air pressure of 60 psi (415 kPa) minimum for 5 s without showing evidence of leakage. The test method used shall permit easy visual detection of any leakage, such as by having the material under water or by the pressure-differential method. Any evidence of leakage shall be cause for rejection.

9.5 *Purchases for U.S. Government*—If the product is purchased for agencies of the U.S. Government, when specified in the contract or purchase order, the product furnished shall conform to the conditions specified in the Supplementary Requirements of this specification.

10. Dimensions and Permissible Variations

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

10.2 *Standard Dimensions, Wall Thickness, and Diameter Tolerances*—The standard dimensions, wall thickness, and diameter tolerances shall be in accordance with [Table 3](#).

10.3 *Length and Length Tolerances*—The standard length of copper pipe is 12 ft (3.66 m) with a tolerance of $\pm 1/2$ in. (~~± 13 mm~~); (13 mm).

10.4 *Roundness:*

10.4.1 For pipe of H (drawn) tempers in straight lengths, the roundness tolerances shall be as follows:

t/d (ratio of Wall Thickness to Outside Diameter)	Roundness Tolerances as Percent of Outside Diameter (Expressed to the Nearest 0.001 in. (0.025 mm))
0.01 to 0.03, incl	1.5
Over 0.03 to 0.05, incl	1.0
Over 0.05 to 0.10, incl	0.8
Over 0.10	0.7

10.4.2 Compliance with the roundness tolerance shall be determined by taking measurements on the outside diameter only, irrespective of the manner in which the pipe dimensions are specified.

10.4.3 The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube.

10.5 *Squareness of Cut*—The departure from squareness of the end of any pipe shall not exceed the following:

Outside Diameter, in. (mm)	Tolerance
Up to $5/8$ (15.9), incl	0.010 in. (0.25 mm)
Over $5/8$ (15.9)	0.016 in./in. (0.016 mm/mm) of diameter

10.6 *Straightness Tolerance*—For pipe of H (drawn) tempers of ~~Nominal Pipe Sizes~~ nominal pipe sizes from $1/4$ to 12 in. inclusive, the maximum curvature (depth of arc) shall not exceed $1/2$ in. (~~13 mm~~) (13 mm) in any ~~10-ft~~ 10 ft portion of the total length. For H temper pipe of other sizes, and for the O61 (annealed) temper, no numerical values are ~~established~~ established; however, the straightness of the pipe shall be suitable for the intended application.

11. Workmanship, Finish, and Appearance

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

12. Sampling

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

TABLE 3 Standard Dimensions, Weights, and Tolerances

NOTE 1—All tolerances plus and minus except as otherwise indicated.

Nominal or Standard Pipe Size, in.	Outside Diameter, in. (mm)	Average Outside Diameter Tolerance, ^A in. (mm) All Minus	Wall Thickness, in. (mm)	Tolerance, ^B in. (mm)	Theoretical Weight, lb/ft (kg/m)
Regular					
1/8	0.405 (10.3)	0.004 (0.10)	0.062 (1.57)	0.004 (0.10)	0.259 (0.385)
1/4	0.540 (13.7)	0.004 (0.10)	0.082 (2.08)	0.005 (0.13)	0.457 (0.680)
3/8	0.675 (17.1)	0.005 (0.13)	0.090 (2.29)	0.005 (0.13)	0.641 (0.954)
1/2	0.840 (21.3)	0.005 (0.13)	0.107 (2.72)	0.006 (0.15)	0.955 (1.42)
3/4	1.050 (26.7)	0.006 (0.15)	0.114 (2.90)	0.006 (0.15)	1.30 (1.93)
1	1.315 (33.4)	0.006 (0.15)	0.126 (3.20)	0.007 (0.18)	1.82 (2.71)
1 1/4	1.660 (42.2)	0.006 (0.15)	0.146 (3.71)	0.008 (0.20)	2.69 (4.00)
1 1/2	1.900 (48.3)	0.006 (0.15)	0.150 (3.81)	0.008 (0.20)	3.20 (4.76)
2	2.375 (60.3)	0.008 (0.20)	0.156 (3.96)	0.009 (0.23)	4.22 (6.28)
2 1/2	2.875 (73.0)	0.008 (0.20)	0.187 (4.75)	0.010 (0.25)	6.12 (9.11)
3	3.500 (88.9)	0.010 (0.25)	0.219 (5.56)	0.012 (0.30)	8.76 (13.0)
3 1/2	4.000 (102)	0.010 (0.25)	0.250 (6.35)	0.013 (0.33)	11.4 (17.0)
4	4.500 (114)	0.012 (0.30)	0.250 (6.35)	0.014 (0.36)	12.9 (19.2)
5	5.562 (141)	0.014 (0.36)	0.250 (6.35)	0.014 (0.36)	16.2 (24.1)
6	6.625 (168)	0.016 (0.41)	0.250 (6.35)	0.014 (0.36)	19.4 (28.9)
8	8.625 (219)	0.020 (0.51)	0.312 (7.92)	0.022 (0.56)	31.6 (47.0)
10	10.750 (273)	0.022 (0.56)	0.365 (9.27)	0.030 (0.76)	46.2 (68.7)
12	12.750 (324)	0.024 (0.61)	0.375 (9.52)	0.030 (0.76)	56.5 (84.1)
Extra Strong					
1/8	0.405 (10.3)	0.004 (0.10)	0.100 (2.54)	0.006 (0.15)	0.371 (0.552)
1/4	0.540 (13.7)	0.004 (0.10)	0.123 (3.12)	0.007 (0.18)	0.625 (0.930)
3/8	0.675 (17.1)	0.005 (0.13)	0.127 (3.23)	0.007 (0.18)	0.847 (1.26)
1/2	0.840 (21.3)	0.005 (0.13)	0.149 (3.78)	0.008 (0.20)	1.25 (1.86)
3/4	1.050 (26.7)	0.006 (0.15)	0.157 (3.99)	0.009 (0.23)	1.71 (2.54)
1	1.315 (33.4)	0.006 (0.15)	0.182 (4.62)	0.010 (0.25)	2.51 (3.73)
1 1/4	1.660 (42.2)	0.006 (0.15)	0.194 (4.93)	0.010 (0.25)	3.46 (5.15)
1 1/2	1.900 (48.3)	0.006 (0.15)	0.203 (5.16)	0.011 (0.28)	4.19 (6.23)
2	2.375 (60.3)	0.008 (0.20)	0.221 (5.61)	0.012 (0.30)	5.80 (8.63)
2 1/2	2.875 (73.0)	0.008 (0.20)	0.280 (7.11)	0.015 (0.38)	8.85 (13.2)
3	3.500 (88.9)	0.010 (0.25)	0.304 (7.72)	0.016 (0.41)	11.8 (17.6)
3 1/2	4.000 (102)	0.010 (0.25)	0.321 (8.15)	0.017 (0.43)	14.4 (21.4)
4	4.500 (114)	0.012 (0.30)	0.341 (8.66)	0.018 (0.46)	17.3 (25.7)
5	5.562 (141)	0.014 (0.36)	0.375 (9.52)	0.019 (0.48)	23.7 (35.3)
6	6.625 (168)	0.016 (0.41)	0.437 (11.1)	0.027 (0.69)	32.9 (49.0)
8	8.625 (219)	0.020 (0.51)	0.500 (12.7)	0.035 (0.89)	49.5 (73.7)
10	10.750 (273)	0.022 (0.56)	0.500 (12.7)	0.040 (1.0)	62.4 (92.9)

^A The average outside diameter of a tube is the average of the maximum and minimum outside diameters as determined at any one cross section of the pipe.

^B Maximum deviation at any one point.

 12.1.1 *Lot Size*—The lot size shall be as follows:

Pipe Size, in.	Lot Weight, lb (kg)
Up to 1 1/2, incl	5 000 (2270) or fraction thereof
Over 1 1/2 to 4, incl	10 000 (4550) or fraction thereof
Over 4	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:

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

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

13. Number of Tests and Retests

13.1 *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 that is to be divided into three equal parts shall be 150 g.

13.1.1 Instead of sampling in accordance with Practice E255, 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. 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:

13.1.1.1 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.

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

13.1.1.3 Because of 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.

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

13.2 Retests:

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

13.2.2 If a bend test specimen fails because of conditions of bending more severe than required by the specification, a retest shall be permitted on a new sample piece or on the remaining portion of the first sample piece.

13.2.3 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 tests 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.

13.2.4 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 12.1. The results of this retest shall comply with the specified requirements.

14. Test Methods

14.1 Chemical Analysis:

14.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement:

Test	ASTM Designation ^A
Chemical analysis	B170^B , E53, E62, E478
Chemical analysis	B170, ^B E53, E62, E478

^A See 2.1.

^B Reference to Specification B170 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 B170 annex will be eliminated.

14.1.2 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 purchaser.

14.2 The product furnished shall conform to the specified requirements when subjected to test in accordance with the following applicable test methods:

Test	ASTM Designation ^A
Tensile Strength	E8/E8M
Expansion (pin test)	B153
Eddy current	E243
Microscopical Examination	B577
Flattening Test	B968/B968M

^A See 2.1.