



Standard Specification for Seamless Copper Water Tube¹

This standard is issued under the fixed designation B 88; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers seamless copper water tube suitable for general plumbing, similar applications for the conveyance of fluids, and commonly used with solder, flared, or compression-type fittings. The type of copper water tube suitable for any particular application is determined by the internal or external fluid pressure, by the installation and service conditions, and by local requirements. Means of joining or bending are also factors which affect the selection of the type of tube to be used.²

Note 1—Annealed tube is suitable for use with flared or compression fittings, and with solder-type fittings, provided rounding and sizing of the tube ends is performed where needed.

Note 2—Drawn temper tube is suitable for use with solder-type fittings. Types K and L tube, in the drawn temper, are suitable for use with certain types and sizes of compression fittings.

Note 3—A complete metric companion to Specification B 88 has been developed—B 88M; therefore, no metric equivalents are presented in this specification.

Note 4—Fittings used for soldered or brazed connections in plumbing systems are described in ASME B16.14 and ASME B16.22.

1.2 The tube shall be produced from the following coppers, and the manufacturer has the option to supply any one of them, unless otherwise specified.

Copper UNS No.	Previously Used Designation	Description
C10200	OF	Oxygen free without residual deoxidants
C12000	DLP	Phosphorus deoxidized, low residual phosphorus
C12200	DHP	Phosphorus deoxidized, high residual phosphorus

1.3 The assembly of copper plumbing or fire sprinkler systems by soldering is described in Practice B 828.

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

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² The UNS system for copper and copper alloys (see Practice B 327) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix is permitted to be used to accommodate compositional variations of the base alloy.

1.4 Solders for joining copper potable water or fire sprinkler systems are covered by Specification B 32. The requirements for acceptable fluxes for these systems are covered by Specification B 813.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 15, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

2.2 ASTM Standards:³

- B 32 Specification for Solder Metal
- B 88M Specification for Seamless Copper Water Tube [Metric]
- B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
- B 557 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
- B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
- B 813 Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
- B 828 Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- E 2 Methods of Preparation of Micrographs of Metals and Alloys
- E 3 Guide for Preparation of Metallographic Specimens
- E 8 Test Methods for Tension Testing of Metallic Materials
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
- E 29 Practice for Using Significant Digits in Test Data to

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

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

TABLE 1 Dimensions, Weights, and Tolerances in Diameter and Wall Thickness for Nominal or Standard Copper Water Tube Sizes
(All tolerances are plus and minus except as otherwise indicated)

Nominal or Standard Size, in.	Outside Diameter, in.	Average Outside Diameter ^A Tolerance, in.		Wall Thickness and Tolerances, in.						Theoretical Weight, lb/ft		
		Annealed	Drawn	Type K		Type L		Type M		Type K	Type L	Type M
				Wall Thickness	Tolerance ^B	Wall Thickness	Tolerance ^B	Wall Thickness	Tolerance ^B			
1/4	0.375	0.002	0.001	0.035	0.0035	0.030	0.003	c	c	0.145	0.126	c
3/8	0.500	0.0025	0.001	0.049	0.005	0.035	0.004	0.025	0.002	0.269	0.198	0.143
1/2	0.625	0.0025	0.001	0.049	0.005	0.040	0.004	0.028	0.003	0.344	0.285	0.204
3/4	0.750	0.0025	0.001	0.049	0.005	0.042	0.004	c	c	0.418	0.362	c
7/8	0.875	0.003	0.001	0.069	0.008	0.045	0.004	0.032	0.003	0.541	0.455	0.323
1	1.125	0.0035	0.0015	0.065	0.006	0.050	0.005	0.035	0.004	0.639	0.655	0.465
1 1/4	1.375	0.004	0.0015	0.065	0.006	0.055	0.006	0.042	0.004	1.04	0.884	0.652
1 1/2	1.625	0.0045	0.002	0.072	0.007	0.060	0.006	0.049	0.005	1.36	1.14	0.940
2	2.125	0.005	0.002	0.083	0.008	0.070	0.007	0.056	0.006	2.06	1.75	1.46
2 1/2	2.625	0.005	0.002	0.095	0.010	0.080	0.008	0.066	0.006	2.93	2.48	2.03
3	3.125	0.005	0.002	0.109	0.011	0.090	0.009	0.072	0.007	4.03	3.33	2.68
3 1/2	3.625	0.005	0.002	0.120	0.012	0.100	0.010	0.083	0.008	5.12	4.29	3.58
4	4.125	0.005	0.002	0.134	0.013	0.110	0.011	0.095	0.010	6.51	5.38	4.66
5	5.125	0.005	0.002	0.160	0.018	0.128	0.012	0.109	0.011	9.67	7.61	6.68
6	6.125	0.005	0.002	0.192	0.019	0.140	0.014	0.122	0.012	13.9	10.2	8.92
8	8.125	0.006	+ 0.002 - 0.004	0.271	0.027	0.200	0.020	0.170	0.017	25.9	19.3	16.6
10	10.125	0.008	+ 0.002 - 0.006	0.336	0.034	0.250	0.025	0.212	0.021	40.3	30.1	25.6
12	12.125	0.008	+ 0.002 - 0.006	0.406	0.040	0.280	0.028	0.254	0.025	57.6	40.4	36.7

^A The average outside diameter of a tube is the average of the maximum and minimum outside diameter, as determined at any one cross section of the tube.
^B Maximum deviation at any one point.
^C Indicates that the material is not generally available or that no tolerance has been established.

Determine Conformance with Specifications

- E 53 Test Methods for Determination of Copper in Unalloyed Copper by Gravimetry
- E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)
- E 112 Test Methods for Determining the Average Grain Size
- E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes
- E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
- E 527 Practice for Numbering Metals and Alloys (UNS)
- 2.3 ASME Standards:
 - ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings⁴
 - ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings⁴

3. Terminology

3.1 Definitions:

- 3.1.1 *coil, n*—a length of the product wound into a series of connected turns. The unqualified term "coil" as applied to tube usually refers to a bunched coil.
 - 3.1.1.1 *bunched, n*—a coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.
 - 3.1.1.2 *double layer flat, n*—a coil in which the product is spirally wound into two connected disk-like layers such that

one layer is on top of the other. (Sometimes called "double layer pancake coil" or "double layer spirally wound coil.")

3.1.1.3 *level or traverse wound, n*—a coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another. (Sometimes called "helical coil.")

3.1.1.4 *single layer flat, n*—a coil in which the product is spirally wound into a single disk-like layer. (Sometimes called "pancake coil" or "single layer spirally wound coil.")

3.1.2 *lengths, n*—straight pieces of the product.

3.1.2.1 *standard, n*—uniform lengths recommended in a simplified practice recommendation or established as a commercial standard.

3.1.3 *tube, seamless, n*—a tube produced with a continuous periphery in all stages of the operations.

3.1.3.1 *tube, copper service, n*—a bendable copper water tube for underground water service.

3.1.3.2 *tube, copper water, n*—a seamless copper tube conforming to the particular dimensions commercially known as Copper Water Tube and designated as Types K, L, and M.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *capable of*—the test need not be performed by the producer of the material. However, if subsequent testing by the purchaser establishes that the material does not meet these requirements, the material shall be subject to rejection.

4. Ordering Information

4.1 Include the following information for material ordered under this specification.

4.1.1 ASTM designation and year of issue (for example, B 88 - 03),

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

TABLE 2 Chemical Composition—Weight %

Element	Copper UNS No.		
	C10200 ^a	C12000	C12200
Copper, % min	99.95	99.90	99.9
Phosphorus	—	0.004-0.012	0.015-0.040

^a Oxygen shall be 10 ppm max.

^b Copper + silver.

4.1.2 Copper UNS No. (not necessary unless a specific copper is desired),

4.1.3 Nominal or standard size (Column 1 of Table 1) and whether Type K, L, or M (Sections 3 and 11),

4.1.4 Temper (Sections 5 and 7),

4.1.5 Length (see 11.5),

4.1.6 How furnished: straight or coils, and

4.1.7 Quantity (pieces) of each size and type.

4.1.8 In addition, when material is purchased for agencies of the U.S. Government, it shall conform to the Supplementary Requirements as defined herein when specified in the contract or purchase order.

4.2 The following options are available and shall be specified in the contract or purchase order when required:

4.2.1 Tension test (Section 8),

4.2.2 Grain size determination (Section 8),

4.2.3 Expansion test (9.1), and

4.2.4 Microscopical Examination for Hydrogen Embrittlement, Procedure B (9.3.2).

5. Materials and Manufacture

5.1 The material shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification, and shall be cold drawn to size.

5.2 The tube shall be finished by such cold-working and annealing operations as are necessary to produce the required temper and surface finish.

5.3 Tube when furnished in coils shall be annealed after coiling.

5.4 Tube when furnished in straight lengths shall normally be in the drawn temper. Upon agreement between the manufacturer or supplier and the purchaser, the manufacturer shall have the option to supply annealed straight length tubing.

6. Chemical Composition

6.1 The material shall conform to the chemical requirements in Table 2 for the specific type of copper.

6.2 These specification limits do not preclude the presence of other elements. When included in the contract or purchase order, and agreed upon by the manufacturer or supplier and the purchaser, limits shall be established and analysis required for unnamed elements.

7. Temper

7.1 Seamless copper water tube shall be furnished in the tempers designated below. Current designations as defined in Classification B 601 are shown.

Annealed—O

Drawn—H

8. Mechanical Properties

8.1 The tube shall conform to the mechanical property requirements prescribed in Table 3. Tension tests and grain-size determinations need not be made except when indicated by the purchaser at the time of placing the order. A convenient method of indicating that these tests are to be made is to state that "Test Procedure 'T' is required" (see 4.2.1). Where agreement on the Rockwell hardness tests cannot be reached, the tensile strength and grain-size requirements of Table 3 shall be the basis for acceptance or rejection.

9. Performance Requirements

9.1 Expansion Test:

9.1.1 The annealed (O) tube shall be capable of being expanded in accordance with Test Method B 153 with an expansion of the outside diameter in the following amount:

Nominal or Standard Size, in.	Expansion of Outside Diameter, %
% and under	40
Over %	30

The expanded tube shall show no cracking or rupture visible to the unaided eye.

9.2 Flattening Test:

9.2.1 As an alternative to the expansion test for tube standard sizes 4 in. and over in the annealed condition, a section 4 in. in length shall be cut from the end of one of the lengths for a flattening test. This 4-in. test specimen shall be flattened so that a gage set at three times the wall thickness will pass over the tube freely throughout the flattened part. The tube so tested shall develop no cracks or flaws visible to the unaided eye as a result of this test. In making the flattening test the elements shall be slowly flattened by one stroke of the press.

9.3 Microscopical Examination for Susceptibility to Hydrogen Embrittlement:

9.3.1 Tubes furnished in Copper UNS No. C10200 and C12000 shall be essentially free of cuprous oxide as determined by Procedure A of Test Methods B 577. When Copper UNS No. C12200 is supplied, examination is not required. In case of a dispute, Procedure C of Test Methods B 577 shall be used as the referee method.

9.3.2 Tubes furnished in all coppers shall be capable of passing the embrittlement test specified in Procedure B of Test Methods B 577. The actual performance of the test is not required unless specifically requested in the ordering document. In case of a dispute, Procedure C of Test Methods B 577 shall be used as the referee method.

10. Nondestructive Testing

10.1 Each tube up to and including 3½ in. in outside diameter shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice E 243, except for the determination of "end effect." Tubes shall be passed through an eddy-current test unit adjusted to provide information on the suitability of the tube for the intended application.

10.1.1 Notch-depth standards, rounded to the nearest 0.001 in., shall be 22 % of the wall thickness. The notch-depth tolerance shall be plus and minus 0.0005 in. Alternatively, at

TABLE 3 Mechanical Property Requirements

Temper Designation		Form	Rockwell Hardness ^A		Tensile Strength, min, ksi ^B	Average Grain Size, mm
Standard	Former		Scale	Value		
C80	annealed	coils	F	80 max	30	0.040 min
C50	annealed	straight lengths	F	85 max	30	0.025 min
H56	drawn	drawn	30 T	30 min	36	...

^A Rockwell hardness tests shall be made on the inside surfaces of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values shall be specified subject to agreement between the purchaser and the supplier.

^B ksi = 1000 psi.

the option of the manufacturer using speed insensitive eddy-current units that are equipped to select a fraction of the maximum unbalance signal, the following percent maximum unbalance signals shall be used:

Nominal or Standard Tube Size, in.	Unbalance Signal Magnitude, max %
Up to ½, incl	0.2
½ to 2, incl	0.3
Over 2 to 3, incl	0.4

10.1.2 Tubes that do not actuate the signalling device of the eddy-current testers shall be considered as conforming to the requirements of this test. Tubes with discontinuities indicated by the testing unit shall, at the option of the manufacturer, be reexamined or retested to determine whether the discontinuity is cause for rejection. Signals that are found to have been caused by minor mechanical damage, soil or moisture, shall not be cause for rejection of the tubes provided the tube dimensions are still within prescribed limits and the tube is suitable for its intended application.

10.2 Tube made to this specification shall be capable of withstanding the pressure test of 10.2.1 or 10.2.2. On subsequent testing by the purchaser, failure to meet the requirements of 10.2.1 or 10.2.2 are grounds for rejection of the material by the purchaser.

10.2.1 The tube shall stand, without showing evidence of leakage, an internal hydrostatic pressure sufficient to subject the material to a fiber stress of 6000 psi, calculated from the following equation for thin hollow cylinders under tension:

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

where:

P = hydrostatic pressure, psi;

t = wall thickness, in.;

D = outside diameter of the tube, in.; and

S = allowable stress of the material, psi.

10.2.2 The tube shall stand an internal air pressure of 50 psig for 5 s without showing evidence of leakage. The test method used shall permit easy visual detection of any leakage, such as by having the tube under water or by the pressure differential method.

11. Dimensions, Mass, and Permissible Variations

11.1 For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimensions shall make the tube subject to rejection at the option of the purchaser.

11.2 *Standard Dimensions, Wall Thickness, and Diameter Tolerances*—The standard dimensions, wall thickness, and diameter tolerances shall be in accordance with Table 1.

11.3 *Mass*—For purposes of calculating weights, cross sections, and so forth, the density of the copper shall be taken as 0.323 lb/in.³. The theoretical weight per foot is given in Table 1.

11.4 *Roundness*—For drawn unannealed tube in straight lengths, the roundness tolerance shall be as prescribed in Table 4. The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube. No roundness tolerance has been established for annealed tube in straight lengths or for tubes furnished in coils.

11.5 Lengths and Tolerances:

11.5.1 *Standard Lengths and Tolerances*—The standard lengths and tolerances shall be as specified in Table 5.

11.5.2 Tube supplied in other than standard lengths and tolerances shall be in accordance with requirements established by agreement between the manufacturer or supplier and the purchaser.

11.6 *Squareness of Cut*—For tube in straight lengths, the departure from squareness of the end of any tube shall not exceed more than 0.010 in. for tube up to and including ½-in. standard size; and not more than 0.016 in./in. of outside diameter for tube larger than ½-in. standard size.

12. Workmanship, Finish, and Appearance

12.1 The material shall be clean, free of dirt and defects of a nature that interfere with normal commercial applications.

13. Sampling

13.1 Sample pieces shall be selected for test purposes from each lot of 5000 lbs or fraction thereof, of each size and type, in accordance with the schedule of Table 6.

14. Number of Tests and Retests

14.1 *Chemical Analysis*—Samples for chemical analysis shall be taken in accordance with Practice E 255. Drillings, millings, and so forth shall be taken in approximately equal weight from each of the sample pieces selected in accordance with 13.1 and combined into one composite sample. The minimum weight of the composite sample that is to be divided into three equal parts shall be 150 g.

14.1.1 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of determining conformance to chemical composition as follows: Conformance shall be determined by the manufacturer by analyzing samples taken at the time the castings are poured or samples taken from the semifinished product. If the manufacturer determines the chemical composition of the material during the course of manufacture, he shall not be required to sample and

TABLE 4 Roundness Tolerance

<i>t/D</i> (Ratio of Wall Thickness to Outside Diameter)	Roundness Tolerance % of Outside Diameter (Expressed to Nearest 0.001 in.)
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

TABLE 5 Standard Lengths and Tolerances

Nominal or Standard Size, in.	Type	Standard Length, ft	Tolerance (All Plus)
Tubes Furnished in Straight Lengths			
Up to 6, incl	K, L, M	20	1 in.
10	L, M	20	1 in.
10	K	18	1 in.
12	M	20	1 in.
12	L	18	1 in.
12	K	12	1 in.
Tubes Furnished in Coils			
Up to 1, incl	K, L	60 and 100	2 ft
1 1/4 and 1 1/2	K, L	60	2 ft
2	K, L	40 and 45	1 ft

TABLE 6 Sampling Schedule

Number of Pieces in Lot	Number of Sample Pieces to be Taken ^a
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of total number of pieces in the lot but not more than 10 sample pieces

^a Each sample piece shall be taken from a separate tube.

analyze the finished product. The number of samples taken for determination of chemical composition shall be as follows:

14.1.1.1 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.

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

14.1.1.3 Because of the discontinuous nature of the processing of castings into wrought products, it is not practical to identify specific casting analysis with a specific quantity of finished material.

14.1.1.4 In the event that heat identification or traceability is required, the purchaser shall specify the details desired.

14.2 **Mechanical Tests**—For the mechanical tests, a specimen shall be taken from each of the sample pieces selected in accordance with 13.1. The required mechanical test shall be made on each of the specimens so selected. The value for the Rockwell hardness number of each specimen shall be established by taking the arithmetical average of at least three readings.

14.3 **Microscopical Examination**—One specimen shall be examined from each of the sample pieces selected in accordance with 13.1.

TABLE 7 Test Methods

Test	ASTM Designation
Chemical Analysis	E 83, E 82
Tension	E 8 (also see 15.2)
Rockwell Hardness	E 18
Grain size	E 2, E 3, E 112 (also see 15.3)
Expansion (pln test)	B 153
Microscopical Examination Procedure A	E 3, B 577 (also see 15.3)
Microscopical Examination Procedure B	E 3, B 577 (also see 15.3)

14.4 In the case of tube furnished in coils, a length sufficient for all necessary tests shall be cut from each coil selected for the purpose of tests. The remaining portion of these coils shall be included in the shipment, and the permissible variations in length of such coils shall be waived.

14.5 Retests:

14.5.1 If any test specimen shows defective machining or develops flaws, it shall be discarded and another specimen substituted.

14.5.2 If the results of any test for microscopical examination or mechanical properties fail to meet the specified requirements, two additional specimens shall be taken from different sample pieces and tested. The results of the tests on both of these specimens shall meet the specified requirements. Failure of more than one specimen to meet the specified requirements for a particular property shall be the cause for rejection of the entire lot.

14.5.3 If the chemical analysis fails to conform to the specified limits, analysis shall be made on a new composite sample prepared from additional pieces selected in accordance with 13.1. The results of this retest shall comply with the specified requirements.

15. Test Methods

15.1 The properties enumerated in this specification shall, in case of disagreement, be determined in accordance with the ASTM methods listed in Table 7.

15.2 Tension Test:

15.2.1 Tension test specimens shall be of the full section of the tube and shall conform to the requirements of the section, Specimens for Pipe and Tube, of Test Methods E 8, unless the limitations of the testing machine preclude the use of such a specimen. Use test specimens conforming to type No. 1 of Fig. 13, Tension Test Specimens for Large-Diameter Tubular Products, of Test Methods E 8 when a full-section specimen cannot be tested.

15.2.2 Whenever different tension test results are obtained from both full-size and from machined test specimens, the results obtained from full-size test specimens shall be used to determine conformance to the requirements of this specification.

15.2.3 Tension test results on material covered by this specification are not seriously affected by variations in speed of testing. It is not prohibited to use a considerable range of testing speeds; however, the rate of stressing to the yield strength shall not exceed 100 ksi/min. Above the yield strength, the movement per minute of the testing machine head under

TABLE 8 Rounding Units

Property	Rounded Unit for Observed or Calculated Value
Chemical composition Hardness	nearest unit in the last right-hand place of figures of the specified limit
Tensile strength	nearest ksi
Expansion	nearest 1 %
Grain size:	
Up to 0.055 mm, incl	nearest multiple of 0.005 mm
Over 0.055 to 0.160 mm, incl	nearest 0.01 mm

load shall not exceed 0.5 in./in. of gage length (or distance between grips for full-section specimens).

15.3 Grain Size and Microscopical Examination:

15.3.1 The specimen(s) shall be prepared in accordance with Guide E 3.

15.3.2 The surface of the test specimen shall approximate a radial longitudinal section of the tube.

16. Significance of Numerical Limits

16.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in Table 8, an observed value or calculated value shall be rounded as indicated in accordance with the rounding method of Practice E 29.

17. Inspection

17.1 The manufacturer shall afford the inspector representing the purchaser, all reasonable facilities, without charge, to satisfy him that the tubes are being furnished in accordance with the specified requirements.

18. Rejection and Rehearing

18.1 Material that fails to conform to the requirements of this specification is subject to rejection at the option of the purchaser. Rejection shall be reported to the manufacturer or supplier promptly and in writing. When requested by the manufacturer or supplier, a rehearing shall be granted.

19. Packaging and Package Marking

19.1 The material shall be separated by size, composition, and temper, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation at the lowest rate applicable and to afford protection from the normal hazards of transportation.

19.2 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, total length or piece count, or both, and name of supplier. The specification number shall be shown, when specified.

19.3 Product Identification:

19.3.1 The name or trademark of the manufacturer and the mark indicative of the type shall be permanently (incised) marked on each tube at intervals not greater than 1½ ft. Tube in straight lengths shall be further identified throughout its length by means of a colored stripe, symbol, or logo not less than ⅜ in. in height, including a legend repeated at intervals not greater than 3 ft. The legend shall include the type of the tube, name or trademark of the manufacturer, or both, and the country of origin. The manufacturer has the option to include other information.

19.3.2 Colors used are: green for Type K, blue for Type L, and red for Type M. Such color marking is not applicable to tube furnished in annealed straight lengths or coils.

19.3.3

19.4 UNS Copper Designation:

19.4.1 *Hard Drawn Tubing*—On hard drawn tubing produced from C10200 and C12000, the UNS copper designation shall be identified at intervals not greater than 3 ft with color coded ink per 19.3.2.

19.4.2 *Annealed Tubing*—On annealed tubing produced from C10200 and C12000, the UNS copper designation shall be identified with ink or some other permanent mark that is repeated at intervals not greater than 3 ft. Color marking to distinguish Type K from Type L is not required.

20. Keywords

20.1 copper tube; seamless; water tube; UNS No. C10200; UNS No. C12000; UNS No. C12200

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order for agencies of the U. S. Government.

S1. Referenced Documents

S1.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

S1.1.1 Federal Standards:⁵

Fed. Std. No. 102 Preservation, Packaging and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
 Fed. Std. No. 185 Identification Marking of Copper and Copper-Base Alloy Mill Products
 S1.1.2 *Military Standard*:⁵
 MIL-STD-129 Marking for Shipment and Storage
 S1.1.3 *Military Specification*:⁵
 MIL-C-3993 Packaging of Copper and Copper-Base Alloy Mill Products

S2. Quality Assurance

S2.1 Responsibility for Inspection:

⁵ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, Attn: NPODS.

S2.1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. Except as otherwise specified in the contract or purchase order, the manufacturer has the option to use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections or tests set forth when such inspections and tests are deemed necessary to assure that the material conforms to prescribed requirements.

S3. Identification Marking

S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification number and the alloy number shall be used.

S4. Preparation for Delivery

S4.1 Preservation, Packaging, Packing:

S4.1.1 *Military Agencies*—The material shall be separated by size, composition, grade or class and shall be preserved and packaged, Level A or C, packed, Level A, B, or C as specified in the contract or purchase order, in accordance with the requirements of MIL-C-3993.

S4.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S4.2 Marking:

S4.2.1 *Military Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with MIL-STD-129.

S4.2.2 *Civil Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with Fed. Std. No. 123.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 88 - 02) that may impact the use of this standard. (Approved Oct. 1, 2003.)

- (1) Added paragraph 1.2.
- (2) Added information (paragraphs 4.1.1, 4.1.2, 4.2.2 and subsections) to Ordering Information section.
- (3) Added new Table 2.
- (4) Revised Section 9 and added paragraph 9.3 and subsections.
- (5) Added paragraph 14.3.
- (6) Added paragraph 15.3 and revised paragraph 15.2.
- (7) Added paragraph 19.4.
- (8) Added UNS Nos. C10200, C12000, and C12200 to Keywords.
- (9) Revised Table 7.

Committee B05 has identified the location of selected changes to this standard since the last issue (B 88-99¹) that may impact the use of this standard. (Approved Oct. 10, 2002.)

- (1) Sections 3.2.1 and 10.2 were modified to replace nonmandatory language with mandatory language.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

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Copper and Copper Alloy Tube, Pipe and Fittings

COPPER and COPPER ALLOY TUBE and PIPE

Seamless Copper Pipe:

Copper pipe is almost pure copper manufactured to the requirements of **ASTM B 42 - Standard Specification for Seamless Copper Pipe, Standard Sizes**. It may be manufactured from any of five (5) copper alloys (C10200, C10300, C10800, C12000, C12200) that all conform to the chemical composition requirements of alloys containing a minimum of 99.9% Copper (Cu) and a maximum of 0.04% Phosphorous (P). Available sizes are 1/8" to 12" diameters in regular wall thickness and 1/8" to 10" in extra strong wall thickness. The standard length for copper pipe is 12 feet.

Copper pipe is suitable for plumbing, boiler feed lines, refrigeration and for similar purposes.

Joints in seamless copper pipe can be threaded, flanged or brazed to fittings of the appropriate joint configuration.

Seamless Red Brass Pipe:

(Red) Brass pipe is an alloy of copper manufactured to the requirements of **ASTM B 43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes**. It is manufactured from alloy C23000 which is comprised of approximately 85% Copper (Cu) with no greater than 0.05% Lead (Pb) and 0.05% Iron (Fe) and the remainder Zinc (Zn). Available sizes are 1/8" to 12" diameters in both regular and extra strong wall thickness. The standard length for red brass pipe is 12 feet.

Brass pipe is moderately resistant to many corrosive solutions and is often utilized for water supply and distribution.

Joints in red brass pipe can be threaded, flanged or brazed to fittings of the appropriate joint configuration. Fittings in the smaller sizes, normally those below 2" diameter are, screwed cast copper alloy or brazed cup cast copper alloy. Fittings above 2" diameter are normally threaded, flanged, brazed or in some cases grooved mechanical joint fittings are employed.

Seamless Copper Tube, Bright Annealed:

Bright annealed copper tube is an almost pure copper tube manufactured to the requirements of **ASTM B 68 - Standard Specification for Seamless Copper Tube, Bright Annealed**. It may be manufactured from any one of the following alloys: C10200, C10300, C10800, C12000, or C12200 unless specified otherwise on the original contract or purchase order.

ASTM B68 tube is suitable for use in refrigeration, fuel oil, gasoline, or oil lines where the interior surface of the tube is essentially free of any scale or dirt and is specifically specified as ASTM B68.

This tube is provided in annealed tempers meeting O50 – Light annealed or O60 – Soft annealed in either straight lengths or coils.

It is the responsibility of the purchaser, when ordering to provide the requirements for alloy (UNS#), temper, dimensions (diameter and wall thickness), form (straight lengths or coils), and total length or number of pieces of any particular size. It is this requirement that forces this tube to be a special order tube and not a standard stocked material.

There is no specific requirements for identification of B68 tube and thus is not specifically designated as a tube permitted for use in most plumbing or mechanical codes. It is usually limited to use in specific manufacturing processes or production line type applications.

Seamless Copper Tube:

Seamless copper tube manufactured to the **ASTM B 75 - Standard Specification for Seamless Copper Tube** may be either round, square, or rectangular and is suitable for general engineering applications. It may be manufactured from any one of the following alloys: C10100, C10200, C10300, C10800, C12000, or C12200 unless specified otherwise on the original contract or purchase order.

Tubes meeting this standard may be furnished in any of several tempers (H55, H58, H80, O60, or O50) ranging from light drawn (usually limited to round tubes) to light annealed.

It is the responsibility of the purchaser, when ordering, to provide the requirements for alloy (UNS#), temper, dimensions (diameter, wall thickness, or distance between parallel surfaces), form (straight lengths or coils), and total length or number of pieces of any particular size. It is this requirement that forces this tube to be a special order tube and not a standard stocked material.

It is usually limited to use in specific manufacturing processes or production line type applications.

Seamless Copper Water Tube:

Copper water tube is a seamless, almost pure copper material manufactured to the requirements of **ASTM B 88 - Standard Specification for Seamless Copper Water Tube**, of three basic wall thickness dimensions designated as types K, L, and M. Type K is the thickest and type M is the thinnest with type L being of intermediate thickness. All three types of tube are manufactured from copper alloy C12200 having a chemical composition of a minimum of 99.9% Copper (Cu) and Silver (Ag) combined and a maximum allowable range of Phosphorous (P) of 0.015 % - 0.040 %.

Seamless copper water tube is manufactured in sizes 1/4" through 12" nominal. Types K and L are manufactured in drawn temper (hard) 1/4" through 12" and annealed temper (soft) coils 1/4" through 2" while type M is only manufactured in drawn (hard) temper 1/4" through 12".

Seamless copper water tube of drawn temper is required to be identified with a color stripe that contains the manufacturer's name or trademark, type of tube and nation of origin. This color

stripe is green for type K, blue for type L and red for type M. In addition to the color stripe the tube is incised with the type of tube and the manufacturer's name or trademark at intervals not in excess of 1½ ft. Annealed (soft) coils or annealed straight lengths are not required to be identified with a color stripe.

Seamless Brass Tube:

Seamless brass tube is manufactured to the requirements of **ASTM B 135 – Standard Specification for Seamless Brass Tube** and may be either round, square, or rectangular and is suitable for general engineering applications. It may be manufactured from any one of the following alloys: C22000, C23000, C26000, C27000, C27200, C27400, C28000, C33000, C33200, C37000, or C44300 and these alloys contain Copper (Cu) concentrations of between 60% and 90% with various percentages of Zinc (Zn), Lead (Pb), and Tin (Sn) permitted, depending on the alloy.

Tubes meeting this standard may be furnished in any of several tempers ranging from light drawn to light annealed.

It is the responsibility of the purchaser, when ordering to provide the requirements for alloy (UNS#), temper, dimensions (diameter and wall thickness, or distance between parallel surfaces), form (straight lengths or coils), and total length or number of pieces of any particular size.

Wrought Seamless Copper and Copper Alloy Tube:

ASTM B 251 – Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube covers a number of general requirements common to many wrought copper products. A few of these specifications are B 68, B75, B135, B466 and B743.

Products manufactured under the requirements of ASTM B251 may be of alloys of copper, brass or copper-nickel and may be produced in any number of tempers or shapes as specified by the purchaser.

Air Conditioning & Refrigeration Tube:

Copper tube used for air conditioning and refrigeration applications in the field (sometimes called "refer" or "ACR" tube) is an almost pure copper material meeting the requirements of **ASTM B 280 – Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service**. It is manufactured from copper alloy C12200 having a chemical composition of a minimum of 99.9% Copper (Cu) and Silver (Ag) combined and a maximum allowable range of Phosphorous (P) of 0.015 % - 0.040 %.

B 280 tube is produced in straight lengths or coils in tempers H58 or O60 respectively, although annealed straight lengths may be special ordered. Straight lengths are provided in sizes from 3/8" O.D. through 4 1/8" O.D. while annealed coils are supplied in sizes ranging from 1/8" O.D. through 1 5/8" O.D.

ACR tube is required to be identified in the following fashion:

Coils: The name or trademark of the manufacturer and ACR shall be permanently incised on each tube ¼" or larger at intervals not greater than 1½ ft.

Hard Straight Lengths: The name or trademark of the manufacturer and a mark indicating either L or ACR shall be incised at intervals not greater than 1½ ft. along the length of the tube. Hard straight lengths shall further be marked with a blue stripe containing

the manufacturer's name or trademark, the nation of origin, outside diameter and ACR repeating at intervals not greater than 3 ft.

Air conditioning and refrigeration tube (ASTM B 280) either coiled or straight length is further required to be cleaned and capped prior to shipping.

The maximum particulate residue limit for coils or straight lengths is 0.0035 g/ft² or as listed in Table 2 and Table 3 of the standard.

Threadless Copper Pipe (TP):

Threadless copper pipe, often referred to as TP pipe, is a seamless copper pipe material manufactured to the requirements of **ASTM B 302 – Standard specification for Threadless Copper Pipe, Standard Sizes**. This pipe may be manufactured from either of two alloys, C10300 or C12200 with C12200 being the most popular. Both of these alloys are composed of copper (Cu) concentrations in excess of 99.9% thereby making this material an almost pure copper product.

Threadless copper pipe (TP) is manufactured in drawn temper (hard) only and is furnished in H58 temper in nominal or standard sizes ¼" through 12". The outside diameter of threadless copper pipe (TP) is essentially the same as schedule 40 pipe, although the wall thickness is much less than that for the same size pipe. The available lengths for threadless copper pipe is 20 foot for sizes ¼" to 10" with 12" being furnished in 15 foot lengths.

Threadless copper pipe (TP) is required, by the standard, to be identified by a gray colored stripe throughout its length that contains the manufacturers name or trademark, the nation of origin and "TP". It is further required to be incised at intervals not less than 1½ feet with the manufacturers name or trademark and "TP" throughout its entire length.

Threadless copper pipe (TP) is usually joined by brazed socket-cup type fittings or socket-cup type flanges. *It should be noted that standard copper pressure fittings of the B16.22 or B16.18 type are not compatible for use with TP pipe.*

Copper Drainage Tube:

Seamless copper tube used for sanitary drainage, waste and vent systems in plumbing applications is often referred to as "DWV" tube and is manufactured to the requirements of **ASTM B 306 – Standard Specification for Copper Drainage Tube (DWV)**. DWV tube is manufactured from alloy C12200 that is 99.9% copper (Cu) and has a phosphorous (P) content of between 0.015% to 0.040%.

DWV copper tube is furnished in H58 drawn (hard) temper only, in sizes 1¼" through 8". The standard length for DWV tube is 20 foot, however other lengths may be provided through prior agreement between the purchaser and the manufacturer.

DWV copper tube shall be identified in two manners. The first is by an incised mark, at intervals not greater than 1½ feet, containing the manufacturers name or trademark and "DWV". The second is by a continuous yellow stripe containing the manufacturer's name or trademark, the nation of origin and "DWV" to be repeated at intervals not greater than 3 feet.

Soldering of drainage pattern fittings meeting the ASME/ANSI B16.23 or B16.29 standards is the usual manner for joining DWV tube.

Welded Copper Tube:

This is a copper tube that is manufactured from either sheet or strip and has a longitudinal seam that is free of any type of filler metal and is usually manufactured to the requirements of **ASTM B 447 – Standard Specification for Welded Copper Tube**.

Welded copper tube may be manufactured from any of the following alloys of copper: C10100, C10200, C10300, C10800, C11000, C12000, C12200, or C14200. Unless it is specifically specified in the contract for manufacturer any of the listed alloys shall be considered acceptable; however welded copper tube manufactured from alloy C11000 may not be used in applications where hydrogen embrittlement may occur.

Welded copper tube may be furnished in the annealed (soft), O60, O50 or drawn (hard) temper in sizes and lengths specified by the purchaser.

Essentially this tube is an engineered type tube where the purchaser must specify the type of copper alloy, the form of the tube (straight length or coil), temper, internal flash treatment, and dimensions (diameter, wall thickness, length).

Welded Brass Tube:

Welded brass tube may be provided in either round, rectangular or square form and is manufactured to the requirements of **ASTM B 587 – Standard specification for Welded Brass Tube** for engineered applications.

Welded brass tube may be manufactured from any one of the following copper alloys: C21000, C22000, C23000, C26000, C26800, C27000, or C27200. the copper(Cu) content of these alloys ranges from 62.0% to 96.0% depending on the alloy chosen.

Essentially this tube is an engineered type tube where the purchaser must specify the type of copper alloy, the form of the tube (straight length or coil), dimensions, (distances between parallel surfaces if square or rectangular, inside and outside diameter if round), wall thickness, overall length, and temper.

Medical Gas Tube:

Seamless copper tube used for the installation of non-flammable medical gases (and in some cases high-purity applications) where the gases being delivered are not considered flammable is manufactured to the requirements of **ASTM B819 – Standard Specification for Seamless Copper Tube for Medical Gas Systems**.

Medical gas tube may be provided in one of two types, type K or type L, in drawn (hard) H58 temper only. (Both of these types are defined and described in ASTM B88.) Alloy C12200 is the only alloy permitted for use for medical gas tube and is a minimum 99.9% pure copper (Cu) and silver (Ag) combined with no greater than 0.040% phosphorous (P).

Medical gas tube is required to be cleaned, by the manufacturer, so that the maximum interior surface residue does not exceed 0.0035 g/ft² of interior surface. Cleaning techniques may be found in CGA G4.1 although the manufacturer is not limited to those procedures or practices.

Medical gas tube is required, by the ASTM B 819 standard, to be identified with a continuous stripe of either green for type K or blue for type L containing the type of tube, the manufacturers name or trademark, the nation of origin at intervals not to exceed 3 feet. It is further required to be incised

with the type of tube, the manufacturers name or trademark at intervals not to exceed 1½ foot. Acceptable additional required markings in the color appropriate for type K (green) or type L (blue) shall be “OXY”, “MED”, “OXY/MED”, “OXY/ACR”, “ACR/MED”

Fuel Gas Tube:

Seamless copper tube for fuel gas installations of natural gas or liquefied petroleum (LP) can, in some jurisdictions, use tube manufactured to the requirements of **ASTM B 837 – Standard specification for Seamless copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems**. This tube is manufactured from alloy C12200 that is 99.9% copper (Cu) and silver (Ag) combined and has a phosphorous (P) content of between 0.015% to 0.040% making it an almost pure copper material.

(It should be noted that ASTM B837 copper tube is not permitted for use by NFPA 54 – National Fuel Gas Code as an acceptable copper tube material for fuel gas applications and adherence to applicable model, local, state and federal codes should be referred to prior to its use.)

This tube is furnished in annealed (soft) (O60) temper in sizes 3/8” O.D. through 7/8” O.D. and in drawn (hard) (H58) temper in sizes 3/8” O.D. through 1 1/8” O.D.. Coils may be provided in 60 or 100 foot lengths while straight lengths may be provided in 12 or 20 foot lengths. Longer lengths may be provided upon prior agreement between the manufacturer or supplier and the purchaser.

This tube is required to be permanently marked (incised) with the mark “Type GAS” and the name or trademark of the manufacturer at intervals not to exceed 18 inches. Additionally, drawn (hard) temper straight lengths of tube shall be identified by a yellow colored stripe containing the type of tube, name or trademark of the manufacturer or both, and the country of origin.

COPPER and COPPER ALLOY FITTINGS

Cast Bronze Threaded Fittings: Classes 125 and 250

Cast bronze threaded fittings in class 125 and class 250 shall be manufactured to the requirements of **ANSI/ASME B16.15 – Cast Bronze Threaded Fittings**.

These fittings shall be produced to meet the general requirements of ASTM B 62, Alloy C83600 or the chemical and tensile requirements of ASTM B 584, alloys C83800 or C84400. Other alloys permitted for use to manufacture fittings from bar stock in smaller sizes for wrought plugs, caps, couplings and bushings shall meet the requirements of Alloy C36000 (Free Cutting Brass Rod, Bar and Shapes) or C32000 or C31400 (Leaded Brass)

Essentially, the elemental make-up of these cast brass fittings is approximately but not exactly equal to 85% Copper (Cu), 5% Tin (Sn), 5% Lead (Pb) and 5% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

These fittings shall be threaded in accordance with the requirements of ANSI/ASME B1.20.1 general-purpose pipe threads and the threads shall be tapered. Wrought couplings, caps, and bushings in nominal pipe sizes of $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", and $\frac{1}{2}$ " may have straight internal threads.

Class 125 fittings shall be identified with the manufacturer's name or trademark and Class 250 fittings shall be marked with the manufacturer's name or trademark and the numbers "250". The requirement for marking may be omitted from fittings that are deemed too small to provide adequate surface area for marking.

Cast Copper Solder Joint Fittings: Pressure Applications

Cast copper alloy fittings used in solder joint applications are to be manufactured to meet the requirements of **ANSI/ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings**.

These fittings shall be produced to meet the general requirements of ASTM B 62, Alloy C83600 or the chemical and tensile requirements of ASTM B 584, alloys C83800 or C84400.

Essentially, the elemental make-up of these cast brass fittings is approximately but not exactly equal to 85% Copper (Cu), 5% Tin (Sn), 5% Lead (Pb) and 5% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

These fittings (socket end diameter) are sized in accordance with the requirements of the ASTM B88 – Seamless Copper Water Tube (1/4" – 12" nominal diameters), while the sizes of any threaded connections (female or male) correspond to nominal pipe sizing.

Marking of these fittings shall be in accordance with MSS SP-25. They shall bear a permanent mark indicative of the manufacturer's name or trademark; although fittings in sizes less than $\frac{1}{2}$ " may have this requirement omitted.

The actual burst strength of the fitting shall not be less than the burst strength, as computed, for type L seamless copper water tube of annealed temper.

Wrought Copper Solder Joint Fittings: Pressure Applications

Wrought (Wrot) copper fittings used for pressure applications shall be manufactured to meet the requirements of **ANSI/ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings**.

These fittings may be manufactured from any one of the following alloys: C10200, C12000, C12200, or C23000 or any copper alloy that contains at least 84% Copper (Cu) and a maximum of 16% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

These fittings (socket end diameter) are sized in accordance with the requirements of the ASTM B88 – Seamless Copper Water Tube (1/4" – 12" nominal diameters), while the sizes of any threaded connections (female or male) correspond to nominal pipe sizing and the requirements of ANSI/ASME B1.20.1.

These fittings shall have a burst pressure approximately equal to four (4) times the rated internal working pressure of type L seamless copper water tube in annealed temper.

Marking of these fittings shall be in accordance with MSS SP-25. They shall bear a permanent mark indicative of the manufacturer's name or trademark; however, marking may be omitted from any fitting if it could damage the soldering surfaces.

Cast Copper Solder Joint Drainage Fittings: Drain, Waste and Vent Applications

Cast copper alloy fittings used for drainage, waste, and vent applications with solder joints are manufactured to the requirements of **ANSI/ASME B16.23 – Cast Copper Alloy Solder Joint Drainage Fittings – DWV**.

These fittings shall be produced to meet the general requirements of ASTM B 62, Alloy C83600 or the chemical and tensile requirements of ASTM B 584, alloys C83800 or C84400.

Essentially, the elemental make-up of these cast brass fittings is approximately but not exactly equal to 85% Copper (Cu), 5% Tin (Sn), 5% Lead (Pb) and 5% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

These fittings (socket end diameter) are sized in accordance with the requirements of the ASTM B306 – Copper Drainage Tube (1¼" – 8" nominal), while the size of any threaded connections (female or male) correspond to nominal pipe sizing (slip-joints are excepted).

Drainage fittings are required to be identified (marked) with a permanent mark containing the manufacturer's name or trademark and "DWV". Vent fittings shall be identified with the words "VENT ONLY" and have the manufacturer's name or trademark permanently marked in accordance with MSS SP-25.

All 90° fittings shall be pitched so that a slope of 0.25 in./ft. (2.1%) is developed in horizontal tube as referenced along a horizontal plane.

Cast Copper Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500

Cast copper alloy flanges or flanged fittings shall be manufactured to the requirements of **ANSI/ASME B16.24 – Cast Copper Alloy Pipe Flanges, Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500**.

Cast copper alloy flanges may be manufactured from alloy C83600 a leaded red brass alloy, C922200 a leaded tin bronze alloy, or C95200 an aluminum bronze alloy. These alloys are about 85 – 86% copper (Cu) with other elements making the remainder. *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

Flanges and flanged fittings shall be identified with the manufacturer's name or trademark along with the ASTM specification number, the rating class for which the flange was designed (ie. 150, 300, etc.), and "B16" to indicate the flange conforms to the requirements of this standard. The nominal size shall be included, although it may be omitted from reducing flanges and reducing flanged fittings.

Cast copper alloy flanged fittings may be manufactured from alloy C83600 a leaded red brass alloy or C922200 a leaded tin bronze alloy.

Flanges and flanged fittings furnished to this standard have the same flange diameters and drilling templates (bolt hole arrangement and size) as prescribed in ASME/ANSI B16.1, B16.5, and B16.42.

Gasketing and bolting materials for use with cast copper flanges and flanged fittings shall be as prescribed in the applicable ANSI or ASME standards.

Flared Copper Fittings: Cold Water Service

Flared fittings for use with flared copper tube for cold water applications with a maximum water pressure of 175 psig are manufactured to the requirements of **ANSI/ASME B16.26 – Cast Copper Alloy Fittings for Flared Copper Tubes**.

These fittings shall be produced to meet the general requirements of ASTM B 62, Alloy C83600 or the chemical and tensile requirements of ASTM B 584, alloys C83800 or C84400.

Essentially, the elemental make-up of these cast brass fittings is approximately but not exactly equal to 85% Copper (Cu), 5% Tin (Sn), 5% Lead (Pb) and 5% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

These flared fittings are limited in size from 3/8" nominal to 2" nominal as designated by ASTM B88 for Seamless Copper Water Tube.

Marking of these fittings is limited to the manufacturer's name or trademark and that identification may be omitted from fittings less than 1/2" nominal size.

(These flared fittings are normally limited to use in underground water service lines and in some rare cases above ground water distribution piping and should not be mistaken for 45° flared fittings manufactured for higher pressure applications.)

NOTE:

As additional information for flared fittings for copper tube applications it should be understood that forged or machined brass flared fittings for pressure applications are manufactured to the dimensions and configurations of SAE standards.

The flare dimension and configuration for a 45° single flare is to be in accordance with the specifications of SAE J533

Wrought Copper Solder Joint Drainage Fittings: Drain, Waste and Vent Applications

Wrought (wrot) copper alloy fittings used for drainage, waste, and vent applications with solder joints are manufactured to the requirements of **ANSI/ASME B16.29 – Wrought copper And Wrought Copper Alloy Solder Joint Drainage Fittings – DWV**.

Fittings manufactured to this standard are to have a copper (Cu) content of not less than 84%.

These fittings (socket end diameter) are sized in accordance with the requirements of the ASTM B306 – Copper Drainage Tube while the size of any threaded connections (female or male) corresponds to nominal pipe sizing (slip-joints are excepted).

Drainage fittings are required to be identified (marked) with a permanent mark containing the manufacturer's name or trademark and "DWV".

All 90° fittings shall be pitched so that a slope of 0.25 in./ft. (2.1%) is developed in horizontal tube as referenced along a horizontal plane.

Wrought Copper Braze Joint Fittings

Fittings manufactured with "braze cup depth sockets" (short cups) shall be manufactured to the requirements of **ANSI/ASME B16.50 – Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings**.

These fittings may be manufactured from any one of the following alloys: C10200, C12000, C12200, or C23000 or any copper alloy that contains at least 84% Copper (Cu) and a maximum of 16% Zinc (Zn). *(Although other elements may be part of the Alloy structure more detailed analysis of the Alloys can be obtained from Copper Development Association Inc from their website at <http://piping.copper.org>)*

Braze fittings (socket end diameter) are sized in accordance with the requirements of the ASTM B88 – Seamless Copper Water Tube (1/4" – 8" nominal diameters), while the sizes of any threaded connections (female or male) correspond to nominal pipe sizing and the requirements of ANSI/ASME B1.20.1.

The maximum operating pressure (MOP) for fittings manufactured to this standard shall be essentially equal to the maximum system operating pressure listed for type L annealed seamless copper water tube. *It should be noted that maximum pressure-temperature ratings for any system is dependent upon many factors, including valves and other in-line appurtenances, and these other in-line items must be taken into account when determining the MOP of the entire system.)*

Fittings manufactured with "short cup depth" for brazing applications only shall be identified with the manufacturer's name or trademark and have the letters "BZ" in upper-case letters permanently marked on each fitting. Fittings smaller than 1/2" or fittings where such marking may damage the brazing surfaces may have the marking requirement omitted.

Copper and Copper Alloy Braze Fittings for TP Pipe Applications:

The following reference information is provided for information only and should not be misconstrued to be the final specification document for Copper and Copper Alloy Braze Fittings for "TP" of Pipe applications)

Fittings for use with copper and copper alloy threadless pipe ("TP"), or other copper alloy pipe types with O.D. dimensions equal to I.P.S. sizing are usually provided under standards other than ANSI or ASME. The most common reference standards are:

MIL F-1183 for fittings smaller than 6 in. diameter and with a pressure rating of 200 lbs. W.S.P. (water steam pressure)

MIL F-1183 for fittings over 6 in. diameter and with pressure Ratings of 150 lbs. W.S.P. (water steam pressure)

These fittings are manufactured from copper alloys meeting the requirements of ASTM B-61 or B-62 (C92200 or C83600 respectively). Many elements may be part of the Alloy structure and more detailed analysis of the Alloys can be obtained from Copper Development Association Inc or from their website at <http://piping.copper.org>)