



Standard Specification for Welded Copper-Alloy Pipe¹

This standard is issued under the fixed designation B 608; 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 arc-welded pipe for use in brackish water or seawater piping systems.

1.2 Values stated in inch-pound units are the standard. SI values given in parentheses and in the tables are for information only.

1.3 The following hazard statement pertains only to the test method described in 8.2 and 14.3.2 of 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:

B 169 Specification for Aluminum Bronze Plate, Sheet, Strip, and Rolled Bar²

B 171 Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers²

E 8 Test Methods for Tension Testing of Metallic Materials³

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁴

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)⁵

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys⁵

E 190 Test Method for Guided Bend Test for Ductility of Welds³

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition⁵

E 478 Test Methods for Chemical Analysis of Copper Alloys⁵

2.2 AWS Standards:⁶

A 5.7 Copper and Copper-Alloy Arc-Welding Electrodes

A 5.7 Copper and Copper-Alloy Welding Rods

2.3 ASME Standards:⁷

Boiler and Pressure Vessel Code, Nuclear Power Plant Components, Section III, Division I

Boiler and Pressure Vessel Code, Nondestructive Examination, Section V

Boiler and Pressure Vessel Code, Pressure Vessels, Section VIII, Division I

Boiler and Pressure Vessel Code, Welding Qualifications, Section IX

3. Terminology

3.1 Definitions:

3.1.1 *arc-welding, n*—a group of welding processes wherein coalescence is produced by heating with an electric arc or arcs, with or without the application of pressure and with or without the use of filler metal.

3.1.2 *as-welded condition, n*—the result of forming annealed sheet or plate into tubular form and welding without subsequent heat treatment or cold work.

3.1.3 *base metal, n*—the sheet or plate from which the pipe is formed.

3.1.4 *weld reinforcement, n*—the portion of the welded joint which extends beyond the inner and outer surface of the base metal of the welded pipe.

3.2 Terms Specific to This Specification:

3.2.1 *capable of, adj*—possessing the required properties or characteristics, or both, necessary to conform to specification requirements when subjected to specified test(s).

3.2.2 *rehearing, n*—a petition by the manufacturer or supplier to the purchaser, as a result of material rejection, for additional testing to be conducted by the manufacturer or supplier and the purchaser. Identical samples of the product are to be tested by both parties using a method(s) specified in the product specification. Alternatively, upon agreement of both parties, an independent laboratory may be selected for the tests using the specified methods.

4. Ordering Information

4.1 Contracts or purchase orders for product furnished under this specification should include the following information:

⁷ Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

¹ This specification is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

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² Annual Book of ASTM Standards, Vol 02.01.

³ Annual Book of ASTM Standards, Vol 03.01.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ Annual Book of ASTM Standards, Vol 03.05.

⁶ Available from the American Welding Society, 2501 North West 7th Street, Miami, FL 33125.

4.1.1 ASTM specification designation and year of issue, (for example, B 608 – XX),

4.1.2 Copper alloy UNS No. required (Section 5 and Table 1),

4.1.3 Dimensions required; diameter and wall thickness (Section 10),

4.1.4 Unit length required, and

4.1.5 When purchased for *ASME Boiler and Pressure Vessel Code* application.

4.2 The following options are available:

4.2.1 Determination of chemical composition (Section 6.1.1),

4.2.2 Guided bend test (Section 8.1),

4.2.3 Hydrostatic test (Section 8.2),

4.2.4 Radiographic examination (Section 8.3),

4.2.4.1 The number of pipe lengths to be examined,

4.2.5 Liquid penetration examination (Section 8.4),

4.2.6 Weld reinforcement removal, (Section 8.5),

4.2.7 Certification (Section 18), and

4.2.8 Test Report (Section 19).

5. Material and Manufacture

5.1 Material:

5.1.1 The pipe shall be made from annealed copper alloy sheet or plate that conforms to the requirements of Specification B 169 for Copper Alloys UNS Nos. C61300 and C61400 or Specification B 171 for Copper Alloys UNS Nos. C70600 and C71500.

5.2 Manufacture:

5.2.1 Welded joints shall be made either manually or automatically by an arc welding process.

5.2.2 Filler metal, if used in an arc-welding process, shall conform to one of the following specifications and classifications shown for each base metal:

Base Metal Copper Alloy UNS Number	Filler Metal AWS Specification	
	A5.6	A5.7
C61300	ECuAl-A2	ERCuAl-A2
C61400	ECuAl-A2	ERCuAl-A2
C70600	ECuNi	ERCuNi
C71500	ECuNi	ERCuNi

5.2.3 Welding procedures and welding operators shall be qualified in accordance with the *ASME Boiler and Pressure Vessel Code*, Section IX.

5.2.4 Each length of pipe may contain more than one longitudinal welded joint.

5.2.4.1 The welded joint shall be a full-penetration weld and may have a reinforcing bead on each side; such reinforcement

shall not be more than 1/16 in. (1.6 mm) per side measured in the radial direction.

5.2.4.2 At no place shall the thickness of the weld section be less than the thickness of the adjacent base metal.

5.2.4.3 The contour of the weld bead shall be smooth, having no sharp valley or groove at the weld center or edges.

5.2.4.4 Smooth concavity of the weld bead contour is acceptable provided the minimum weld bead thickness is not less than the thickness of the adjacent base metal.

5.2.4.5 Any offset of base metal edges at a weld that is within the tolerance of 9.2.7 shall be faired at a 3 to 1 minimum taper over the width of the finished weld, or if necessary, by adding additional weld metal beyond what would otherwise be the edge of the weld. Such build-up welding shall be performed in accordance with the requirements of 5.2.3.

5.2.4.6 Weld reinforcement may be removed at the option of the manufacturer or when specified by the purchaser.

5.2.5 Weld defects shall be repaired by removal to sound metal and rewelding. A repaired weld shall meet all requirements of an original weld.

5.2.6 Base metal defects such as slivers, inclusions or laps shall be repaired by removal to sound metal. Build-up welding shall be performed when such removal reduces the wall thickness below the minimum allowed by the specification. Such build-up welding shall be performed in accordance with the requirements of 5.2.3. The thickness of the repaired section shall meet the requirements of a welded joint.

5.2.7 Pipe shall be furnished in the as-welded condition (Section 3).

NOTE 1—Although no restriction is placed on the size of pipe that may be furnished under this specification, usage is normally limited to normal sizes 4 in. (101 mm) and larger in diameter.

6. Chemical Composition

6.1 The pipe material shall conform to the requirements of Table 1 for the specified alloy.

6.1.1 When the material of manufacturer has been certified to conform to the requirements of the strip specification to which it was ordered, the determination of composition is not required of the tube manufacturer or supplier unless specified in the contract or purchase order.

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

6.3 When determining composition, copper may be taken as

TABLE 1 Chemical Requirements

Composition, %											
Copper Alloy UNS Number	Copper ^A	Nickel incl Cobalt	Aluminum	Lead, max	Iron	Zinc, max	Manganese, max	Sulfur, max	Phosphorus, max	Carbon, max	Tin
C61300 ^B	remainder	0.15 max	6.0–7.5	0.01	2.0–3.0	0.10	0.20	...	0.015	...	0.20–0.50
C61400	remainder	...	6.0–8.0	0.01	1.5–3.5	0.20	1.0	...	0.015
C70600	remainder	9.0–11.0	...	0.02	1.0–1.8	0.50	1.0	0.02	0.02	0.05	...
C71500	remainder	29.0–33.0	...	0.02	0.4–1.0	0.50	1.0	0.02	0.02	0.05	...

^A Silver counting as copper.

^B 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.

the difference between the sum of results for specified elements and 100 %.

6.4 When all elements in Table 1 for the specified alloy are determined the sum of results shall be as follows:

Copper Alloy UNS No.	Copper Plus Specified Elements, Percent, %, Minimum
C61300	99.8
C61400, C70600, C71500	99.5

7. Mechanical Property Requirements

7.1 Transverse Tensional Strength:

7.1.1 With the test taken across any weld, the pipe shall be capable of conforming to the value given in Table 2 for the particular alloy.

8. Performance Requirements

8.1 Transverse Guided-Bend Test:

8.1.1 The transverse face and root guided bend test shall be taken with the weld in the center of the test specimen and there shall be no open defects exceeding 0.125 in. (3.18 mm) measured in any direction on the convex surface of the specimen when tested in accordance with Test Methods E 190. Cracks originating from corners of the specimen shall not be considered.

8.1.2 This test is not required unless specified in the contract or purchase order.

8.2 Hydrostatic Test:

8.2.1 Each length of pipe shall be capable of withstanding an internal hydrostatic pressure sufficient to produce a fiber stress of 7 000 psi (48 MPa) without showing evidence of weakness, defects, or leakage.

8.2.1.1 This requirement is not recommended for pipe with an outside diameter greater than 24 in. (610 mm).

8.2.2 No pipe size need be subjected to a pressure gage reading greater than 1 000 psi (6 900 kPa).

8.2.3 This test is not required unless specified in the contract or purchase order.

8.3 Radiographic Examination:

8.3.1 When specified in the contract or purchase order, pipe shall be examined in accordance with the procedure and acceptance criteria of the *ASME Boiler and Pressure Vessel Code*, Section III, Division 1, or Section VIII, Division 1, as specified.

8.3.1.1 The number of pipe lengths to be examined shall be specified by the purchaser.

8.3.2 All welded joints in any individual length of pipe shall be radiographed completely.

8.4 Liquid Penetration Examination:

8.4.1 When specified in the contract or purchase order, all welded joints in all lengths of pipe shall be examined, both the inside and outside surfaces, in accordance with the procedure and acceptance criteria of the *ASME Boiler and Pressure Vessel*

TABLE 2 Transverse Tensile Strength

Copper Alloy UNS Number	Tensile Strength, min, ksi (MPa) ^A
C61300	70 (485)
C61400	70 (485)
C70600	40 (275)
C71500	50 (345)

^A See Appendix X1.

Code, Section III, Division 1, or Section VIII, Division 1, as specified.

9. Weld Reinforcement Removal

9.1 When specified in the contract or purchase order, weld reinforcement shall be completely removed from the inside surface and outside surface longitudinal welded joints.

9.2 Weld thickness shall conform to wall thickness requirements after removal of reinforcement.

10. Dimensions and Permissible Variations

10.1 Dimensions:

10.1.1 Pipe diameter shall be specified as a nominal diameter in inches as shown in Table 3, Table 4, or Table 5.

10.1.2 Pipe wall thickness shall be that shown in Table 3, Table 4, or Table 5 for the diameter and pressure class specified.

10.1.3 If a pipe outside diameter or wall thickness, not specified in Table 3, Table 4, or Table 5 is desired, the diameter and the wall thickness shall be specified in decimal fractions of an inch.

TABLE 3 Standard Sizes and Wall Thickness
Copper Alloy UNS Nos. C61300 and C61400

Inch-Pound Units, Thickness, in.						
Nom-inal	Diameter, in.		Pressure Class, psi ^A			
	Outside	50	75	100	150	200
4	4.50	0.094	0.094	0.094	0.094	0.094
5	5.563	0.094	0.094	0.094	0.094	0.094
6	6.625	0.094	0.094	0.094	0.094	0.094
8	8.625	0.094	0.094	0.094	0.094	0.094
10	10.75	0.094	0.094	0.094	0.125	0.125
12	12.75	0.094	0.094	0.094	0.125	0.165
14	14.00	0.125	0.125	0.125	0.125	0.165
16	16.00	0.125	0.125	0.125	0.134	0.187
18	18.00	0.125	0.125	0.125	0.165	0.187
20	20.00	0.125	0.125	0.125	0.165	0.250
24	24.00	0.125	0.125	0.134	0.187	0.250
30	30.00	0.134	0.134	0.165	0.250	0.312
36	36.00	0.134	0.165	0.187	0.312	0.375
42	42.00	0.187	0.187	0.250	0.312	0.437
48	48.00	0.187	0.187	0.259	0.375	0.437

SI Units, Thickness, mm						
Nom-inal	Diameter, in.		Pressure Class, kPa ^A			
	Outside	345	517	689	1034	1379
4	4.50	2.38	2.38	2.38	2.38	2.38
5	5.563	2.38	2.38	2.38	2.38	2.38
6	6.625	2.38	2.38	2.38	2.38	2.38
8	8.625	2.38	2.38	2.38	2.38	2.38
10	10.75	2.38	2.38	2.38	3.18	3.18
12	12.75	2.38	2.38	2.38	3.18	4.19
14	14.00	3.18	3.18	3.18	3.18	4.19
16	16.00	3.18	3.18	3.18	3.40	4.76
18	18.00	3.18	3.18	3.18	4.19	4.76
20	20.00	3.18	3.18	3.18	4.76	6.35
24	24.00	3.18	3.18	3.40	4.76	6.35
30	30.00	3.40	3.40	4.19	6.35	7.94
36	36.00	3.40	4.19	4.76	7.94	9.53
42	42.00	4.76	4.76	6.35	7.94	11.1
48	48.00	4.76	4.76	6.35	9.53	11.1

^A Pressure ratings apply to any design temperature not exceeding 350°F (176°C). Pressure ratings are calculated for each size and pressure class based on a corrosion allowance of 0.020 in. (0.508 mm), a weld efficiency of 70 %, and the thickness tolerances shown in Table 8Table 8.

TABLE 4 Standard Sizes and Wall Thickness
Copper Alloy UNS No. C70600

Inch-Pound Units, Thickness, in.						
Diameter, in.		Pressure Class, psi ^A				
Nomi- nal	Outside	50	75	100	150	200
4	4.50	0.094	0.094	0.094	0.094	0.109
5	5.563	0.094	0.094	0.094	0.094	0.125
6	6.625	0.094	0.094	0.094	0.109	0.134
8	8.625	0.094	0.094	0.094	0.148	0.165
10	10.75	0.094	0.094	0.125	0.165	0.250
12	12.75	0.094	0.125	0.134	0.187	0.250
14	14.00	0.125	0.125	0.148	0.250	0.250
16	16.00	0.125	0.125	0.165	0.250	0.312
18	18.00	0.125	0.148	0.187	0.250	0.312
20	20.00	0.125	0.148	0.187	0.312	0.375
24	24.00	0.134	0.187	0.250	0.312	0.437
30	30.00	0.148	0.250	0.312	0.437	0.500
36	36.00	0.187	0.250	0.312	0.500	0.625
42	42.00	0.250	0.312	0.375	0.562	0.687
48	48.00	0.250	0.312	0.437	0.625	0.812

SI Units Thickness, mm						
Diameter, in.		Pressure Class, kPa ^A				
Nomi- nal	Outside	345	517	689	1034	1379
4	4.50	2.38	2.38	2.38	2.38	2.77
5	5.563	2.38	2.38	2.38	2.38	3.18
6	6.625	2.38	2.38	2.38	2.77	3.40
8	8.625	2.38	2.38	2.38	3.76	4.19
10	10.75	2.38	2.38	3.18	4.19	6.35
12	12.75	2.38	3.18	3.40	4.76	6.35
14	14.00	3.18	3.18	3.76	6.35	6.35
16	16.00	3.18	3.18	4.19	6.35	7.94
18	18.00	3.18	3.76	4.76	6.35	7.94
20	20.00	3.18	3.76	4.76	7.94	9.53
24	24.00	3.40	4.76	6.35	7.94	11.1
30	30.00	3.76	6.35	7.94	11.1	12.7
36	36.00	4.76	6.35	7.94	12.7	15.9
42	42.00	6.35	7.94	9.53	14.3	17.5
48	48.00	6.35	7.94	11.1	15.9	20.6

^A Pressure ratings apply to any design temperature not exceeding 150°F (65°C). Pressure ratings are calculated for each size and pressure class based on a corrosion allowance of 0.020 in. (0.508 mm), a weld efficiency of 70 %, and the thickness tolerances shown in Table 8.

10.1.4 Pipe shall be furnished in 12-ft (3.66-m) lengths unless otherwise specified.

10.1.5 Circumferential welds, of the same quality as the longitudinal welds, may be used to create pipe lengths that are ordered longer than 12 ft (3.66 m).

10.2 *Permissible Variations:*

10.2.1 *Outside Diameter*—The average outside diameter shall not vary from the specified outside diameter by more than the tolerances specified in Table 6.

10.2.2 *Roundness*—The difference between the major and minor outside diameter at any pipe cross section shall not be greater than the differences specified in Table 7.

10.2.3 *Wall Thickness*—The wall thickness at any point of the pipe shall not vary from the specified wall thickness by more than the tolerances specified in Table 8.

10.2.4 *Length*—The length of any pipe shall be the specified length plus or minus 0.500 in. (13 mm).

10.2.5 *Straightness*—The maximum curvature (depth of arc), when measured as a deviation from a straightedge 10 ft (3.05 m) in length, shall not exceed 0.5 in. (13 mm).

10.2.6 *Squareness of Cut*—The departure from squareness of the end of any pipe shall not exceed 0.016 in./in. (0.016

TABLE 5 Standard Sizes and Wall Thicknesses
Copper Alloy UNS No. C71500

Inch-Pound Units, Thickness, in.						
Diameter, in.		Pressure Class, psi ^A				
Nomi- nal	Outside	50	75	100	150	200
4	4.50	0.094	0.094	0.094	0.094	0.094
5	5.563	0.094	0.094	0.094	0.094	0.109
6	6.625	0.094	0.094	0.094	0.094	0.125
8	8.625	0.094	0.094	0.094	0.125	0.148
10	10.75	0.094	0.094	0.125	0.148	0.165
12	12.75	0.094	0.094	0.125	0.165	0.250
14	14.00	0.125	0.125	0.125	0.187	0.250
16	16.00	0.125	0.125	0.148	0.187	0.250
18	18.00	0.125	0.125	0.165	0.250	0.312
20	20.00	0.125	0.134	0.165	0.250	0.312
24	24.00	0.125	0.165	0.187	0.312	0.375
30	30.00	0.134	0.187	0.250	0.375	0.437
36	36.00	0.165	0.250	0.312	0.437	0.500
42	42.00	0.187	0.250	0.312	0.437	0.625
48	48.00	0.187	0.312	0.375	0.500	0.687

SI Units, Thickness, mm						
Diameter, in.		Pressure Class, kPa ^A				
Nomi- nal	Outside	345	517	689	1034	1379
4	4.50	2.38	2.38	2.38	2.38	2.38
5	5.563	2.38	2.38	2.38	2.38	2.77
6	6.625	2.38	2.38	2.38	2.38	3.18
8	8.625	2.38	2.38	2.38	3.18	3.76
10	10.75	2.38	2.38	3.18	3.76	4.19
12	12.75	2.38	2.38	3.18	3.18	4.19
14	14.00	3.18	3.18	3.18	3.18	4.76
16	16.00	3.18	3.18	3.76	4.76	6.35
18	18.00	3.18	3.18	4.19	6.35	7.94
20	20.00	3.18	3.40	4.19	6.35	7.94
24	24.00	3.18	4.19	4.76	7.94	9.53
30	30.00	3.40	4.76	6.35	9.53	11.1
36	36.00	4.19	6.35	7.94	11.1	12.7
42	42.00	4.76	6.35	7.94	11.1	15.9
48	48.00	4.76	7.94	9.53	12.7	17.5

^A Pressure ratings apply to any design temperature not exceeding 150°F (65°C). Pressure ratings are calculated for each size and pressure class based on a corrosion allowance of 0.020 in. (0.508 mm), a weld efficiency of 70 %, and the thickness tolerances shown in Table 8.

TABLE 6 Average Outside Diameter^A Tolerances, in. (mm)

Specified Outside Diameter	Tolerance, plus and minus
Up to 8.625 (219), incl	0.031 (0.79)
Over 8.625 to 18 (219 to 457), incl	0.063 (1.6)
Over 18 to 30 (457 to 762), incl	0.094 (2.4)
Over 30 to 48 (762 to 1220), incl	0.125 (3.2)
Over 48 (1220)	0.3 %

^A The average outside diameter of a pipe is the outside circumference at any one cross section of the pipe divided by 3.1416.

mm/mm) of outside diameter.

10.2.7 *Offset*—Radial misalignment of two edges to be butt welded shall not exceed the offset tolerances specified in Table 9.

11. Workmanship, Finish, and Appearance

11.1 *Workmanship:*

11.1.1 Roundness, straightness, ovality, and uniformity of contour shall be such as to make the product suitable for the intended application.

11.2 *Finish:*

11.2.1 The inner and outer surfaces shall be such as to make the product suitable for the intended application. Repaired

TABLE 7 Roundness^A Requirements

Specified Outside Diameter, in. (mm)	Roundness, % ^A
Up to 8.625 (219), incl	3.0
Over 8.625 to 18 (219 to 457), incl	2.5
Over 18 to 24 (457 to 610), incl	2.0
Over 24 to 48 (610 to 1220), incl	1.5
Over 48 (1220)	1.0

^A The roundness of a pipe is the difference between the major and minor outside pipe diameter, as determined at any one cross section, divided by the specified outside diameter and expressed in percent.

TABLE 8 Wall Thickness Tolerances,^A in. (mm)

Specified Wall Thickness	Tolerance, plus and minus
Up to 0.094 (2.38), incl	0.010 (0.25)
Over 0.094 to 0.134 (2.38 to 3.40), incl	0.014 (0.36)
Over 0.134 to 0.250 (3.40 to 6.35), incl	0.016 (0.41)
Over 0.250 to 0.500 (6.35 to 12.7), incl	0.023 (0.58)
Over 0.500 to 0.750 (12.7 to 19.1), incl	0.029 (0.74)
Over 0.750 to 1.000 (19.1 to 25.4), incl	0.037 (0.94)
Over 1.000 (25.4)	0.045 (1.10)

^A Maximum deviation at any point.

TABLE 9 Weld Offset Tolerances, in. (mm)

Specified Wall Thickness (t)	Radial Offset Longitudinal Circumferential	
	Weld	Weld
Up to 0.125 (3.18), incl	$\frac{1}{4} t$	$\frac{1}{4} t$
Over 0.125 to 0.250 (3.18 to 6.35), incl	0.032 (0.81)	0.032 (0.81)
Over 0.250 to 0.375 (6.35 to 9.53), incl	0.047 (1.20)	0.047 (1.20)
Over 0.375 to 0.500 (9.53 to 12.7), incl	0.063 (1.60)	0.063 (1.60)
Over 0.500 to 0.750 (12.7 to 19.1), incl	0.063 (1.60)	0.094 (2.40)
Over 0.750 (19.1)	0.094 (2.40)	0.125 (3.20)

areas conforming to the requirements of this specification shall be acceptable.

12. Sampling

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

12.1.1 *Lot Size*—A lot shall consist of the following quantity, or fraction thereof, of pipe of the same alloy UNS No., diameter and wall thickness manufactured at the same time:

Outside Diameter, in. (mm)	Lot Size, ft (m)
Up to 10.750 (273) incl	1000 (305)
Over 10.75 to 24 (273 to 610) incl	500 (152)
Over 24 to 36 (610 to 914)	200 (61)
Over 36 to 48 (914 to 1220)	100 (30.5)
Over 48 (1220)	50 (15.2)

12.1.2 *Portion Size*—The number of lengths to be selected shall be as agreed upon between the manufacturer or supplier and the purchaser.

12.1.3 *Selection of Samples*—The sample piece(s) shall be randomly selected.

12.2 Chemical Analysis:

12.2.1 When determination of the alloy composition is specified in the contract or purchase order, the sample shall be taken and prepared in accordance with Practice E 255 from the length(s) selected in 12.1.2.

12.3 Other Tests:

12.3.1 Test specimens shall be taken from the length(s) selected in 12.1.2.

13. Number of Tests and Retests

13.1 Tests:

13.1.1 *Chemical Analysis*—Composition shall be determined as the average of results from at least two replicate analysis for each specified element.

13.1.2 *Transverse Tensile Strength*—Conformance with test requirements shall be determined by the test result of one specimen.

13.1.3 *Transverse Guided Bend Test*—Conformance with test requirements shall be determined by the test result of one transverse root bend test and one transverse face bend test.

13.2 Retests:

13.2.1 *Chemical Analysis*—Should one, or more, of the elements with specified limits fail to meet the composition requirement of the product specification, a retest may be permitted from a new composite sample prepared as directed in 12.1.2 and the number of replicate determinations shall be doubled.

13.2.2 *Other Tests*—Should a test specimen fail to conform to a test requirement of the product specification, a retest may be permitted with specimens prepared from the remaining pieces of the finished product selected in 12.1.2 and the number of test specimens shall be doubled.

13.2.2.1 In the event only one sample piece was selected in 12.1.2, retest shall not be permitted.

13.2.3 All test specimen shall conform to specification requirement in retest and failure to comply shall be cause for lot rejection.

13.2.4 Umpire Test:

13.2.4.1 In the case where the retest does not settle the dispute, a test may be permitted by a third qualified laboratory agreeable to manufacturer or supplier and the purchaser.

13.2.4.2 The sample shall be taken and test specimens prepared as directed in this specification.

13.2.4.3 The test method to be followed shall be as specified in this specification.

14. Specimen Preparation

14.1 Chemical Analysis:

14.1.1 Preparation of the analytical test specimen shall be the responsibility of the reporting laboratory.

14.2 Transverse Tensile Test:

14.2.1 The test specimen shall conform to the requirements of Test Specimens section and Fig. 13, Standard Test Specimen for Cast Iron, of Test Methods E 8.

14.2.2 The test specimen shall be of the full thickness of the base metal and shall be taken from the end of the finished pipe and flattened cold and machined to test specimen dimensions.

14.2.3 Alternatively, the test specimen may be taken from a test plate of the same material as the pipe which has been attached to the end of the pipe and welded as a prolongation of the longitudinal seam.

14.3 Transverse Guided Bend Test:

14.3.1 The test specimens shall be taken from the pipe with the weld joint in the approximate center of the specimens.

14.3.2 The test specimens shall be of the full thickness of the base metal and shall be taken from the end of the finished pipe and flattened cold and cut to test specimen size as

described in Test Method E 190.

15. Test Methods

15.1 Test methods used for production control or quality control, or both, for determining conformance with product property requirements are discretionary.

15.1.1 Test methods used to obtain data for preparation of certification and test report shall be made available to the purchaser upon request.

15.2 Chemical Analysis:

15.2.1 The test methods used for determining chemical composition shall, in case of dispute, be as specified in the specification under which the manufacturing material was ordered.

15.2.2 Test methods used for the determination of elements required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

15.3 Other Tests:

15.3.1 The product furnished shall conform with the mechanical and other requirements enumerated in this specification when tested in accordance with the following appropriate method:

Test	Method
Tension	E 8
Transverse Guided Bend Test	E 190
Hydrostatic	Section 14.3.2

15.3.1.1 Tensile strength shall be determined in accordance with Test Methods E 8. Test results are not seriously affected by variations in speed of testing. However, the rate of stressing to the yield strength should not exceed 50 ksi/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) of gage length (or distance between grips for full section specimens).

15.3.2 Hydrostatic Test:

15.3.2.1 The internal hydrostatic pressure necessary to produce the required fiber stress shall be determined by the following equation:

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

where:

- P = Hydrostatic pressure, psi (or MPa),
- t = Thickness of tube wall, in. (or mm),
- D = Outside diameter of tube, in. (or mm), and
- S = Allowable fiber stress of the material, psi (or MPa).

16. Significance of Numerical Limits

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

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	nearest unit in the last right-hand place of figures of the specified limit
Tensile strength	nearest 1 ksi (nearest 5 MPa)

17. Inspection

17.1 The manufacturer shall inspect and make necessary tests to verify that the pipe furnished conforms to the requirements of this specification.

17.2 If in addition the purchaser elects to perform his own inspection, the manufacturer shall afford the inspector all reasonable facilities to satisfy him that the pipe furnished conforms to the requirements of this specification. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere with the operation of the works. When automated finishing and inspection equipment is available at a facility, purchaser and manufacturer or supplier may by mutual agreement accomplish the final inspection simultaneously.

18. Rejection and Rehearing

18.1 Rejection:

18.1.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the manufacturer or supplier promptly and in writing.

18.1.2 Radiographic or liquid penetrate examinations by the purchaser shall not be a basis for rejection unless those examinations were specified in the contract or purchase order at the time of ordering.

18.2 Rehearing:

18.2.1 The manufacturer, or supplier, may make claim for a rehearing when dissatisfied with test results upon which rejection was based.

19. Certification

19.1 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.

19.2 Certification is mandatory when the product is for ASME Boiler and Pressure Vessel Code application.

20. Mill Test Report

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

21. Product Marking

21.1 Each length of pipe shall be marked with the specification number, alloy UNS No., nominal size, pressure class, and the trademark of the manufacturer.

21.1.1 When a nonstandard size or wall thickness has been specified, the markings shall contain the exact outside diameter and wall thickness in inches instead of the nominal diameter.

22. Packaging and Package Marking

22.1 Pipe shall be prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation and to provide protection from normal hazards of transportation.

23. Keywords

23.1 copper-alloy pipe; welded copper-alloy pipe; welded pipe



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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 one kilogram gives it an acceleration of one metre per second squared ($N = \text{kg}\cdot\text{m}/\text{s}^2$). 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 section identifies the location of selected changes to this specification that have been incorporated since the 1988 issue. For the convenience of the user, Committee B5 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

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| (1) Scope has been revised. | (4) Supplementary Requirements section deleted with the former contents incorporated in the body of the text in this revision. |
| (2) No retests permitted when a single test piece is taken. | |
| (3) The Number of Tests and Retests section significantly revised. | |

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