



Designation: B608 – 11

# Standard Specification for Welded Copper-Alloy Pipe<sup>1</sup>

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 reapproval. A superscript epsilon ( $\epsilon$ ) 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 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

[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](#)

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

[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 \(Photometric Methods\)](#)

[E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys](#)

[E190 Test Method for Guided Bend Test for Ductility of Welds](#)

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[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*:<sup>3</sup>

[A 5.6 Covered Copper-Alloy Arc-Welding Electrodes](#)

[A 5.7 Copper and Copper-Alloy Welding Rods](#)

2.3 *ASME Standards*:<sup>4</sup>

[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 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, (for example, B608 – 02),

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 (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),

<sup>3</sup> Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.

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

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

TABLE 1 Chemical Requirements

| Copper Alloy UNS Number | Composition, %      |                    |          |           |          |           |                |             |                 |             |           |      |
|-------------------------|---------------------|--------------------|----------|-----------|----------|-----------|----------------|-------------|-----------------|-------------|-----------|------|
|                         | Copper <sup>A</sup> | Nickel incl Cobalt | Aluminum | Lead, max | Iron     | Zinc, max | Manganese, max | Sulfur, max | Phosphorus, max | Carbon, max | Tin       | Si   |
| C61300 <sup>B</sup>     | 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        | ...       | ...  |

<sup>A</sup> Silver counting as copper.

<sup>B</sup> 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.

- 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 18), 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<br>UNS Number | Filler Metal AWS Specification |           |
|---------------------------------------|--------------------------------|-----------|
|                                       | A5.6                           | A5.7      |
| C61300                                | ECuAl-A2                       | ERCuAl-A2 |
| C61400                                | ECuAl-A2                       | ERCuAl-A2 |
| C70620                                | ECuNi                          | ERCuNi    |
| C71520                                | 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 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 10.2.7 shall be flared 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 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,<br>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 **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.

### 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 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 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 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*—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.

## 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:

**TABLE 2 Transverse Tensile Strength**

| Copper Alloy UNS Number | Tensile Strength, min, ksi (MPa) <sup>A</sup> |
|-------------------------|-----------------------------------------------|
| C61300                  | 70 (485)                                      |
| C61400                  | 70 (485)                                      |
| C70620                  | 40 (275)                                      |
| C71520                  | 50 (345)                                      |

<sup>A</sup> See **Appendix X1**.