Designation: B467 – 14

Standard Specification for Welded Copper-Nickel Pipe[1]

This standard is issued under the fixed designation B467; 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 welded copper-nickel alloy pipe for general engineering purposes. The following alloys are covered:[2]

Copper Alloy UNS No.[2]	Type of Metal
C70600	90-10 copper-nickel
C70620	90-10 copper-nickel (Modified for Welding)
C71500	70-30 copper-nickel
C71520	70-30 copper-nickel (Modified for Welding)

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

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

B950 Guide for Editorial Procedures and Form of Product Specifications 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

E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[4]

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[4]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

2.2 *Other Documents:*[5]

American Welding Society Specification A5.6

American Welding Society Specification A5.7

3. Terminology

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

4. Types of Welded Pipe

4.1 *As-Welded*—Pipe that has been welded with no further work performed other than straightening or cutting to length, or both.

4.2 *Welded and Annealed*—Welded pipe that has been annealed to produce a uniform grain size appropriate to the specified annealed temper.

4.3 *Welded and Cold Drawn*—Welded pipe with internal flash removed by scarfing, and subsequently cold drawn to conform to the specified temper.

4.4 *Fully Finished*—Welded pipe with internal and external flash removed by scarfing and the pipe or tube subsequently cold drawn over a mandrel and annealed as necessary to conform to the specified temper.

5. Ordering Information

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

5.1.1 ASTM designation and year of issue,

5.1.2 Copper Alloy UNS No. (Section 1 and Table 1),

5.1.3 Temper (Section 8),

[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] The UNS system for copper and copper alloys 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.

[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.

[5] Available from American Welding Society (AWS), 8669 NW 36 Street, #130, Miami, FL 33166-6672, http://www.aws.org.

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

TABLE 1 Chemical Requirements

Element	Composition, %						
Copper or Copper Alloy by UNS No	Copper (incl silver)	Nickel (incl Cobalt)	Lead, max	Iron	Zinc, max	Manganese	Other Named Alloys
C70600[A]	Remainder	9.0–11.0	0.05	1.0–1.8	1.0	1.0	
C70620[A]	86.5 min	9.0–11.0	.02	1.0–1.8	.50	1.0	C .05 max P .02 max S .02 max
C71500[A]	Remainder	29.0–33.0	0.05	.40–1.0	1.0	1.0	
C71520[A]	65.0 min	29.0–33.0	.02	.40–1.0	.50	1.0	C .05 max P .02 max S .02 max

[A]Cu + Sum of Named Elements, 99.5 % min.

5.1.4 Dimensions: diameter and wall thickness (12.2 and 12.3),
5.1.5 Lengths: whether specific or stock (12.4),
5.1.6 Quantity of each size,
5.1.7 If the product is to be subsequently welded,
5.1.8 Packaging and Package Marking (Section 23), and
5.1.9 Intended application.

5.2 The following options are available but may not be included unless specified at the time of placing the order when required.
5.2.1 Heat identification or traceability requirements, or both (see 14.2.1.4).
5.2.2 Certifications (see Section 21).
5.2.3 Test report (see Section 22).
5.2.4 Radiographic examination: whether or not required (see Section 11),
5.2.5 Source inspection: Whether or not required (19.2),
5.2.6 Hydrostatic test (see 11.3),
5.2.7 When product is ordered for ASME Boiler & Pressure Vessel Code Application,[6]
5.2.8 Type of *flash* to be furnished (6.3),
5.2.9 Pneumatic Test (see 11.3.2).

6. Materials and Manufacture

6.1 *Material:*
6.1.1 The material of manufacture shall be strip of one of the Copper Alloy UNS Nos. listed in 1.1 of such purity and soundness as to be suitable for processing into the products prescribed herein.
6.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

6.2 *Manufacture:*
6.2.1 The product shall be manufactured by forming the material into a tubular shape and welded on a suitable forming mill.

6.3 *Flash:*
6.3.1 If the pipe is made by the high-frequency welding process, the external flash shall always be removed. The internal flash shall be treated as one of the following:
6.3.1.1 *IFI*—Internal flash to remain in the "as-welded" condition,
6.3.1.2 *IFR*—Internal flash to be removed by scarfing, or
6.3.1.3 *IFD*—Internal flash to be displaced.
6.3.2 Unless otherwise specified, the IFI condition will be furnished.

6.4 *Filler Material:*
6.4.1 Filler material, if used in the welding process, shall conform to Classification ECuNi of AWS Specification A5.6 or RCuNi of AWS Specification A5.7.

7. Chemical Composition

7.1 The material shall conform to the chemical requirements specified in Table 1.

7.2 These specification limits do not preclude the presence of other elements. Limits for unnamed elements may be established by agreement between manufacturer or supplier and purchaser.
7.2.1 For copper alloys in which copper is specified as the remainder, copper may be taken as the difference between the sum of all the elements analyzed and 100 %.
7.2.1.1 When all the elements in Table 1 are analyzed, their sum shall be 99.5 % minimum.

8. Temper

8.1 Tempers, as defined in Classification B601 and this specification, are as follows:
8.1.1 The pipe shall be supplied in any one of the following tempers as specified and shall meet the mechanical requirements of Table 2, Table 3, or Table 4:

TABLE 2 Mechanical Requirements of As-Welded and Fully Finished Pipe When Furnished in the Annealed Temper (WO61)

Copper Alloy UNS No.	Outside Diameter, in. (mm)	Tensile Strength, min, ksi[A] (MPa)[B]	Yield Strength at 0.5 % Extension Under Load, min, ksi[A] (MPa)[B]	Elongation in 2 in. (50.8 mm), min, %
C70600	up to 4½ (114), incl	40 (275)	15 (105)	25.0
	over 4½ (114)	38 (260)	13 (90)	25.0
C70620	up to 4½ (114), incl	40 (275)	15 (105)	25.0
	over 4½ (114)	38 (260)	13 (90)	25.0
C71500	up to 4½ (114), incl	50 (345)	20 (140)	30.0
	over 4½ (114)	45 (310)	15 (105)	30.0
C71520	up to 4½ (114), incl	50 (345)	20(140)	30.0
	over 4½ (114)	45 (310)	15 (105)	30.0

[A] ksi = 1000 psi.
[B] See Appendix X2.

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

TABLE 3 Mechanical Requirements of Welded and Cold-Drawn and Fully Finished Pipe in Drawn Tempers

Copper Alloy UNS No.	Outside Diameter, in. (mm)	Tensile Strength, min, ksi[A] (MPa)[B]	Yield Strength at 0.5 % Extension Under Load, min, ksi[A] (MPa)[B]	Elongation in 2 in. (50.8 mm), min, %
C71500	up to 2 (50.8), incl, for wall thicknesses up to 0.048 (1.21 mm), incl.	72 (495)	50 (345)	12.0
	for wall thicknesses over 0.048 in. (1.21 mm)	72 (495)	50 (345)	15.0
C71520	up to 2 (50.8), incl, for wall thicknesses up to 0.048 (1.21 mm), incl.	72 (495)	50 (345)	12.0
	for wall thicknesses over 0.048 in. (1.21 mm)	72 (495)	50 (345)	15.0

[A] ksi = 1000 psi.
[B] See Appendix X2.

TABLE 4 Mechanical Requirements of As-Welded Pipe

Copper Alloy UNS No.	Condition	Outside Diameter, in. (mm)	Tensile Strength, min, ksi (MPa)	Yield Strength at 0.5 % Extension Under Load, min, ksi (MPa)
C70600	welded from annealed strip	up to 4½ (114), incl	45 (310)	30 (205)
	welded from cold-rolled strip	up to 4½ (114), incl	54 (375)	45 (310)
C70620	welded from annealed strip	up to 4½ (114), incl	45 (310)	30 (205)
	welded from cold-rolled strip	up to 4½ (114), incl	54 (375)	45 (310)

8.1.1.1 As welded from annealed sheet, strip, or plate (WM50),

8.1.1.2 As welded from cold-worked sheet, strip, or plate (WM00, WM01, WM02, etc.).

8.1.1.3 Welded and light annealed (WO50),

8.1.1.4 Welded and cold drawn in either light drawn, eight hard (Copper Alloy UNS No. C70600 and C70620 only) or hard drawn and stress relieved (WR00), (WR04), or

8.1.1.5 Fully finished welded and annealed (WO61).

9. Mechanical Property Requirements

9.1 *Tensile Strength Requirements:*

9.1.1 Product furnished under this specification shall conform to the tensile and yield strength requirements prescribed in Table 2, Table 3, or Table 4 when tested in accordance with Test Methods E8/E8M.

10. Performance Requirements

10.1 *Expansion Test Requirements:*

10.1.1 The annealed pipe shall be capable of (see 8.1.1.1 and 8.1.1.3) being expanded in accordance with Test Method B153 to 30 % of its outside diameter. Pipe supplied in the "as welded" condition shall be expanded to 20 % of its outside diameter.

10.1.2 The annealed ends of pipe furnished end annealed shall be capable of being expanded 30 % of its outside diameter in accordance with Test Method B153.

10.1.3 The expanded tube area shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

10.1.4 Pipe furnished in other tempers is not subject to this test

10.2 *Flattening Test Alternative:*

10.2.1 As an alternative to the expansion test for product over 4 in. (102 mm) in diameter, the flattening test described in the Test Method section in Test Method B968/B968M may be performed.

11. Nondestructive Tests for Pipe

11.1 *Radiographic Examination*—Radiographic examination of the welds shall be as agreed upon.

11.2 *Eddy-Current Test*—Each pipe of nominal outside diameter within the capabilities of the eddy-current tester shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice E243. The pipe shall be passed through an eddy-current testing unit adjusted to provide information on the suitability of the material for the intended application.

11.2.1 Notch depth standards rounded to the nearest 0.001 in. (0.025 mm) shall be 22 % of the nominal wall thickness. The notch depth tolerance shall be ±0.0005 in. (0.013 mm).

11.2.1.1 Pipe that does not actuate the signaling device of the eddy-current tester shall be considered as conforming to the requirements of this test. Pipe with discontinuities indicated by the testing unit may be reexamined 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 pipe, provided the dimensions are still within prescribed limits and the pipe is suitable for its intended application.

11.2.2 As an alternate to the Eddy Current test, the manufacturer shall have the option to perform a Hydrostatic Test (11.3.1).

11.3 *Hydrostatic Test Alternative*—As an alternative to the eddy current test for tubes above 2.000 in. (50.8 mm), the manufacturer shall have the option to perform the hydrostatic test to the tests described in 11.3.1 and 11.3.2.

11.3.1 *Hydrostatic Test*—When specified, the pipe shall withstand, without showing weakness or defects, 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 tension. The pipe need not be tested at a hydrostatic pressure of over 1000 psig (7 MPa), unless so specified.

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

where:

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

11.3.2 *Pneumatic Test*—When specified, the pipe shall be subjected to an internal air pressure of 60 psig (400 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 pipe under water or by the pressure-differential method. Any evidence of leakage shall be cause for rejection.

12. Dimensions, Mass, and Permissible Variations

12.1 For purposes 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.

NOTE 1—Blank spaces in the tolerance tables indicate that the material is not generally available or that no tolerance has been established (see Appendix X1).

12.2 *Outside Diameter Tolerances:*

12.2.1 The outside diameter for pipe furnished "as-welded," "as-welded and drawn," and "as-welded fully finished" shall conform to the tolerances in Table 5 except as noted in 12.2.2.

12.2.2 These outside diameter tolerances shall not apply to the "as-welded" pipe when measured across that portion which contains the weld zone.

12.3 *Wall Thickness Tolerances:*

12.3.1 The wall thickness of pipe furnished in drawn tempers or as fully finished shall conform to the tolerances shown in Table 6, except as noted in 12.3.2 and 12.3.3.

12.3.2 The tolerances of Table 6 shall not apply to that portion of the "as-welded" wall which contains the weld flash or bead.

12.3.3 The tolerances of Table 6 shall be increased by 100 % for that portion of the "as-welded" wall which contains the weld zone.

12.4 *Lengths and Tolerances:*

12.4.1 Pipe in straight lengths shall be furnished in stock lengths with ends included unless the order requires specific lengths or specific lengths with ends.

12.4.2 The tolerances for pipe furnished in straight lengths shall be as shown in Table 7.

12.4.3 The schedule for pipe furnished with specific or stock lengths with ends shall be in accordance with Table 8.

12.5 *Squareness of Cut*—The departure from squareness of the end of any pipe shall not exceed 0.016 in./in. (0.406 mm/mm) of diameter.

TABLE 5 Average Outside Diameter[A] Tolerances

Specified Diameter, in. (mm)	Tolerances, plus and minus,[B] in. (mm) for Pipe of Copper Alloy UNS Nos. C70600, C71000, C71500
Over 2 to 3 (50.8 to 76.2), incl	0.005 (0.13)
Over 3 to 4 (76.2 to 102), incl	0.006 (0.15)
Over 4 to 5 (102 to 127), incl	0.008 (0.20)
Over 5 to 6 (127 to 152), incl	0.009 (0.23)
Over 6 to 8 (152 to 203), incl	0.010 (0.25)
Over 8 to 10 (203 to 254), incl	0.013 (0.33)
Over 10 to 12 (254 to 305), incl	0.015 (0.38)
Over 12 (305)	0.5 %

[A] The average outside diameter of a pipe is the average of the maximum and minimum outside diameters, as determined at any one cross section.
[B] If tolerances all plus or all minus are desired, double the values given.

12.6 *Roundness*—The difference between the major and minor diameter of pipe as determined at any one cross section shall not exceed 3 % of the nominal outside diameter.

13. Workmanship, Finish, and Appearance

13.1 Roundness, straightness, uniformity of the wall thickness, and inner and outer surface of the tube shall be such as to make it suitable for the intended application. Unless otherwise specified on the purchase order, the cut ends of the tubes shall be deburred by use of a rotating wire wheel or other suitable tool.

13.2 The product shall be clean and free from defects, but blemishes of a nature that do not interfere with the intended application are acceptable. Annealed temper tubes may have a dull iridescent film on both the inside and outside surface, and drawn temper tubes may have a superficial film of drawing lubricant on the surfaces.

14. Sampling

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

14.1.1 *Lot Size:*

Outside Diameter, in. (mm)	Lot Size, lb (kg)
Up to 4 (102) (102), incl	10 000 (4550)
Over 4 (102)	20 000 (9100)

14.1.2 *Portion Size:*

No. of Pieces in Lot	No. of Sample Pieces to Be Taken
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of the total number of pieces in the lot

14.2 *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 14.1.2 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.

14.2.1 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:

14.2.1.1 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.

14.2.1.2 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.