



Designation: B587 – 19

## Standard Specification for Welded Brass Tube<sup>1</sup>

This standard is issued under the fixed designation B587; 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 round, rectangular, and square copper alloy welded tube for general engineering applications.

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 safety hazard caveat pertains only to the test method(s) 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 to 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:<sup>2</sup>

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

**B154** Test Method for Mercurous Nitrate Test for Copper Alloys

**B428** Test Method for Angle of Twist in Rectangular and Square Copper and Copper Alloy Tube

**B846** Terminology for Copper and Copper Alloys

**B968/B968M** Test Method for Flattening of Copper and

Copper-Alloy Pipe and Tube

**E3** Guide for Preparation of Metallographic Specimens

**E8/E8M** Test Methods for Tension Testing of Metallic Materials

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

**E112** Test Methods for Determining Average Grain Size

**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)

### 3. Terminology

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

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *as-welded*—a condition created as a result of shaping sheet, strip, or plate into a tubular form and welding without subsequent heat treatment or cold work, or both.

3.2.2 *ends*—straight pieces, shorter than the nominal length, left over after cutting the product into mill lengths, stock lengths, or specified lengths. They are subject to minimum length and maximum weight requirements.

3.2.3 *fully finished*—welded tube with internal and processed to conform to the specified temper.

3.2.4 *mill length*—lengths that can be conveniently manufactured in the mills.

3.2.5 *mill lengths with ends*—lengths, including ends, that can be conveniently manufactured in the mills.

3.2.6 *specific*—straight lengths that are uniform in length, as specified, and subject to established tolerances.

3.2.7 *stock*—straight lengths that are mill cut and stored in advance of orders. They are usually subject to established tolerances.

3.2.8 *welded and annealed*—welded tube that has been annealed to produce a uniformed grain size appropriate to the specified annealed temper.

<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.

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

3.2.9 *welded and cold-drawn*—welded tube with internal flash removed by scarfing and subsequently cold-drawn to conform to the specified temper.

**4. Classification (Type)**

4.1 The basic types of welded brass tube are:

4.1.1 *Type I*—As-welded tube finished by passing through sizing and straightening rolls at ambient temperature.

4.1.2 *Type II*—As-welded tube finished by sizing, straightening, and annealing.

4.1.3 *Type III*—As-welded tube finished by cold reducing or cold drawing over a plug or mandrel.

4.1.4 *Type IV*—As-welded tube finished by both cold drawing over a plug or mandrel and annealing, and redrawing and annealing when necessary to conform to a specified size and temper.

4.1.4.1 Type IV tube may be substituted for Types I, II, and III by agreement between the manufacturer or supplier and the purchaser. The temper of substituted Type IV tube shall be stated in the contract or purchase order.

**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 (for example, B587 – 12);

5.1.2 Copper Alloy UNS<sup>3</sup> No. (for example, C21000) (Section 6);

5.1.3 Classification (type) (Section 4);

5.1.4 Temper (Section 8 and Table 2 and Table 3);

5.1.5 Dimensions (diameter, distances between parallel surfaces, wall thickness and so forth) (Section 13);

5.1.6 How furnished (coils or lengths, specific or stock, with or without ends);

5.1.7 Quantity—Number of coils or pieces, each size and type;

5.1.8 Total weight, each size and type; 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 of the order, when required:

5.2.1 Mercurous nitrate test (11.1),

5.2.2 Hydrostatic test (12.2),

5.2.3 Pneumatic test (12.3),

5.2.4 Certification (Section 22),

5.2.5 Mill test report (Section 23),

5.2.6 Product marking (Section 24), and

5.2.7 Package marking of the specification number.

**6. Material and Manufacture**

6.1 *Material*—The material of manufacture shall be strip, sheet, or plate produced of Copper Alloy UNS No. C21000, C22000, C23000, C26000, C26800, C27000, or C27200 [or other designation] of such purity and soundness as to be suitable for processing into the products described herein.

<sup>3</sup> Refer to Practice E527 for explanation of the Unified Numbering System (UNS).

**6.2 Manufacture:**

6.2.1 Tubes shall be welded by any process which produces forged or fusion welds.

6.2.1.1 Tube welded from flat rolled strip can be regularly furnished by welding standard strip tempers and shall have mechanical properties as agreed upon between the manufacturer or supplier and the purchaser.

6.2.2 Forged-welded tube shall be scarfed to remove both internal and external flash.

6.2.2.1 Forged-welded tube to be drawn over a mandrel to produce Types III and IV may have the internal flash completely removed.

6.2.2.2 Forged-welded Types I, II, and III tube may contain a residual thickness at the weld not to exceed 0.006 in. (0.15 mm) or 10 % of the nominal wall thickness, whichever is greater.

6.2.3 Fusion-welded tube shall be mechanically worked to produce a smooth external and internal surface without the application of scarfing or other removal of the weld metal bead.

**7. Chemical Composition**

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

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

7.2 For alloys in which zinc is listed as “remainder,” either copper or zinc may be taken as the difference between the sum of results of all other elements determined and 100 %. When all elements in Table 1 are determined, the sum of results shall be as follows:

| Copper Alloy UNS No.           | Copper Plus Sum of Named Elements, min, % |
|--------------------------------|---|
| C21000, C22000, C23000         | 99.8                                      |
| C26000, C26800, C27000, C27200 | 99.7                                      |

**8. Temper**

8.1 The product furnished shall be one of the tempers indicated in Table 2 or Table 3.

8.1.1 Light-drawn and hard-drawn tempers are normally available in round tube only.

8.1.2 Special temper requirements are subject to agreement between the manufacturer or supplier and the purchaser.

**9. Grain Size for Annealed Tempers**

9.1 *Grain Size:*

TABLE 1 Chemical Requirements

| Copper Alloy UNS No. | Composition, % |           |           |           |
|----------------------|----------------|-----------|-----------|-----------|
|                      | Copper         | Lead, max | Iron, max | Zinc      |
| C21000               | 94.0–96.0      | 0.05      | 0.05      | remainder |
| C22000               | 89.0–91.0      | 0.05      | 0.05      | remainder |
| C23000               | 84.0–86.0      | 0.05      | 0.05      | remainder |
| C26000               | 68.5–71.5      | 0.07      | 0.05      | remainder |
| C26800               | 64.0–68.5      | 0.09      | 0.05      | remainder |
| C27000               | 63.0–68.5      | 0.09      | 0.07      | remainder |
| C27200               | 62.0–65.0      | 0.07      | 0.07      | remainder |

**TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values for Welded (Type I), Welded and Cold-Worked (Type III), and Fully Finished (Type IV) Tube**

| Copper Alloy UNS No.           | Temper                                  | Type    | Outside Diameter, in. (mm)       | Wall Thickness, in. (mm)       | Rockwell 30T Hardness, <sup>A</sup> min | Tensile Strength, min, ksi <sup>B</sup> (MPa) <sup>C</sup> |
|--------------------------------|---|---------|----------------------------------|--------------------------------|---|--|
| C21000                         | welded from annealed strip              | I       | all                              | all                            | 7                                       | 34 (235)   |
| C21000                         | welded from cold-rolled strip           | I       | all                              | all                            | D                                       | D  |
| C21000                         | cold reduced or light drawn             | III, IV | all                              | all                            | 34                                      | 37 (255)   |
| C21000                         | cold reduced or hard drawn              | III, IV | up to 1 (25.4) incl              | 0.020 to 0.119 (0.508 to 3.02) | 52                                      | 46 (315)   |
|                                |   |         | over 1 to 2 (25.4 to 50.8) incl  | 0.035 to 0.119 (0.889 to 3.02) |   |  |
|                                |   |         | over 2 to 3½ (50.8 to 88.9) incl | 0.060 to 0.119 (1.52 to 3.02)  |   |  |
| C22000                         | welded from annealed strip              | I       | all                              | all                            | 10                                      | 37 (255)   |
| C22000                         | welded from cold-rolled strip           | I       | all                              | all                            | D                                       | D  |
| C22000                         | cold reduced or light drawn             | III, IV | all                              | all                            | 38                                      | 40 (275)   |
| C22000                         | cold reduced or hard drawn              | III, IV | up to 1 (25.4) incl              | 0.020 to 0.119 (0.508 to 3.02) | 55                                      | 52 (360)   |
|                                |   |         | over 1 to 2 (25.4 to 50.8) incl  | 0.035 to 0.119 (0.889 to 3.02) |   |  |
|                                |   |         | over 2 to 3½ (50.8 to 88.9) incl | 0.060 to 0.119 (1.52 to 3.02)  |   |  |
| C23000                         | welded from annealed strip              | I       | all                              | all                            | 24                                      | 40 (275)   |
| C23000                         | welded from cold-rolled strip           | I       | all                              | all                            | D                                       | D  |
| C23000                         | cold reduced or light drawn             | III, IV | all                              | all                            | 43                                      | 44 (305)   |
| C23000                         | cold reduced or drawn (general purpose) | III, IV | all                              | all                            | 43                                      | 44 (305)   |
| C23000                         | cold reduced or hard drawn              | III, IV | up to 1 (25.4) incl              | 0.020 to 0.119 (0.508 to 3.02) | 65                                      | 57 (395)   |
|                                |   |         | over 1 to 2 (25.4 to 50.8) incl  | 0.035 to 0.119 (0.889 to 3.02) |   |  |
|                                |   |         | over 2 to 3½ (50.8 to 88.9) incl | 0.060 to 0.119 (1.52 to 3.02)  |   |  |
| C26000, C26800, C27000, C27200 | welded from annealed strip              | I       | all                              | all                            | 25                                      | 48 (330)   |
| C26000, C26800, C27000, C27200 | welded from cold-rolled strip           | I       | all                              | all                            | D                                       | D  |
| C26000, C26800, C27000, C27200 | cold reduced or drawn (general purpose) | III, IV | all                              | all                            | 53                                      | 54 (370)   |
| C26000, C26800, C27000, C27200 | cold reduced or hard drawn <sup>E</sup> | III, IV | up to 1 (25.4) incl              | 0.020 to 0.119 (0.508 to 3.02) | 70                                      | 66 (455)   |
|                                |   |         | over 1 to 2 (25.4 to 50.8) incl  | 0.035 to 0.119 (0.889 to 3.02) |   |  |
|                                |   |         | over 2 to 3½ (50.8 to 88.9) incl | 0.060 to 0.119 (1.52 to 3.02)  |   |  |

<sup>A</sup> Rockwell hardness values shall only apply to: (a) tubes having a wall thickness of 0.012 in. (0.305 mm) or greater; (b) round tube having an inside diameter of 5/16 in. (7.94 mm) or greater; and (c) rectangular and square tube having an inside major distance between parallel surfaces of 3/4 in. (4.76 mm) or greater. Rockwell hardness tests shall be made on the inside surface of the tube, and the value of the Rockwell hardness number of each specimen shall be established by taking the arithmetical average of at least three readings. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values may be specified subject to agreement between the manufacturer and the purchaser.

<sup>B</sup> ksi = 1000 psi.

<sup>C</sup> See Appendix X1.

<sup>D</sup> Tube welded from cold-rolled strip can be regularly supplied by welding standard strip tempers and shall have mechanical properties as agreed upon between the purchaser and the supplier.

<sup>E</sup> Light-drawn and hard-drawn tempers are normally available in round tube only.

9.1.1 Type II and Type IV tubes with tempers designated as W060 (welded and soft-annealed) and W050 (welded and light-annealed) shall conform to the requirements prescribed in Table 3 for the specified copper alloy UNS No. and temper when tested in accordance with Test Methods E112.

9.1.2 Grain size shall be the basis for acceptance or rejection based upon physical properties.

## 10. Mechanical Properties

### 10.1 Tensile Strength Requirements:

10.1.1 Type I, Type III, and Type IV tube in drawn tempers shall conform to the requirements prescribed in Table 2 for the specified copper alloy and temper when tested in accordance with Test Methods E8/E8M.

**TABLE 3 Grain Size Requirements and Approximate Rockwell Hardness Values for Welded Tube and Fully Finished Tube When Furnished in the Annealed Temper**

| Copper Alloy<br>UNS No.              | Temper      |              | Types  | Outside<br>Diameter, in.<br>(mm) | Wall Thickness, in. (mm)                      | Approximate<br>Rockwell Hardness <sup>A</sup> |          | Avg Grain Size, mm           |                |        |              |        |     |  |          |          |                              |                |
|--------------------------------------|-------------|--------------|--------|----------------------------------|---|---|----------|------------------------------|----------------|--------|--------------|--------|-----|--|----------|----------|------------------------------|----------------|
|                                      | Designation | Name         |        |                                  |   | Scale   | Max      | min                          | max            |        |              |        |     |  |          |          |                              |                |
| C21000                               | WO60        | soft anneal  | II, IV | all                              | up to 0.045 (1.14) incl<br>over 0.045 (1.14)  | 30T<br>F                                      | 17<br>61 | 0.025                        | 0.060          |        |              |        |     |  |          |          |                              |                |
| C21000                               | WO50        | light anneal | II, IV | all                              | up to 0.045 (1.14)<br>over 0.045 (1.14)       | 30T<br>F                                      | 27<br>68 | <sup>B</sup><br><sup>B</sup> | 0.035<br>0.035 |        |              |        |     |  |          |          |                              |                |
| C22000                               | WO60        | soft anneal  | II, IV | all                              | up to 0.045 (1.14) incl<br>over 0.045, (1.14) | 30T<br>F                                      | 30<br>70 | 0.025                        | 0.060          |        |              |        |     |  |          |          |                              |                |
| C22000                               | WO50        | light anneal | II, IV | all                              | up to 0.045 (1.14) incl<br>over 0.045, (1.14) | 30T<br>F                                      | 37<br>78 | <sup>B</sup><br><sup>B</sup> | 0.035<br>0.035 |        |              |        |     |  |          |          |                              |                |
| C23000                               | WO60        | soft anneal  | II, IV | all                              | up to 0.045 (1.14) incl<br>over 0.045, (1.14) | 30T<br>F                                      | 36<br>75 | 0.025                        | 0.060          |        |              |        |     |  |          |          |                              |                |
| C23000                               | WO50        | light anneal | II, IV | all                              | up to 0.045 (1.14) incl<br>over 0.045 (1.14)  | 30T<br>F                                      | 39<br>85 | <sup>B</sup><br><sup>B</sup> | 0.035<br>0.035 |        |              |        |     |  |          |          |                              |                |
| C26000<br>C26800<br>C27000<br>C27200 | } WO60      | soft anneal  | II, IV | all                              | up to 0.30 (0.762 incl<br>over 0.030 (0.762)  | 30T<br>F                                      | 40<br>80 | 0.025                        | 0.060          |        |              |        |     |  |          |          |                              |                |
| C26000<br>C26800<br>C27000<br>C27200 |             |              |        |                                  |   |   |          |                              |                | } WO50 | light anneal | II, IV | all | up to 0.30 (0.762 incl<br>over 0.030 (0.762) | 30T<br>F | 60<br>90 | <sup>B</sup><br><sup>B</sup> | 0.035<br>0.035 |

<sup>A</sup> Rockwell hardness values only apply to: (a) tube having a wall thickness of 0.015 in. (0.38 mm) or greater; (b) round tube having an inside diameter of 5/16 in. (7.94 mm) or greater; and (c) rectangular and square tube having an inside major distance between parallel surfaces of 3/16 in. (4.76 mm) or greater. Rockwell hardness values do not apply for other tube. Rockwell hardness tests shall be made on the inside surface of the tube and the value of the Rockwell hardness number of each specimen shall be established by taking the arithmetical average of at least three readings. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values may be specified subject to agreement between the manufacturer and the purchaser.

<sup>B</sup> Although no minimum grain size is specified, the product must, nevertheless, have a fully recrystallized grain structure.

10.1.2 The tensile test results shall be the basis for acceptance or rejection based upon mechanical properties.

10.2 *Rockwell Hardness Requirement*—The approximate Rockwell hardness value(s) for each copper alloy and temper given in **Table 2** and **Table 3** are for general information and assistance in testing.

NOTE 1—The Rockwell hardness test offers a quick and convenient method for checking for general conformity to the requirements for tensile strength or grain size.

### 11. Performance Requirements

11.1 *Mercurous Nitrate Test*—When specified in the contract or purchase order, specimens of annealed tube in all copper alloys and tempers shall be tested for residual stress according to the requirements in Test Method **B154** and show no signs of cracking.

#### 11.2 *Expansion Test:*

11.2.1 Test specimen shall conform to the requirements of the Specimen Preparation section of Test Method **B153** and to the below amounts.

| Standard Size, in. (mm) | Expansion in Outside<br>Diameter, % |
|-------------------------|-------------------------------------|
| 3/4 (19.0) and under    | 20                                  |
| Over 3/4 (19.0)         | 15                                  |

#### 11.3 *Flattening Test:*

11.3.1 The flattening test shall be performed in accordance with Test Method **B968/B968M**.

#### 11.4 *Reverse Bend Test:*

11.4.1 A representative tube sample shall be cut to a length that will accommodate the test. The sample is permitted to be annealed when the temper is other than annealed.

### 12. Nondestructive Testing Requirements

12.1 *Electromagnetic (Eddy-Current) Examination*—Each tube up to and including 3 1/8 in. (79.4 mm) outside diameter or within the capabilities of the testing unit shall be passed through the testing unit adjusted to provide information on the suitability of the tube for the intended application in accordance with Practice **E243**. Tube that does not actuate the signaling device shall be considered as conforming with test requirements.

#### 12.2 *Hydrostatic Test:*

12.2.1 When specified in the contract or purchase order, each tube shall withstand an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 6000 psi (41 MPa) without leakage.

12.2.2 The tube need not be tested at a gauge pressure over 1000 psi (6.9 MPa) unless so specified in the contract or purchase order.

12.3 *Pneumatic Test*—When specified in the contract or purchase order, each tube shall withstand an internal air pressure of 60 psi (415 kPa) minimum for 5 s without leakage.

### 13. Dimensions, Mass, and Permissible Variations

13.1 Tube diameter shall be expressed as outside diameter or inside diameter in numerical fractions of an inch. Wall thickness shall be expressed in decimal fractions of an inch.

13.2 Tolerances on a given tube may be specified with respect to any two, but not all three, of the following: outside diameter, inside diameter, and wall thickness.

13.3 For purposes of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension shall be cause for rejection.

13.4 *Wall Thickness Tolerances*—Wall thickness tolerances for round tube shall conform to the tolerances listed in **Table 4**. Wall thickness tolerances for rectangular including square tube shall be in accordance with **Table 5**.

13.5 Diameter tolerances for round tubes furnished in straight lengths only shall be in accordance with **Table 6**. Tolerances have not been established for tube furnished in coils.

13.6 Tolerances on distance between parallel surfaces for rectangular (including square) tube shall be in accordance with **Table 7**.

13.7 *Lengths and Tolerances:*

13.7.1 Tube in straight lengths shall be furnished in stock lengths with ends unless the order requires specific lengths or specific lengths with ends.

13.7.2 The tolerances on the length for tubes furnished in straight lengths shall be in accordance with **Table 8**.

13.7.3 The schedule of ends for tubes furnished in specific or stock lengths with ends shall be in accordance with **Table 9**.

13.7.4 The tolerances for tubes furnished in coils shall be in accordance with **Table 10**, **Table 11**, and **Table 12**.

13.8 *Roundness:*

13.8.1 For as-welded from cold-worked strip, and redrawn unannealed tube in straight lengths, the roundness tolerances shall be in accordance with **Table 13**.

13.8.2 Compliance with the roundness tolerance shall be determined by taking measurements on the outside diameter only, irrespective of the manner in which the tube dimensions are specified. The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube.

13.8.3 Tolerances have not been established for redrawn tube, annealed tube, tube as welded from annealed strip, any

tube furnished in coils, or tube whose wall thickness is under 0.016 in. (0.406 mm).

13.9 *Squareness-of-Cut*—For tube in straight lengths, the departure from squareness at the end of any tube shall not exceed the following:

13.9.1 *Round Tubes:*

| Specified 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 |

13.9.2 *Rectangular and Square Tube:*

| Specified Distance Between Major Outside Parallel Surfaces, in. (mm) | Tolerance   |
|--|---|
| Up to 5/8 (15.9), incl   | 0.016 in. (0.41 mm)   |
| Over 5/8 (15.9)  | 0.025 in./in. (0.025 mm/mm) of distance between outside parallel surfaces |

13.10 *Straightness Tolerances:*

13.10.1 *Round Tubes*—For round tubes of any drawn temper or round tubes as welded from cold-rolled strip, 1/4 to 3 1/2 in. (6.35 to 88.9 mm) in outside diameter, inclusive, the straightness tolerances shall be in accordance with **Table 14**. Straightness tolerances have not been established for redraw tube, tube as welded from annealed strip, or any annealed tube.

13.10.2 *Rectangular and Square Tubes*—For rectangular and square tubes of any drawn temper or rectangular or square tubes as welded from cold-rolled strip, the straightness tolerance shall be 1/2 in. (12.7 mm) maximum curvature (depth of arc) in any 6 ft (1.83 m) portion of the total length. (Not applicable to redraw tube, tube as welded from annealed strip, or any annealed tube.)

13.11 *Corner Radius, Rectangular and Square Tubes*—The permissible radii for commercially square corners applicable to welded rectangular and square tubes shall be in accordance with **Table 15**.

13.12 *Twist Tolerances, Rectangular and Square Tubes*—The maximum twist about the longitudinal axis of drawn temper and as welded from cold-rolled strip temper rectangular and square tubes shall not exceed 1°/ft (0.305 m) length, measured to the nearest degree, and the total angle of twist

**TABLE 4 Wall Thickness Tolerances<sup>A</sup> for Welded Brass Tube**

NOTE 1—*Maximum Deviation at any Point*—The following tolerances are plus and minus. If tolerances all plus or all minus are desired, double the values given.

| Wall Thickness, <sup>B</sup> in. (mm)     | Outside Diameters, <sup>C</sup> in. (mm) |                                     |                                   |                                 |                                     |
|---|--|-------------------------------------|-----------------------------------|---------------------------------|-------------------------------------|
|   | 1/32 (0.794) to 1/8 (3.18), incl         | Over 1/8 (3.18) to 3/8 (15.9), incl | Over 3/8 (15.9) to 1 (25.4), incl | Over 1 (25.4) to 2 (50.8), incl | Over 2 (50.8) to 3 1/2 (88.9), incl |
| Up to 0.017 (0.432), incl                 | 0.002 (0.051)                            | 0.001 (0.025)                       | 0.0015 (0.038)                    | 0.002 (0.051)                   | ...                                 |
| Over 0.017 (0.432) to 0.024 (0.610), incl | 0.003 (0.076)                            | 0.002 (0.051)                       | 0.002 (0.051)                     | 0.0025 (0.064)                  | ...                                 |
| Over 0.024 (0.610) to 0.034 (0.864), incl | 0.003 (0.076)                            | 0.0025 (0.064)                      | 0.0025 (0.064)                    | 0.003 (0.076)                   | 0.004 (0.10)                        |
| Over 0.034 (0.864) to 0.057 (1.48), incl  | 0.003 (0.076)                            | 0.003 (0.076)                       | 0.0035 (0.089)                    | 0.0035 (0.089)                  | 0.005 (0.13)                        |
| Over 0.057 (1.48) to 0.082 (2.08), incl   | ...                                      | 0.0035 (0.089)                      | 0.004 (0.10)                      | 0.004 (0.10)                    | 0.006 (0.15)                        |
| Over 0.082 (2.08) to 0.119 (3.02), incl   | ...                                      | 0.004 (0.10)                        | 0.005 (0.13)                      | 0.005 (0.13)                    | 0.007 (0.18)                        |

<sup>A</sup> The thickness tolerance is the maximum deviation at any point from the specified thickness.

<sup>B</sup> The wall thickness at the weld in Types I, II, and III tube may exceed the nominal wall thickness by an amount double the value shown in the tolerance table.

<sup>C</sup> When round tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in the table by more than 50 %.

**TABLE 5 Wall Thickness Tolerances<sup>A</sup> for Rectangular and Square Welded Brass Tube**

NOTE 1—*Maximum Deviation at Any Point*—The following tolerances are plus and minus. If tolerances all plus or all minus are desired, double the values given.

| Wall Thickness, in. (mm)                  | Distance Between Outside Parallel Surfaces, <sup>B</sup> in. (mm) |                                      |                                    |                                 |                                |                               |
|---|---|--------------------------------------|------------------------------------|---------------------------------|--------------------------------|-------------------------------|
|   | 1/32 (0.794) to 1/8 (3.18), incl                                  | Over 1/8 (3.18) to 5/16 (15.9), incl | Over 5/16 (15.9) to 1 (25.4), incl | Over 1 (25.4) to 2 (50.8), incl | Over 2 (50.8) to 4 (102), incl | Over 4 (102) to 6 (152), incl |
| Up to 0.017 (0.432), incl                 | 0.002 (0.051)   | 0.002 (0.051)                        | 0.0025 (0.064)                     | 0.003 (0.076)                   | ...                            | ...                           |
| Over 0.017 (0.432) to 0.024 (0.610), incl | 0.003 (0.076)   | 0.0025 (0.064)                       | 0.003 (0.076)                      | 0.0035 (0.089)                  | ...                            | ...                           |
| Over 0.024 (0.610) to 0.034 (0.864), incl | 0.0035 (0.089)  | 0.0035 (0.089)                       | 0.0035 (0.089)                     | 0.004 (0.10)                    | 0.006 (0.15)                   | ...                           |
| Over 0.034 (0.864) to 0.057 (1.45), incl  | 0.004 (0.10)  | 0.004 (0.10)                         | 0.0045 (0.11)                      | 0.005 (0.12)                    | 0.007 (0.18)                   | 0.009 (0.23)                  |
| Over 0.057 (1.45) to 0.082 (2.08), incl   | ...   | 0.005 (0.13)                         | 0.006 (0.15)                       | 0.007 (0.18)                    | 0.008 (0.20)                   | 0.010 (0.25)                  |
| Over 0.082 (2.08) to 0.119 (3.02), incl   | ...   | 0.007 (0.18)                         | 0.008 (0.20)                       | 0.009 (0.23)                    | 0.010 (0.25)                   | 0.012 (0.30)                  |

<sup>A</sup> The thickness tolerance is the maximum deviation at any point from the specified thickness.

<sup>B</sup> In the case of rectangular tube, the major dimension determines the thickness tolerance applicable to all walls.

**TABLE 6 Average Diameter Tolerances<sup>A</sup>**

NOTE 1—Applicable to straight lengths only.

| Specified Diameter, in. (mm)         | Outside Diameter                   |
|--------------------------------------|------------------------------------|
|                                      | Tolerance, plus and minus in. (mm) |
| 1/4 to 5/8 (6.35 to 15.9), incl      | 0.002 (0.051)                      |
| Over 5/8 to 1 (15.9 to 25.4), incl   | 0.0025 (0.064)                     |
| Over 1 to 2 (25.4 to 50.8), incl     | 0.003 (0.076)                      |
| Over 2 to 3 (50.8 to 76.2), incl     | 0.004 (0.10)                       |
| Over 3 to 3 1/2 (76.2 to 88.9), incl | 0.005 (0.13)                       |

<sup>A</sup> When tolerances are required for inside diameter, double the values shown.

**TABLE 7 Tolerances on Distance Between Parallel Surfaces for Rectangular and Square Welded Brass Tube**

NOTE 1—The following tolerances are plus and minus. If tolerances all plus or all minus are desired, double the values given.

| Major Outside Dimensions, <sup>A</sup> in. (mm) | Tolerances    |
|---|---------------|
|   | in. (mm)      |
| Up to 1/8 (3.18), incl                          | 0.003 (0.076) |
| Over 1/8 to 5/8 (3.18 to 15.9), incl            | 0.004 (0.10)  |
| Over 5/8 to 1 (15.9 to 25.4), incl              | 0.005 (0.13)  |
| Over 1 to 2 (25.4 to 50.8), incl                | 0.006 (0.15)  |
| Over 2 to 3 (50.8 to 76.2), incl                | 0.007 (0.18)  |
| Over 3 to 4 (76.2 to 102), incl                 | 0.008 (0.20)  |
| Over 4 to 5 (102 to 127), incl                  | 0.009 (0.23)  |
| Over 5 to 6 (127 to 152), incl                  | 0.010 (0.25)  |

<sup>A</sup> The major outside dimension determines the tolerance applicable to minor outside dimension.

shall not exceed 20° when measured in accordance with Test Method B428. The requirement is not applicable to any annealed tubes, tubes as welded from annealed strip, or tubes whose specified major dimension is less than 1/2 in. (12.7 mm).

**14. Workmanship, Finish, and Appearance**

14.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

**15. Sampling**

15.1 The lot size, portion size, and number of sample pieces to be taken shall be as follows:

**TABLE 8 Length Tolerances for Welded Brass Tube in Straight Lengths**

NOTE 1—Tolerances are all plus; if all minus tolerances are desired, use the same values; if tolerances plus and minus are desired, halve the values given.

| Length                                   | Tolerances Applicable Only to Full-Length Pieces         |  |
|--|--|--|
|  | For Major Outside Dimensions up to 1 in. (25.4 mm), incl | For Major Outside Dimensions Over 1 in. (25.4 mm) to 3 1/2 in. (88.9 mm), incl |
|  | in. (mm)   | in. (mm)   |
| Specific lengths:                        |  |  |
| Up to 6 in. (152 mm), incl               | 1/32 (0.79)  | 1/16 (1.6)   |
| Over 6 in. to 2 ft (152 to 610 mm), incl | 1/16 (1.6)   | 3/32 (2.4)   |
| Over 2 to 6 ft (0.610 to 1.83 m), incl   | 3/32 (2.4)   | 1/8 (3.2)  |
| Over 6 to 14 ft (1.83 to 4.27 m), incl   | 1/4 (6.4)  | 1/4 (6.4)  |
| Over 14 ft (4.27 m)                      | 1/2 (13)   | 1/2 (13)   |
| Specific lengths with ends               | 1 (25)   | 1 (25)   |
| Stock lengths with or without ends       | 1 <sup>A</sup> (25 <sup>A</sup> )                        | 1 <sup>A</sup> (25 <sup>A</sup> )  |

<sup>A</sup> As stock lengths are cut and placed in stock in advance of orders, departure from this tolerance is not practicable.

**TABLE 9 Schedule of Tube Lengths (Specific and Stock) with Ends for Welded Brass Tube**

| Major Outside Dimensions, in. (mm)  | Nominal Length, ft (m)      | Shortest Permissible Length, <sup>A</sup> % of Nominal Length | Maximum Permissible Weight of Ends, % of Lot Weight |
|-------------------------------------|-----------------------------|---|---|
| Up to 1 (25.4), incl                | 6 (1.83) to 20 (6.10), incl | 70  | 20  |
| Over 1 (25.4) to 2 (50.8), incl     | 6 (1.83) to 20 (6.10), incl | 60  | 25  |
| Over 2 (50.8) to 3 (76.2), incl     | 6 (1.83) to 20 (6.10), incl | 55  | 30  |
| Over 3 (76.2) to 3 1/2 (88.9), incl | 6 (1.83) to 20 (6.10), incl | 50  | 40  |

<sup>A</sup> Expressed to the nearest 1/2 ft (150 mm).

15.1.1 *Lot Size*—The lot size shall be 10 000 lb (4550 kg) or fraction thereof.

**TABLE 10 Coil Length Tolerances (Specific Lengths)**

| Outside Diameter, in. (mm) | Tolerances, in. (m), All Plus for Nominal Lengths, ft (m) |                                   |
|----------------------------|---|-----------------------------------|
|                            | Up to 50 (15.2) incl                                      | Over 50 (15.2) to 100 (30.5) incl |
| Up to 1½ (38.1) incl       | 12 (0.30)   | 24 (0.61)                         |

**TABLE 11 Coil Length Tolerances (Mill Lengths)**

| Outside Diameter, in. (mm) | Tolerances, %, for Nominal Lengths, ft (m)            |                                     |
|----------------------------|---|-------------------------------------|
|                            | Up to 100 (30.5), incl                                | Over 100 (30.5) to 2000 (610), incl |
| Up to 1 (25.4), incl       | 5 <sup>A</sup> or 2 ft (0.61 m), whichever is greater | 10 <sup>A</sup>                     |
| Over 1 (25.4) to 1½ (38.1) | 5 <sup>A</sup> or 2 ft (0.61 m), whichever is greater | no tolerances established           |

<sup>A</sup> Expressed to the nearest 1 ft (300 mm).

**TABLE 12 Schedule of Mill Lengths with Ends, in Coils**

| Outside Diameter, in. (mm)       | Nominal Length, ft (m)              | Shortest Permissible Length, % of Nominal Length | Maximum Permissible Weight of Ends, % of Lot Weight |
|----------------------------------|-------------------------------------|--|---|
| Up to 1 (25.4), incl             | Up to 100 (30.4), incl              | 70 <sup>A</sup>                                  | 10  |
| Over 1 (25.4) to 1½ (38.1), incl | Up to 100 (30.4), incl              | 60 <sup>A</sup>                                  | 20  |
| Up to 1 (25.4), incl             | Over 100 (30.4) to 2000 (610), incl | 50   | 50 <sup>B</sup>                                     |

<sup>A</sup> Expressed to the nearest foot (300 mm).

<sup>B</sup> Short pieces may be included as follows: up to 10 % of lot weight between 50 ft (15.2 m) and one quarter of full length; and up to 40 % between one quarter and full length.

**TABLE 13 Roundness Tolerances**

| t/D (Ratio of Nominal Wall Thickness to Nominal Outside Diameter) | Roundness Tolerances <sup>A</sup> as % of Nominal Outside Diameter |
|---|--|
| 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 or 0.002 in. (0.051 mm) whichever is greater                   |
| Over 0.10   | 0.7 or 0.002 in. (0.051 mm) whichever is greater                   |

<sup>A</sup> Expressed to the nearest 1 ft (300 mm).

15.1.2 *Portion Size*—The number of pieces to be randomly selected shall be in accordance with the following schedule:

| Number of Tubes in Lot | Number of Pieces to be Taken <sup>A</sup>                                   |
|------------------------|---|
| 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, but not to exceed 10 pieces |

<sup>A</sup> Each sample piece shall be taken from a separate tube.

**15.2 Chemical Composition:**

15.2.1 The sample shall be taken in approximately equal weight from each portion piece selected in 15.1.2 and in accordance with Practice E255. The minimum weight of the composite sample shall be 150 g.

**TABLE 14 Straightness Tolerances for Tube in Drawn Tempers and Welded from Flat-Rolled Strip**

NOTE 1—Applies to round tube in any cold-worked temper from ¼ (6.35) to 3½ in. (88.9 mm) in outside diameter, inclusive.

| Length, ft (m) <sup>A</sup>      | Maximum Curvature (Depth of Arc), in. (mm) |
|----------------------------------|--|
| Over 3 (0.914) to 6 (1.83), incl | ⅜ (4.8)                                    |
| Over 6 (1.83) to 8 (2.44), incl  | ⅝ (7.9)                                    |
| Over 8 (2.44) to 10 (3.05), incl | ½ (13)                                     |

<sup>A</sup> For lengths greater than 10 ft (3.05 m), the maximum curvature shall not exceed ½ in. (13 mm) in any 10 ft portion of the total length.

**TABLE 15 Permissible Radii for Commercially Square Corners for Rectangular and Square Welded Tube**

| Wall Thickness, in. (mm)                 | Maximum Radii            |                         |
|--|--------------------------|-------------------------|
|  | Outside Corners in. (mm) | Inside Corners in. (mm) |
| Up to 0.058 (1.47), incl                 | ⅜ (1.2)                  | ⅜ (0.79)                |
| Over 0.058 to 0.120 (1.47 to 3.03), incl | ⅜ (1.6)                  | ⅜ (0.79)                |
| Over 0.120 to 0.156 (3.03 to 3.96), incl | ⅜ (2.4)                  | ⅜ (0.79)                |

15.2.2 Instead of sampling in accordance with Practice E255, the manufacturer shall have the option of sampling at the time castings are poured or taken from the semifinished product. When chemical composition is determined during the course of manufacture, sampling of the finished product is not required.

15.2.3 The number of samples taken during the course of manufacture shall be as follows:

15.2.3.1 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.

15.2.3.2 When samples are taken from the semifinished product, at least one sample shall be taken to represent each 10 000 lb or fraction thereof, except that not more than one sample per piece shall be required.

**15.3 Other Tests:**

15.3.1 Unless otherwise specified in the contract or purchase order, specimens for all other tests shall be taken from two of the sample pieces taken in 15.1.2. In the event only one sample piece is required, all specimens shall be taken from the piece selected.

15.3.1.1 When tube is furnished in coils, a length sufficient for all necessary tests shall be taken from each coil selected for sampling. The remaining portion of the sampled coil shall be included in the shipment with the permissible variation for such coils waived.

**16. Number of Tests and Retests**

**16.1 Tests:**

16.1.1 *Chemical Analysis*—Chemical composition shall be determined in accordance with the element mean of the results from at least two replicate analyses of the sample(s).

16.1.2 *Other Tests*—Grain size and tensile strength shall be reported as the test results obtained from specimens prepared from each of two pieces selected in 15.1.2, except where only

one piece was required, and all specimens shall meet the minimum test requirement.

#### 16.2 Retests:

16.2.1 When requested by the manufacturer or supplier, a retest shall be permitted when results of tests obtained by the purchaser fail to conform to the requirements of the product specification.

16.2.2 The retest shall be as directed in the product specification for the initial test, except the number of test specimens shall be twice that normally required for the specified test.

16.2.3 All test specimens shall conform to the product specification requirement(s) in retest. Failure to conform shall be cause for rejection.

### 17. Specimen Preparation

17.1 *Chemical Analysis*—Preparation of the analytical test specimens shall be the responsibility of the reporting laboratory.

17.2 *Grain Size*—The test specimens shall be prepared in accordance with Guide E3. The test specimen surface shall approximate a radial longitudinal section of round tube or a longitudinal section of rectangular and square tube perpendicular to, and bisecting, the major dimensional surface.

17.3 *Tensile Test*—The test specimen shall be of the full section of the tube and shall conform to the requirements specified in the section Specimens for Pipe and Tube in Test Methods E8/E8M. Should limitations of the testing machine preclude the use of such a specimen, specimens conforming to Type No. 1 of Fig. 13, Tension Test Specimen for Large-Diameter Tubular Products, of Test Methods E8/E8M may be used.

#### 17.4 Rockwell Hardness:

17.4.1 The test specimen shall be of a size and shape to permit testing by the available test equipment and shall be taken to permit testing in a plane parallel or perpendicular to the direction of deformation given to the product.

17.4.2 The surface of the test specimen shall be sufficiently smooth and even to permit the accurate determination of hardness.

17.4.3 The test specimen shall be free from scale and foreign matter and care shall be taken to avoid any change in condition, for example, heating or cold working.

17.5 *Mercurous Nitrate Test*—The test specimen shall be prepared as described in Test Method B154 and shall be obtained without bending, springing, polishing, or any other preparation.

17.6 *Expansion (Pin Test)*—The specimen shall be prepared as described in the Test Specimen section of Test Method B153. When the temper is other than annealed, the sample is allowed to be annealed prior to testing.

17.7 *Flattening Test*—Test specimen shall be cut in accordance with Test Method B968/B968M. When the temper is other than annealed, the sample may be annealed prior to testing.

17.8 *Reverse Bend Test*—A representative tube sample shall be cut to a length that will accommodate the test. The sample is permitted to be annealed when the temper is other than annealed.

### 18. Test Methods

#### 18.1 Chemical Analysis:

18.1.1 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.

| Element | Test Method        |
|---------|--------------------|
| Copper  | E478               |
| Iron    | E478               |
| Lead    | E478 (AA)          |
| Zinc    | E478 (Titrimetric) |

18.1.2 Test method(s) used for the determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

18.2 The product furnished shall conform to specified requirements when subjected to test in accordance with the following table:

| Test                                       | Test Method |
|--|-------------|
| Grain size                                 | E112        |
| Tension                                    | E8/E8M      |
| Angle of twist                             | B428        |
| Expansion (pin test)                       | B153        |
| Flattening                                 | B968/B968M  |
| Reverse bend                               | 18.2.4      |
| Electromagnetic examination (eddy current) | E243        |
| Hydrostatic                                | 18.2.6      |
| Pneumatic                                  | 18.2.7      |

18.2.1 *Grain Size*—In case of dispute, the intercept method of Test Methods E112 shall be followed.

#### 18.2.2 Tensile Strength:

18.2.2.1 Tensile strength shall be determined in accordance with Test Methods E8/E8M. Whenever test results are obtained from both full-size and machined specimens and they differ, the test results from the full-size specimens shall prevail.

18.2.2.2 Test results are not seriously affected by variations in speed of testing. A considerable range of testing speed is permitted; however, the rate of stressing to the yield strength should not exceed 100 ksi (690 MPa)/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 gauge length (or distance between grips for full-section specimens).

18.2.3 *Flattening Test*—Test specimen shall be cut in accordance with Test Method B968/B968M. When the temper is other than annealed, the sample may be annealed prior to testing.

18.2.4 *Reverse Bend Test*—A representative tube sample shall be cut to a length that will accommodate the test. The sample is permitted to be annealed when the temper is other than annealed.

18.2.4.1 The test specimen shall be flattened and bent around a mandrel with a diameter four times the wall thickness, with the mandrel parallel to the length and in contact with the outside surface of the tube. The weld shall be placed at the point of maximum bend. The sample shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

**18.2.5 Electromagnetic (Eddy-Current) Examination:**

18.2.5.1 The artificial discontinuity calibration standard shall be prepared in accordance with Option *a* or *d* of Practices **E243**, and the notch depth shall be 22 % of the nominal wall thickness rounded to the nearest 0.001 in. (0.025 mm). The notch depth tolerance shall be ±0.0005 in. (0.013 mm). Alternatively, when the equipment is speed insensitive and equipped so that a fraction of the maximum unbalanced signal can be selected, the following percent maximum unbalance signal may be used.

| Tube Size, in. (mm)             | Unbalanced Signal Magnitude, max, % |
|---------------------------------|-------------------------------------|
| Up to 3/8 (9.4) incl            | 0.2                                 |
| 1/2 to 2 (12.7 to 50.8)         | 0.3                                 |
| Over 2 to 3 (50.8 to 76.2) incl | 0.4                                 |

18.2.5.2 Unless otherwise agreed upon, tube causing irrelevant signals because of visible and identifiable handling marks may be retested by the hydrostatic or the pneumatic test, and tube meeting the requirements of either test shall be considered to conform when the dimensions are within the prescribed limits.

18.2.5.3 Tubes with discontinuities indicated by the testing unit, may at the option of the manufacturer, be reexamined or retested to determine whether the discontinuity is cause for rejection. Tube causing irrelevant signals because of minor mechanical damage moisture, soil, and like effects shall not be cause for rejection provided the tube dimensions are still within prescribed limits and the tube is suitable for its intended application.

18.2.6 *Hydrostatic Test*—The internal hydrostatic pressure necessary to produce the required fiber stress shall be determined by the following equation for thin hollow cylinders under tension.

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

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).

18.2.7 *Pneumatic Test*—The test method shall permit easy visual detection of leakage, such as having the material under water or by the pressure differential method.

**19. Significance of Numerical Limits**

19.1 For the purpose 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 **E29**:

| Property                        | Rounded Unit for Observed or Calculated Value                               |
|---------------------------------|---|
| Chemical composition            | nearest unit in the last right-hand place of figures of the specified limit |
| Hardness                        | nearest ksi   |
| Tensile strength                | nearest multiple of 0.005 mm  |
| Grain size up to 0.060 mm, incl |   |

**20. Inspection**

20.1 The manufacturer or supplier shall inspect and make tests necessary to verify the furnished product conforms to specification requirements.

20.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer or supplier and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector representing the purchaser that the product is being furnished in accordance with the specification, shall be included in the agreement. All testing and inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

20.3 When mutually agreed upon, the manufacturer or supplier and the purchaser shall conduct the final inspection simultaneously.

**21. Rejection and Rehearing**

*21.1 Rejection:*

21.1.1 Product that fails to conform to the specification requirements when tested by the purchaser or purchaser’s agent shall be subject to rejection.

21.1.2 Rejection shall be reported to the manufacturer or supplier promptly. In addition, a written notification or rejection shall follow.

21.1.3 In case of dissatisfaction with results of the test upon which rejection is based, the manufacturer or supplier shall have the option to make claim for a rehearing.

*21.2 Rehearing:*

21.2.1 As a result of product rejection, the manufacturer or supplier shall have the option to make claim for a retest to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or alternately, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

**22. Certification**

22.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and inspected as directed in this specification and requirements have been met.

**23. Test Report**

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

## 24. Product Marking

24.1 When specified in the contract or purchase order, the tube shall be identified throughout its length with a brown color marking, not less than  $\frac{3}{16}$  in. (4.8 mm) in height, including a legend repeated at intervals not greater than 3 ft (0.91 m). The legend shall include the name or trademark of the manufacturer, or both, and an indication that the material is welded tube.

## 25. Packaging and Package Marking

### 25.1 Packaging:

25.1.1 The product shall be separated by size, composition, and temper, and prepared for shipment by common carrier, in such a manner as to afford protection from the normal hazards of transportation.

### 25.2 Package Marking:

25.2.1 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight, and name of supplier.

25.2.2 When specified in the contact or purchase order, the product specification number shall be shown.

## 26. Keywords

26.1 C21000; C22000; C23000; C26000; C26800; C27000; C27200; brass tube; welded brass tube; welded tube

## APPENDIX

### (Nonmandatory Information)

## XI. 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 ( $\text{N}/\text{m}^2$ ), 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  $\text{MN}/\text{m}^2$  and  $\text{N}/\text{mm}^2$ .

## SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B587–12) that may impact the use of this standard. (Approved April 1, 2019.)

(1) Made editorial changes per Guide B950.

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