



Designation: ~~B608 – 11~~ **B608 – 18**

Standard Specification for Welded Copper-Alloy Pipe¹

This standard is issued under the fixed designation B608; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification establishes the requirements for arc-welded pipe for use in brackish water or seawater piping systems.

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.

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, 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:*²

~~B169/B169M~~ Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar

~~B171/B171M~~ Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers

~~B846~~ Terminology for Copper and Copper Alloys

~~E8E8/E8M~~ Test Methods for Tension Testing of Metallic Materials—[Metric] ~~E0008–E0008M~~

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

~~E62~~ Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)³

~~E76~~ Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)³

~~E190~~ Test Method for Guided Bend Test for Ductility of Welds

~~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 *AWS Standards:*⁴

~~A 5.6~~ Covered Copper-Alloy Arc-Welding Electrodes

~~A 5.7~~ Copper and Copper-Alloy Welding Rods

2.2 *ASME Standards:*⁴

~~Boiler and Pressure Vessel Code, Nuclear Power Plant Rules for Construction of Nuclear Facility 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, Brazing, and Fusing Qualifications, Section IX~~

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

⁴ Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

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

2.3 *AWS Standards:*⁵

- [A5.6/A5.6M Specification for Copper and Copper - Alloy Electrodes for Shielded Metal Arc Welding](#)
- [A5.7/A5.7M Specification for Copper and Copper - Alloy Bare Welding Rods and Electrodes](#)

3. Terminology

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

4. Ordering Information

4.1 Include the following information in contracts or purchase orders for product furnished under this specification:

- 4.1.1 ASTM specification designation and year of issue; issue (for example, B608 – 02),
- 4.1.2 Copper alloy [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 (section ~~(19.2)~~).

4.2 The following options are available:

- 4.2.1 Determination of chemical composition (Section ~~(6.1.1)~~),
- 4.2.2 Transverse Guided-Bend 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 Penetrant examination (Section ~~(8.4)~~),
- 4.2.6 Weld reinforcement removal, (Section 9),
- 4.2.7 Certification (Section ~~(19)~~ (Sections **E18 and 19**), and (Section ~~19~~))
- 4.2.8 Test Report (Section 20).

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 **B169/B169M** for Copper Alloys UNS Nos. C61300 and C61400 or Specification **B171/B171M** for Copper Alloys UNS Nos. C70620 and C71520. These specifications reference Test Methods **E62**, **E76**, and **E478** for the appropriate chemical analysis.

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	A5-6	Filler Metal AWS Specification A5-7
	<u>Base Metal Copper Alloy UNS Number</u>	<u>Filler Metal AWS Specification</u>
	C61300	A5.7/A5.7M ERCuAl-A2
	C61400	ERCuAl-A2
	C70620	ECuNi
	C71520	ECuNi

TABLE 1 Chemical Requirements

Copper Alloy UNS Number	Composition, %											
	Copper ^A	Nickel incl Cobalt	Aluminum	Lead, max	Iron	Zinc, max	Manganese, max	Sulfur, max	Phosphorus, max	Carbon, max	Tin	Si
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	0.10
C61400	remainder	...	6.0–8.0	0.01	1.5–3.5	0.20	1.0	...	0.015
C70620	86.5 % min	9.0–11.0	...	0.02	1.0–1.8	0.50	1.0	0.02	0.02	0.05
C71520	65.0 % min	29.0–33.0	...	0.02	0.40–1.0	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.

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

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 longitudinally 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 not within the tolerance of ~~±0.27~~10.2.7 shall be flared at a 3 to 1 minimum taper over the width of the finished weld, or 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 re-welding. 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 nominal sizes 4 in. and larger in diameter.

6. Chemical Composition

6.1 The pipe material shall conform to the chemical compositional 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 composition limits do not preclude the presence of other elements. When required, limits shall 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 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, C70620, C71520	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 Method E190. 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.

TABLE 2 Transverse Tensile Strength

Copper Alloy UNS Number	Tensile Strength, min, ksi (MPa) ^A
C61300	70 (485)
C61400	70 (485)
C70620	40 (275)
C71520	50 (345)

^A See Appendix X1.

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. (See 15.3.2.)

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 tested at a hydrostatic pressure 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 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 removed completely 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, Mass, and Permissible Variations

10.1 Dimensions:

10.1.1 Pipe diameter shall be specified as a nominal diameter 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~~ 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. (See section 21.1.1.)

10.1.4 Pipe shall be furnished in 12 ft (3660 mm) 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 (3660 mm).

10.2 Permissible Variations:

10.2.1 *Outside Diameter*—The average ~~outside diameter~~ outside diameter shall not vary from the specified ~~outside diameter~~ 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](#).

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

Nominal Size	Outside Diameter, in.	Inch-Pound Units, in. (SI Units, mm)				
		Pressure Class, psi (kPa) ^A				
		50 (345)	75 (517)	100 (689)	150 (1034)	200 (1379)
4	4.50 (114.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)
5	5.563 (141.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)
6	6.625 (168.28)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)
8	8.625 (219.08)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)
10	10.75 (273.05)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.125 (3.18)
12	12.75 (323.85)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.165 (4.19)
14	14.00 (355.60)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.165 (4.19)
16	16.00 (406.40)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.134 (3.40)	0.187 (4.76)
18	18.00 (457.20)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.165 (4.19)	0.187 (4.76)
20	20.00 (508.00)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.165 (4.19)	0.250 (6.35)
24	24.00 (609.60)	0.125 (3.18)	0.125 (3.18)	0.134 (3.40)	0.187 (4.76)	0.250 (6.35)
30	30.00 (762.00)	0.134 (3.40)	0.134 (3.40)	0.165 (4.19)	0.250 (6.35)	0.312 (7.94)
36	36.00 (914.40)	0.134 (3.40)	0.165 (4.19)	0.187 (4.76)	0.312 (7.94)	0.375 (9.53)
42	42.00 (1066.80)	0.187 (4.76)	0.187 (4.76)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)
48	48.00 (1219.20)	0.187 (4.76)	0.187 (4.76)	0.250 (6.35)	0.375 (9.53)	0.437 (11.1)

^A Pressure ratings apply to any design temperature not exceeding 350°F (176°C); 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 joint efficiency of 70 %, and the thickness tolerances shown in [Table 8](#).

TABLE 4 Standard Sizes and Wall Thickness
Copper Alloy UNS No. C70620

Inch-Pound Units, in. (SI Units, mm)						
Nominal Size	Outside Diameter, in.	Pressure Class, psi (kPa) ^A				
		50 (345)	75 (517)	100 (689)	150 (1034)	200 (1379)
4	4.50 (114.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.109 (2.77)
5	5.563 (141.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)
6	6.625 (168.28)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.109 (2.77)	0.134 (3.40)
8	8.625 (219.08)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.148 (3.76)	0.165 (4.19)
10	10.75 (273.05)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.165 (4.19)	0.250 (6.35)
12	12.75 (323.85)	0.094 (2.38)	0.125 (3.18)	0.134 (3.40)	0.187 (4.76)	0.250 (6.35)
14	14.00 (355.60)	0.125 (3.18)	0.125 (3.18)	0.148 (3.76)	0.250 (6.35)	0.250 (6.35)
16	16.00 (406.40)	0.125 (3.18)	0.125 (3.18)	0.165 (4.19)	0.250 (6.35)	0.312 (7.94)
18	18.00 (457.20)	0.125 (3.18)	0.148 (3.76)	0.187 (4.76)	0.250 (6.35)	0.312 (7.94)
20	20.00 (508.00)	0.125 (3.18)	0.148 (3.76)	0.187 (4.76)	0.312 (7.94)	0.375 (9.53)
24	24.00 (609.60)	0.134 (3.40)	0.187 (4.76)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)
30	30.00 (762.00)	0.148 (3.76)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)	0.500 (12.7)
36	36.00 (914.40)	0.187 (4.76)	0.250 (6.35)	0.312 (7.94)	0.500 (12.7)	0.625 (15.9)
42	42.00 (1066.80)	0.250 (6.35)	0.312 (7.94)	0.375 (9.53)	0.562 (14.3)	0.687 (17.5)
48	48.00 (1219.20)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)	0.625 (15.9)	0.812 (20.6)

^A Pressure ratings apply to any design temperature not exceeding 450°F (65°C)-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 joint efficiency of 70 %, and the thickness tolerances shown in Table 8.

TABLE 5 Standard Sizes and Wall Thicknesses
Copper Alloy UNS No. C71520

Inch-Pound Units, in. (SI Units, mm)						
Nominal Diameter	Outside Diameter, in.	Pressure Class, psi (kPa) ^A				
		50 (345)	75 (517)	100 (689)	150 (1034)	200 (1379)
4	4.50 (114.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)
5	5.563 (141.30)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.109 (2.77)
6	6.625 (168.28)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)
8	8.625 (219.08)	0.094 (2.38)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.148 (3.76)
10	10.75 (273.05)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.148 (3.76)	0.165 (4.19)
12	12.75 (323.85)	0.094 (2.38)	0.094 (2.38)	0.125 (3.18)	0.165 (4.19)	0.250 (6.35)
14	14.00 (355.60)	0.125 (3.18)	0.125 (3.18)	0.125 (3.18)	0.187 (4.76)	0.250 (6.35)
16	16.00 (406.40)	0.125 (3.18)	0.125 (3.18)	0.148 (3.76)	0.187 (4.76)	0.250 (6.35)
18	18.00 (457.20)	0.125 (3.18)	0.125 (3.18)	0.165 (4.19)	0.250 (6.35)	0.312 (7.94)
20	20.00 (508.00)	0.125 (3.18)	0.134 (3.40)	0.165 (4.19)	0.250 (6.35)	0.312 (7.94)
24	24.00 (609.60)	0.125 (3.18)	0.165 (4.19)	0.187 (4.76)	0.312 (7.94)	0.375 (9.53)
30	30.00 (762.00)	0.134 (3.40)	0.187 (4.76)	0.250 (6.35)	0.375 (9.53)	0.437 (11.1)
36	36.00 (914.40)	0.165 (4.19)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)	0.500 (12.7)
42	42.00 (1066.80)	0.187 (4.76)	0.250 (6.35)	0.312 (7.94)	0.437 (11.1)	0.625 (15.9)
48	48.00 (1219.20)	0.187 (4.76)	0.312 (7.94)	0.375 (9.53)	0.500 (12.7)	0.687 (17.5)

^A Pressure ratings apply to any design temperature not exceeding 450°F (65°C)-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 joint efficiency of 70 %, and the thickness tolerances shown in Table 8.

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

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.

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 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.

TABLE 7 Roundness Requirements, in. (mm)^A

Specified Outside Diameter	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, in. (mm)^A

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

11. Workmanship, Finish, and Appearance

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

11.2 *Finish*—The inner and outer surfaces shall be such as to make the product suitable for the intended application. Repaired areas conforming to the requirements of this specification shall be acceptable.