

ASME B16.50-2001

# WROUGHT COPPER AND COPPER ALLOY BRAZE-JOINT PRESSURE FITTINGS

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# WROUGHT COPPER AND COPPER ALLOY BRAZE-JOINT PRESSURE FITTINGS

ASME B16.50-2001

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## FOREWORD

In 1994, the ASME B16 Committee authorized Subcommittee J Standardization to develop a standard for wrought copper and copper alloy braze-joint pressure fittings. These fittings are intended for use with seamless copper tube conforming to ASTM Standard Specifications, B 88 (Water and General Plumbing Systems), B 280 (Air Conditioning and Refrigeration Service), and B 819 (Medical Gas Systems). Following approval by the Standards Committee and ASME, this Standard was approved as an American National Standard on October 11, 2001, with the new designation ASME B16.50-2001.

Requests for interpretation or suggestions for revision should be sent to the Secretary, B16 Committee, The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016-5990.

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The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

|           |                                                                                                                                                                                                                                                                                                                                                                          |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subject:  | Cite the applicable paragraph number(s) and the topic of the inquiry.                                                                                                                                                                                                                                                                                                    |
| Edition:  | Cite the applicable edition of the Standard for which the interpretation is being requested.                                                                                                                                                                                                                                                                             |
| Question: | Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information. |

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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## WROUGHT COPPER AND COPPER ALLOY BRAZE-JOINT PRESSURE FITTINGS

### 1 SCOPE

#### 1.1 General

This Standard establishes requirements for wrought copper and wrought copper alloy braze-joint seamless fittings designed for use with seamless copper tube conforming to ASTM Standard Specification, B 88 (Water and General Plumbing Systems), B 280 (Air Conditioning and Refrigeration Service), and B 819 (Medical Gas Systems).

This Standard covers joints assembled with brazing materials conforming to ANSI/AWS A5.8.

This Standard is allied to ASME standards B16.18 and B16.22. It provides requirements for fitting-ends suitable for brazing. This Standard covers:

- (a) pressure-temperature ratings;
- (b) abbreviations for end connections;
- (c) size and method of designating openings of fittings;
- (d) marking;
- (e) material;
- (f) dimensions and tolerances; and
- (g) testing.

#### 1.2 Convention

For the purpose of determining conformance with this Standard, the convention for fixing significant digits where limits, maximum or minimum values, are specified shall be "rounding off" as defined in ASTM E 29. This requires that an observed or calculated value shall be rounded off to the nearest unit in the last right-hand digit used for expressing the limit.

#### 1.3 Units of Measure

The values stated in either SI (metric) or US Customary (in.-lb) units of measure shall be regarded separately as standard. Within the main text, SI units are given. For convenience, the customary units are shown in Mandatory Appendix I. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other.

NOTE: Combining values from the two systems may result in nonconformance with the standard.

#### 1.4 References

Standards and specifications adopted by reference in this Standard are shown in Mandatory Appendix II, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the individual references. Instead, the specific edition reference is identified in Mandatory Appendix II.

#### 1.5 Quality Systems

Requirements relating to the product manufacturer's Quality System Programs are described in Nonmandatory Appendix B.

### 2 PRESSURE-TEMPERATURE RATINGS

#### 2.1 Rating of System

The internal working pressure-temperature rating for a braze-joint system is dependent upon, not only fitting and tube strength, but also selection of valves and appurtenances.

Pressure-temperature ratings for fittings and braze joints to the dimensions of Table 3 (Table I3), made with typical commercial brazing materials, shall be considered equal to the values given in Table 1 (Table I1).

The internal working-pressure rating of the system shall be the lowest of the values shown in Table 1 (Table I1) and those of the tube, valves, or appurtenances.

#### 2.2 Fitting Bursting Strength

Fittings manufactured to this Standard shall have an ambient-temperature bursting-strength of at least four times the 38°C (100°F) rated internal working-pressure as shown in Table 1 (Table I1).

**TABLE 1 RATED INTERNAL WORKING-PRESSURE FOR COPPER FITTINGS, kPa**

| Standard Water<br>Tube Size<br>[Note (1)] | -29/38°C | 66°C | 93°C | 121°C | 149°C | 177°C | 204°C |
|-------------------------------------------|----------|------|------|-------|-------|-------|-------|
| 1/8 [Note (2)]                            | 9690     | 8240 | 7750 | 7750  | 7590  | 6460  | 4840  |
| 3/16 [Note (3)]                           | 7630     | 6490 | 6110 | 6110  | 5980  | 5090  | 3810  |
| 1/4                                       | 6280     | 5340 | 5020 | 5020  | 4920  | 4190  | 3140  |
| 3/8                                       | 5360     | 4560 | 4290 | 4290  | 4200  | 3570  | 2680  |
| 1/2                                       | 4970     | 4220 | 3980 | 3980  | 3890  | 3310  | 2480  |
| 5/8                                       | 4350     | 3700 | 3480 | 3480  | 3410  | 2900  | 2170  |
| 3/4                                       | 4010     | 3410 | 3210 | 3210  | 3140  | 2670  | 2000  |
| 1                                         | 3400     | 2890 | 2720 | 2720  | 2660  | 2270  | 1700  |
| 1 1/4                                     | 3020     | 2570 | 2420 | 2420  | 2370  | 2010  | 1510  |
| 1 1/2                                     | 2810     | 2390 | 2250 | 2250  | 2200  | 1870  | 1400  |
| 2                                         | 2500     | 2130 | 2000 | 2000  | 1960  | 1670  | 1250  |
| 2 1/2                                     | 2310     | 1960 | 1850 | 1850  | 1810  | 1540  | 1150  |
| 3                                         | 2180     | 1850 | 1740 | 1740  | 1710  | 1450  | 1090  |
| 3 1/2                                     | 2090     | 1770 | 1670 | 1670  | 1630  | 1390  | 1040  |
| 4                                         | 2020     | 1710 | 1610 | 1610  | 1580  | 1340  | 1010  |
| 5                                         | 1850     | 1570 | 1480 | 1480  | 1450  | 1230  | 920   |
| 6                                         | 1720     | 1460 | 1380 | 1380  | 1350  | 1150  | 860   |
| 8                                         | 1860     | 1580 | 1490 | 1490  | 1460  | 1240  | 930   |

**GENERAL NOTES:**

- (a) The fitting pressure-rating applies to the largest opening of the fitting.  
 (b) The fitting pressure-rating is calculated, as shown in Nonmandatory Appendix A, then rounded down to the nearest unit of 10.

**NOTES:**

- (1) For size designation of fittings, see Section 4.  
 (2) 1/8 nominal size is 1/4 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.  
 (3) 3/16 nominal size is 5/16 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.

**3 TERMINOLOGY****3.1 Abbreviations**

The following symbols are used to designate the type of fitting end:

*C* = braze-joint fitting end made to receive copper tube diameter (female)

*F* = internal ANSI standard taper pipe-thread end (female) NPTI

*M* = external ANSI standard taper pipe-thread end (male) NPTE

*FTG* = braze-joint fitting end made to copper tube diameter (male)

**3.2 Definitions**

*out-of-roundness*: the maximum measured diameter minus minimum measured diameter.

*ovality*: the elliptical condition associated with out-of-roundness.

**4 SIZE**

The size of the fittings shown in Table 3 and Table I3 corresponds to standard water tube size as shown in ASTM B 88, Specification for Seamless Copper Water Tube. The size of the threaded ends corresponds to nominal pipe size as shown in ASME B1.20.1.

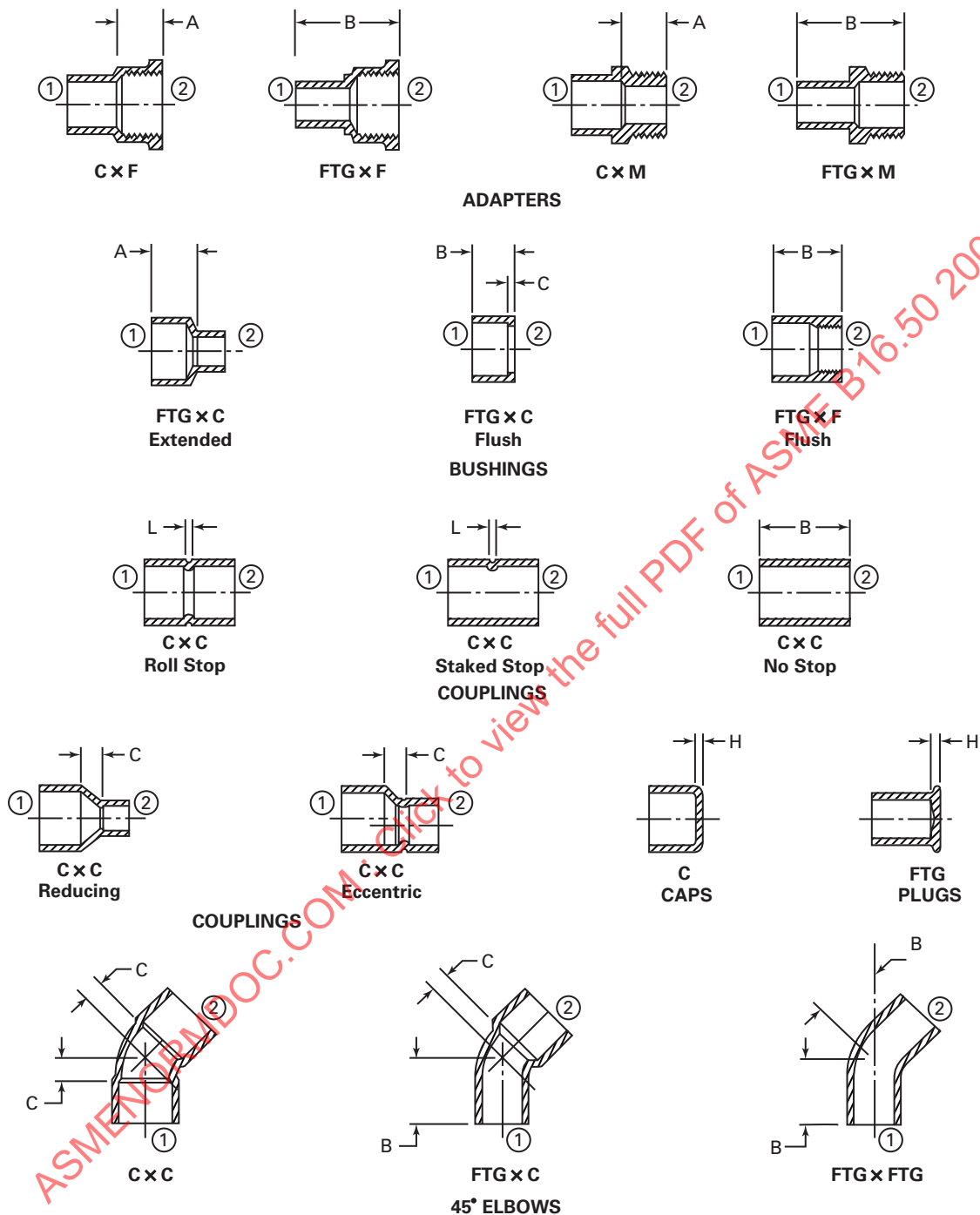
Fittings are designated by the size of the openings in the sequence illustrated in Fig. 1.

**5 MARKING**

Each fitting shall be permanently marked with the manufacturer's name or trademark in accordance with MSS SP-25 and the letters "BZ" in upper case. Marking on fittings less than size 1/2 or on any fitting where it damages the brazing surfaces is not required.

**6 MATERIAL**

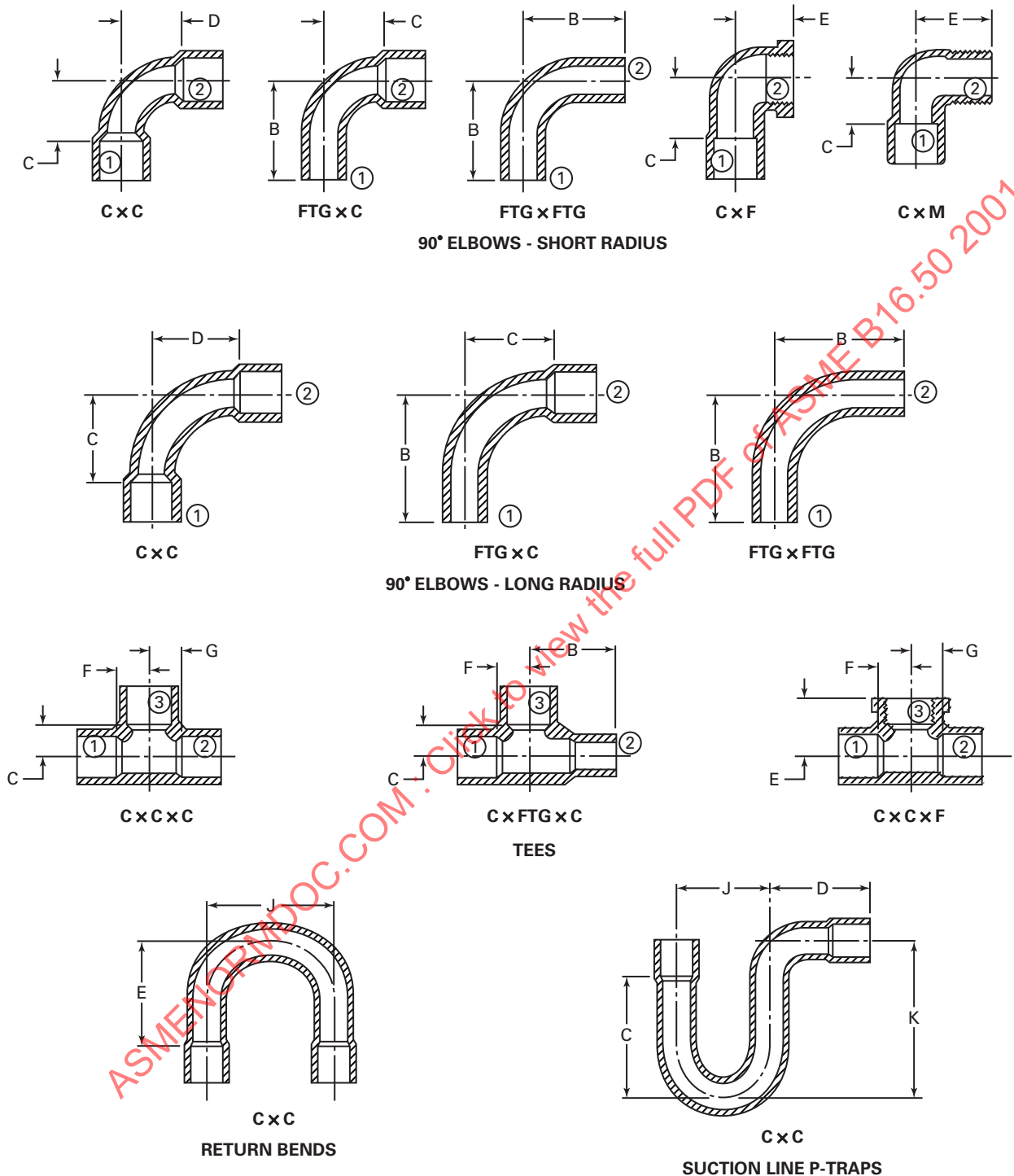
- (a) Fittings shall be made from copper UNS Nos.



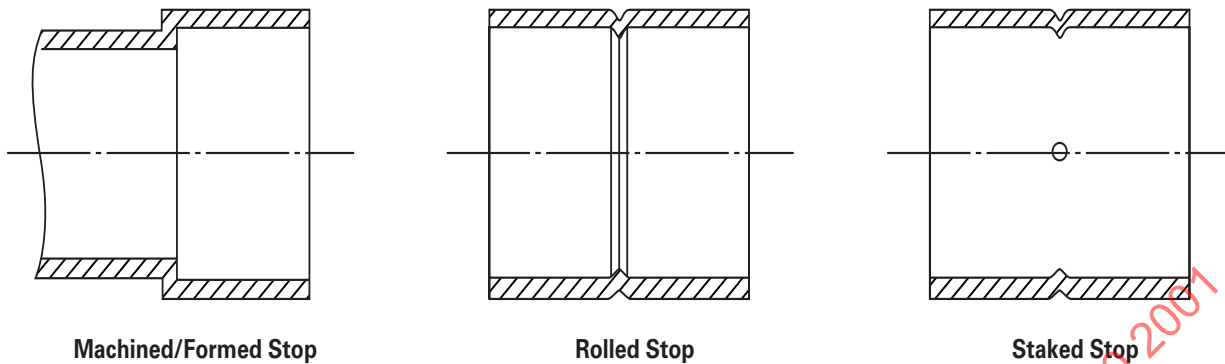
**GENERAL NOTES:**

- Fittings are designated by size in the order: 1 x 2 x 3.
- Fitting designs and drawings are illustrative only.

**FIG. 1 METHOD OF DESIGNATING LAYING LENGTHS OF FITTINGS AND OPENINGS OF REDUCING FITTINGS**



**FIG. 1 METHOD OF DESIGNATING LAYING LENGTHS OF FITTINGS AND OPENINGS OF  
REDUCING FITTINGS (CONT'D)**



GENERAL NOTE: Figure 2 is for information only; the shape and number of abutments are at the manufacturer's discretion.

**FIG. 2 TUBE STOPS**

C10200, C12000, or C12200; or copper alloy UNS C23000, for which allowable stresses are found in ASME B31.1, ASME B31.9, or ASME Boiler and Pressure Vessel Code, Section II, Materials.

(b) Other coppers and copper alloys are permitted provided they meet the chemical requirements of 84% minimum copper and 16% maximum zinc, and provided the fittings produced from the copper alloy meets all the mechanical and corrosion-resistant properties for the end purposes of the fittings. The composition of the copper alloys shall contain nothing that will inhibit joining to the tube or to other fittings.

## 7 LAYING LENGTHS

Due to widely varying manufacturing processes, meaningful laying length requirements of fittings cannot be established. Consult the manufacturer for these dimensions.

## 8 TUBE STOPS

Except for repair couplings, fittings shall be manufactured with a tube stop. Repair couplings shall not require a tube stop. The tube stop shall control joint length, even with an external (FTG) end having the minimum outside diameter shown in Table 3 (Table I3). Examples of various tube stop configurations are shown in Fig. 2.

**TABLE 2 INSPECTION TOLERANCE**

| Standard Water Tube<br>and Pipe Thread Sizes                                       | Tolerance,<br>Plus or Minus,<br>mm |
|------------------------------------------------------------------------------------|------------------------------------|
| $\frac{1}{8}$ [Note (1)], $\frac{3}{16}$ [Note (2)], $\frac{1}{4}$ , $\frac{3}{8}$ | 1.3                                |
| $\frac{1}{2}$ , $\frac{5}{8}$ , $\frac{3}{4}$                                      | 1.5                                |
| 1, $1\frac{1}{4}$ , $1\frac{1}{2}$ , 2                                             | 2.0                                |
| $2\frac{1}{2}$ , 3, $3\frac{1}{2}$                                                 | 2.8                                |
| 4 and 5                                                                            | 3.0                                |
| 6 and 8                                                                            | 4.1                                |

**NOTES:**

- (1)  $\frac{1}{8}$  nominal size is  $\frac{1}{4}$  O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.
- (2)  $\frac{3}{16}$  nominal size is  $\frac{5}{16}$  O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.

## 9 INSPECTION TOLERANCE

### 9.1 Linear Dimensions

An inspection tolerance, as shown in Table 2 (Table I2), shall be allowed on center-to-shoulder, center-to-center, center-to-threaded end, and shoulder-to-threaded end dimensions on all fittings having internal (C) braze ends, as well as, on center-to-braze end and braze end-to-threaded end dimensions on all fittings having external (FTG) braze ends.

Coupling inspection-limits for shoulder-to-shoulder and shoulder-to-end dimensions shall be double those shown in Table 2 (Table I2), except that the minus tolerance applied to dimension *L* (Fig. 1) shall not result in a dimension less than 1.5 mm (0.06 in.).

The largest opening in the fitting shall govern the tolerance to be applied to all openings.

## 9.2 Ovality of Fitting End (C or FTG)

Maximum ovality of the fitting braze-joint end shall not exceed 1% of the maximum diameters shown in Table 3 (Table I3). The average of the maximum and minimum diameters shall be within the dimensions shown in the table.

## 9.3 Inside Diameter of Fitting

The minimum cross-sectional area of the inside diameter through the fitting body shall not be less than the theoretical minimum area defined by diameter "O" in Table 3 (Table I3). The out-of-roundness condition of the cross-sectional area shall not exceed the value shown in Table 3 (Table I3).

For reducer or adapter fittings, the smallest end diameter shall apply, provided that this diameter does not restrict the other outlets.

## 9.4 Wall Thickness

The minimum wall-thickness shall not be less than shown in Table 3 (Table I3).

## 10 THREADED ENDS

Fitting threads shall be right-hand, conforming to ASME B1.20.1, American National Standard for Pipe Threads, General Purpose (Inch). They shall be taper threads (NPT).

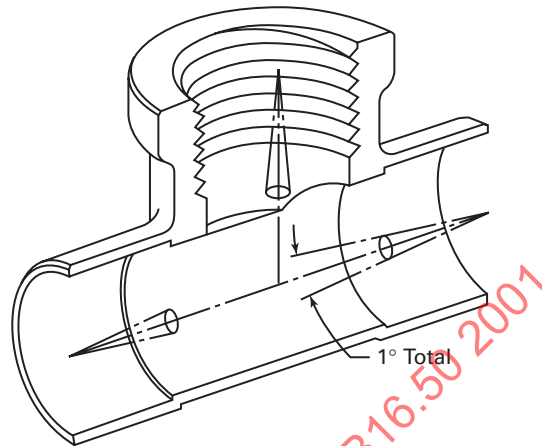
### 10.1 Countersink or Chamfer

All internal threads shall be countersunk a distance no less than one-half the pitch of the thread, at an angle of approximately 45 deg with the axis of the thread. All external threads shall be chamfered at an angle of 30 deg to 45 deg from the axis. Countersinking and chamfering shall be concentric with the threads.

The length of threads shall be measured to include the countersink or chamfer.

### 10.2 Threading Tolerances

Tapered pipe threads (NPT) shall be checked by use of plug or ring gauges in either standard or limit types. When gauging internal taper threads, the plug gauge shall be screwed handtight into the fitting. The reference point for gauging internal product-threads depends on the chamfer diameter. When the internal-chamfer diameter exceeds the major diameter of the internal thread, the reference point shall be the last thread scratch on the chamfer cone. Otherwise, when the internal-chamfer



GENERAL NOTE: Figure 2 is for illustration only.

**FIG. 3 ALIGNMENT**

diameter does not exceed the major diameter of the internal thread, the reference point shall be the end of the fitting. In gauging external taper threads, the ring gauge shall be screwed handtight on the external thread. On the external thread, the ring gauge shall be flush with the end of the thread.

Tolerance for an internally threaded end having an internal shoulder shall be from the gauge reference point (notch) to one turn small. Tolerance for an internally threaded end without a shoulder, and for an externally threaded end, shall be from one turn small to one turn large.

### 10.3 Design of Threaded Ends

The wrenching section of internally threaded ends shall be polygonal, and the wrenching section of externally threaded ends shall be furnished with either polygon or flats, at the manufacturer's option.

## 11 ALIGNMENT

The maximum-allowable deviation in the angular alignment of any end from the specified axis position shall be  $\frac{1}{2}$  deg (1 deg total) (see Fig. 3).

## 12 GAUGING

### 12.1 Preferred Gauging Method of Braze-Joint Ends

The preferred method of gauging the diameter tolerances for external and internal ends shall be by the

use of plain plug and ring gauges designed to hold the product within the limits established in Table 3 (Table 13). Gauge tolerances shall be Class ZM, as defined in ASME B4.4M.

## **12.2 Optional Gauging Method of Braze-Joint Ends**

For gauging the diameter tolerance of external and internal ends, the use of direct reading instruments instead of ring and plug gauges as specified in para. 12.1 shall be permitted. When gauging the diameters

of external and internal ends using direct reading instruments, refer to para. 9.2.

## **12.3 Standard Gauging Method of Threaded Ends**

The standard method of gauging the externally and internally threaded ends shall be in accordance with the requirements of ASME B1.20.1.

NOTE: In gauging pipe threads, it is acceptable and common practice to rap or tap the part to assure proper seating of the gauge. However, it is first necessary to clean both the gauge and the product threads to assure that they are free of chips, burrs, abrasives, or other foreign materials.

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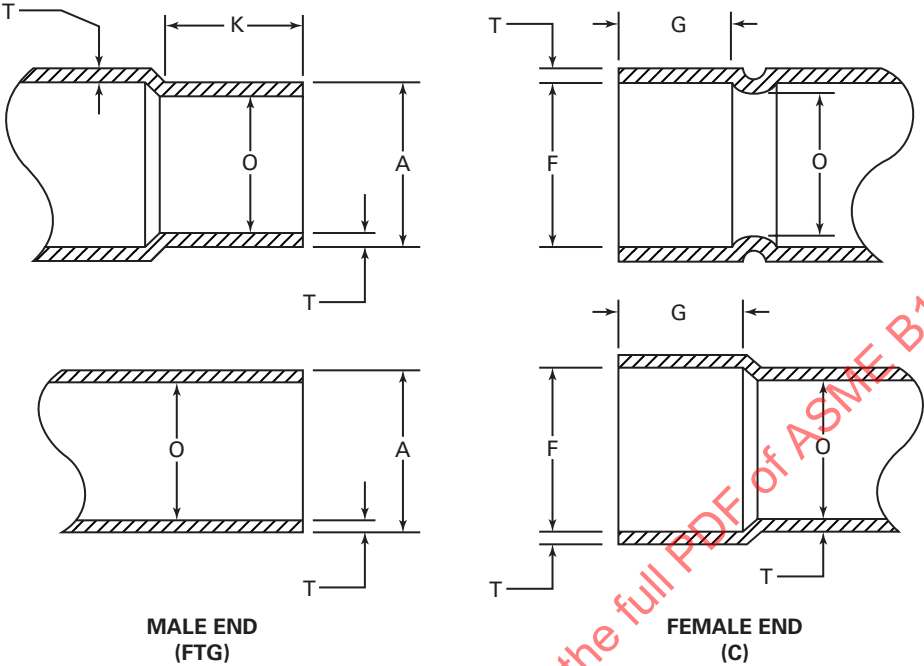


TABLE 3 ILLUSTRATION DIMENSIONS OF BRAZE-JOINT ENDS

**TABLE 3 DIMENSIONS OF BRAZE-JOINT ENDS**

| Standard Water<br>Tube Size<br>[Note (1)] | External End                             |        |                                | Internal End                            |        |                               | Wall<br>Thickness, <i>T</i> | Inside Diameter<br>of Fitting, <i>O</i> | Out-of-<br>Round<br>Max. |
|-------------------------------------------|------------------------------------------|--------|--------------------------------|-----------------------------------------|--------|-------------------------------|-----------------------------|-----------------------------------------|--------------------------|
|                                           | Outside Diameter, <i>A</i><br>[Note (2)] |        | Length, <i>K</i><br>[Note (3)] | Inside Diameter, <i>F</i><br>[Note (2)] |        | Depth, <i>G</i><br>[Note (4)] |                             |                                         |                          |
|                                           | Min.                                     | Max.   | Min.                           | Min.                                    | Max.   | Min.                          |                             |                                         |                          |
| 1/8 [Note (5)]                            | 6.30                                     | 6.38   | 5.1                            | 6.40                                    | 6.50   | 3.8                           | 0.48                        | 4.6                                     | 0.5                      |
| 3/16 [Note (6)]                           | 7.87                                     | 7.95   | 5.1                            | 8.95                                    | 8.08   | 4.1                           | 0.58                        | 6.1                                     | 0.6                      |
| 1/4                                       | 9.47                                     | 9.55   | 5.8                            | 9.58                                    | 9.68   | 4.3                           | 0.58                        | 7.6                                     | 0.8                      |
| 3/8                                       | 12.62                                    | 12.73  | 6.6                            | 12.75                                   | 12.85  | 5.1                           | 0.66                        | 9.9                                     | 1.0                      |
| 1/2                                       | 15.80                                    | 15.90  | 7.1                            | 15.93                                   | 16.03  | 5.6                           | 0.74                        | 13.2                                    | 1.3                      |
| 5/8                                       | 18.97                                    | 19.08  | 7.6                            | 19.10                                   | 19.20  | 6.1                           | 0.79                        | 16.0                                    | 1.6                      |
| 3/4                                       | 22.15                                    | 22.25  | 7.9                            | 22.28                                   | 22.38  | 6.4                           | 0.84                        | 18.8                                    | 1.9                      |
| 1                                         | 28.50                                    | 28.63  | 8.6                            | 28.65                                   | 28.75  | 7.1                           | 1.02                        | 24.9                                    | 2.5                      |
| 1 1/4                                     | 34.85                                    | 34.98  | 9.4                            | 35.00                                   | 35.10  | 7.9                           | 1.12                        | 31.2                                    | 3.1                      |
| 1 1/2                                     | 41.17                                    | 41.33  | 10.2                           | 41.35                                   | 41.48  | 8.6                           | 1.30                        | 37.3                                    | 3.7                      |
| 2                                         | 53.87                                    | 54.03  | 11.9                           | 54.05                                   | 54.18  | 10.2                          | 1.50                        | 49.3                                    | 4.9                      |
| 2 1/2                                     | 66.57                                    | 66.73  | 13.5                           | 66.75                                   | 66.88  | 11.9                          | 1.70                        | 61.5                                    | 6.1                      |
| 3                                         | 79.27                                    | 79.43  | 15.0                           | 79.45                                   | 79.58  | 13.5                          | 1.91                        | 73.4                                    | 7.3                      |
| 3 1/2                                     | 91.97                                    | 92.13  | 16.5                           | 92.15                                   | 92.28  | 14.0                          | 2.18                        | 85.6                                    | 8.6                      |
| 4                                         | 104.67                                   | 104.83 | 18.3                           | 104.85                                  | 104.98 | 16.3                          | 2.44                        | 97.5                                    | 9.8                      |
| 5                                         | 130.07                                   | 130.23 | 20.6                           | 130.25                                  | 130.38 | 18.5                          | 2.82                        | 119.4                                   | 11.9                     |
| 6                                         | 155.47                                   | 155.63 | 23.9                           | 155.65                                  | 155.78 | 21.1                          | 3.15                        | 145.3                                   | 14.5                     |
| 8                                         | 206.22                                   | 206.43 | 32.5                           | 206.45                                  | 206.58 | 29.7                          | 4.39                        | 191.8                                   | 19.2                     |

**GENERAL NOTES:**

- (a) Dimensions are in millimeters.  
(b) Drawings and designs of fittings are illustrative only. Dimensions herein shall govern in all cases.

**NOTES:**

- (1) For size designation of fittings, see Section 4.  
(2) For ovality, see para. 8.2.  
(3) The distance from the point of tangency, at the gauge I.D. to the gauge line, shall be equal to the dimension shown in Column K.  
(4) The distance from the point of tangency, at the gauge O.D. to the gauge line, shall be equal to the dimension shown in Column G.  
(5) 1/8 nominal size is 1/4 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.  
(6) 3/16 nominal size is 5/16 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.

## MANDATORY APPENDIX I U.S. CUSTOMARY EQUIVALENTS

**TABLE I1 RATED INTERNAL WORKING-PRESSURE FOR COPPER FITTINGS (psi)**

| Standard Water<br>Tube Size<br>[Note (1)] | -20-100°F | 150°F | 200°F | 250°F | 300°F | 350°F | 400°F |
|-------------------------------------------|-----------|-------|-------|-------|-------|-------|-------|
| 1/8 [Note (2)]                            | 1405      | 1195  | 1125  | 1125  | 1100  | 935   | 700   |
| 3/16 [Note (3)]                           | 1105      | 940   | 885   | 885   | 865   | 735   | 550   |
| 1/4                                       | 910       | 770   | 725   | 725   | 710   | 605   | 455   |
| 3/8                                       | 775       | 660   | 620   | 620   | 610   | 515   | 385   |
| 1/2                                       | 720       | 610   | 575   | 575   | 565   | 480   | 360   |
| 5/8                                       | 630       | 535   | 505   | 505   | 490   | 420   | 315   |
| 3/4                                       | 580       | 490   | 465   | 465   | 455   | 385   | 290   |
| 1                                         | 490       | 420   | 395   | 395   | 385   | 325   | 245   |
| 1 1/4                                     | 435       | 370   | 350   | 350   | 340   | 290   | 215   |
| 1 1/2                                     | 405       | 345   | 325   | 325   | 315   | 270   | 200   |
| 2                                         | 360       | 305   | 290   | 290   | 280   | 240   | 180   |
| 2 1/2                                     | 335       | 285   | 265   | 265   | 260   | 220   | 165   |
| 3                                         | 315       | 265   | 250   | 250   | 245   | 210   | 155   |
| 3 1/2                                     | 300       | 255   | 240   | 240   | 235   | 200   | 150   |
| 4                                         | 290       | 245   | 230   | 230   | 225   | 195   | 145   |
| 5                                         | 265       | 225   | 215   | 215   | 210   | 175   | 130   |
| 6                                         | 250       | 210   | 200   | 200   | 195   | 165   | 125   |
| 8                                         | 270       | 225   | 215   | 215   | 210   | 180   | 135   |

**GENERAL NOTES:**

- (a) The fitting pressure-rating applies to the largest opening of the fitting.  
 (b) The fitting pressure-rating is calculated, as shown in Nonmandatory Appendix A, then rounded down to the nearest unit of 5.

**NOTES:**

- (1) For size designation of fittings, see Section 4.  
 (2) 1/8 nominal size is 1/4 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.  
 (3) 3/16 nominal size is 5/16 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.

**TABLE I2 INSPECTION TOLERANCE**

| Standard Water Tube<br>and Pipe Thread Sizes | Tolerance,<br>Plus or Minus,<br>in. |
|----------------------------------------------|-------------------------------------|
| 1/8 [Note (1)], 3/16 [Note (2)], 1/4, 3/8    | 0.05                                |
| 1/2, 5/8, 3/4                                | 0.06                                |
| 1, 1 1/4, 1 1/2, 2                           | 0.08                                |
| 2 1/2, 3, 3 1/2                              | 0.11                                |
| 4 and 5                                      | 0.12                                |
| 6 and 8                                      | 0.16                                |

**NOTES:**

- (1) 1/8 nominal size is 1/4 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.  
 (2) 3/16 nominal size is 5/16 O.D. seamless copper tube for refrigeration service, etc., as listed in ASTM B 280.

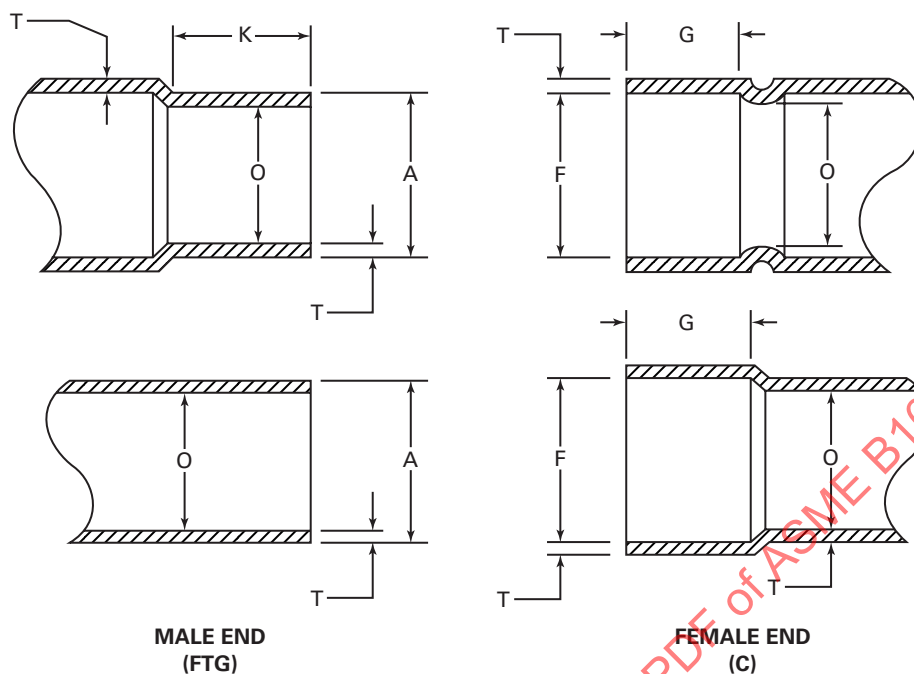


TABLE I3 DIMENSIONS OF BRAZE-JOINT ENDS

| Standard Water<br>Tube Size<br>[Note (1)] | External End                                |                                   | Internal End                                  |       |                                  |      | Wall<br>Thickness,<br><i>T</i> | Inside Diameter<br>of Fitting,<br><i>O</i> | Out-of-<br>Round<br>Max. |
|-------------------------------------------|---------------------------------------------|-----------------------------------|-----------------------------------------------|-------|----------------------------------|------|--------------------------------|--------------------------------------------|--------------------------|
|                                           | Outside Diameter,<br><i>A</i><br>[Note (2)] | Length,<br><i>K</i><br>[Note (3)] | Inside<br>Diameter,<br><i>F</i><br>[Note (2)] |       | Depth,<br><i>G</i><br>[Note (4)] |      |                                |                                            |                          |
|                                           |                                             |                                   | Min.                                          | Max.  |                                  | Min. |                                |                                            |                          |
| 1/8 [Note (5)]                            | 0.248                                       | 0.251                             | 0.20                                          | 0.252 | 0.256                            | 0.15 | 0.019                          | 0.18                                       | 0.02                     |
| 3/16 [Note (6)]                           | 0.310                                       | 0.313                             | 0.20                                          | 0.314 | 0.318                            | 0.16 | 0.023                          | 0.24                                       | 0.02                     |
| 1/4                                       | 0.373                                       | 0.376                             | 0.23                                          | 0.377 | 0.381                            | 0.17 | 0.023                          | 0.30                                       | 0.03                     |
| 3/8                                       | 0.497                                       | 0.501                             | 0.26                                          | 0.502 | 0.506                            | 0.20 | 0.026                          | 0.39                                       | 0.04                     |
| 1/2                                       | 0.622                                       | 0.626                             | 0.28                                          | 0.627 | 0.631                            | 0.22 | 0.029                          | 0.52                                       | 0.05                     |
| 5/8                                       | 0.747                                       | 0.751                             | 0.30                                          | 0.752 | 0.756                            | 0.24 | 0.031                          | 0.63                                       | 0.06                     |
| 3/4                                       | 0.872                                       | 0.876                             | 0.31                                          | 0.877 | 0.881                            | 0.25 | 0.033                          | 0.74                                       | 0.07                     |
| 1                                         | 1.122                                       | 1.127                             | 0.34                                          | 1.128 | 1.132                            | 0.28 | 0.040                          | 0.98                                       | 0.10                     |
| 1 1/4                                     | 1.372                                       | 1.377                             | 0.37                                          | 1.378 | 1.382                            | 0.31 | 0.044                          | 1.23                                       | 0.12                     |
| 1 1/2                                     | 1.621                                       | 1.627                             | 0.40                                          | 1.628 | 1.633                            | 0.34 | 0.051                          | 1.47                                       | 0.15                     |
| 2                                         | 2.121                                       | 2.127                             | 0.47                                          | 2.128 | 2.133                            | 0.40 | 0.059                          | 1.94                                       | 0.19                     |
| 2 1/2                                     | 2.621                                       | 2.627                             | 0.53                                          | 2.628 | 2.633                            | 0.47 | 0.067                          | 2.42                                       | 0.24                     |
| 3                                         | 3.121                                       | 3.127                             | 0.59                                          | 3.128 | 3.133                            | 0.53 | 0.075                          | 2.89                                       | 0.29                     |
| 3 1/2                                     | 3.621                                       | 3.627                             | 0.65                                          | 3.628 | 3.633                            | 0.59 | 0.086                          | 3.37                                       | 0.34                     |
| 4                                         | 4.121                                       | 4.127                             | 0.72                                          | 4.128 | 4.133                            | 0.64 | 0.096                          | 3.84                                       | 0.38                     |
| 5                                         | 5.121                                       | 5.127                             | 0.81                                          | 5.128 | 5.133                            | 0.73 | 0.111                          | 4.70                                       | 0.47                     |
| 6                                         | 6.121                                       | 6.127                             | 0.94                                          | 6.128 | 6.133                            | 0.83 | 0.124                          | 5.72                                       | 0.57                     |
| 8                                         | 8.119                                       | 8.127                             | 1.28                                          | 8.128 | 8.133                            | 1.17 | 0.173                          | 7.55                                       | 0.76                     |

(continued)