



Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing¹

This standard is issued under the fixed designation A 512; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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

1. Scope

1.1 This specification covers cold-drawn buttweld carbon steel tubes for use as mechanical tubing.

1.2 This specification covers round, square, rectangular, and special shape mechanical tubing.

1.3 Round tube size ranges covered are outside diameters up to 3 1/2 in. (88.9 mm) and wall thickness from 0.035 to 0.500 in. (0.89 to 12.70 mm).

1.4 Optional supplementary requirements are provided and, when desired, shall be so stated in the order.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition³

2.2 Military Standards:

MIL-STD-129 Marking for Shipment and Storage⁴

MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage⁴

2.3 Federal Standard:

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)⁴

3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the required material adequately:

3.1.1 Quantity (feet, weight (Note 1), or number of lengths),

NOTE 1—The term “weight” is temporarily used in this specification because of established trade usage. The word is used to mean both “force” and “mass,” and care must be taken to determine which is meant in each case (SI unit for force = newton and for mass = kilogram).

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

Current edition approved Oct. 10, 1996. Published November 1997. Originally published as A 512 – 64. Last previous edition A 512 – 95.

² Annual Book of ASTM Standards, Vol 01.03.

³ Annual Book of ASTM Standards, Vol 03.05.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.1.2 Name of material (buttweld carbon steel mechanical tubing),

3.1.3 Form (round, square, rectangular, special shape),

3.1.4 Condition, description and code letters (Section 5),

3.1.5 Grade, if required (Section 6),

3.1.6 Dimensions (round, Section 9 or square and rectangular, Section 10),

3.1.7 Length (round length, 9.2; square and rectangular length, 10.5),

3.1.8 Burr removal (Section 11),

3.1.9 Report of chemical analysis and products analysis, if required,

3.1.10 Individual supplementary requirements if required (S1 through S5),

3.1.11 Special requirements,

3.1.12 End use,

3.1.13 Specification designation,

3.1.14 Special marking (Section 15), and

3.1.15 Special packaging (Section 16).

4. Materials and Manufacture

4.1 The steel shall be made by any process.

4.2 If a specific type of melting is required by the purchaser, it shall be as stated on the purchase order.

4.3 The primary melting may incorporate separate degassing or refining, and may be followed by secondary melting, such as electroslag or vacuum-arc remelting. If secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

4.4 Steel may be cast in ingots or may be strand cast. When steel of different grades is sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by an established procedure that positively separates the grades.

4.5 Tubes shall be made by the furnace buttweld process.

4.6 Tubes shall be cold finished, either externally only (sunk) or externally and internally (mandrel drawn).

5. Condition

5.1 The purchaser shall specify in the order one of the following conditions:

MD (Mandrel Drawn)—No final thermal treatment

SD (Sink Drawn)—No final thermal treatment

MDSR—Mandrel Drawn and Stress Relieved

SDSR—Sink Drawn and Stress Relieved

MDSA—Mandrel Drawn and Soft Annealed or normalized
 SDSA—Sink Drawn and Soft Annealed or normalized
 NORM-MD-SR—Normalized, Mandrel Drawn, and Stress Relieved
 NORM-SD-SR—Normalized, Sink Drawn, and Stress Relieved

6. Chemical Composition

6.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1 or Table 2 and Table 3.

6.2 When a grade is ordered under this specification, supplying an alloy grade that specifically requires the addition of any element other than those listed for the ordered grade in Table 1 or Table 2 is not permitted.

7. Heat Analysis

7.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified; if secondary melting processes are used, the heat analysis shall be obtained from one remelted ingot or the product of one remelted ingot of each primary melt. The heat analysis shall conform to the requirements specified, except that where the heat identity has not been maintained or where the analysis is not sufficiently complete to permit conformance to be determined, the chemical composition determined from a product analysis made by the tubular manufacturer shall conform to the requirements specified for heat analysis. When requested in the order or contract, a report of such analyses shall be furnished to the purchaser.

7.2 A report of this analysis shall be furnished only when requested on the order.

8. Product Analysis

8.1 When requested on the purchase order, a product analysis shall be made by the manufacturer. The chemical composition thus determined shall conform to the requirements prescribed in Table 1 or Table 2 as modified by Table 3.

8.2 The product analysis limits shown for carbon are not normally applicable to the MT grades.

8.3 The number and source of samples for such product analysis shall be based on the individual heat or lot identity of one of the following forms of material.

8.3.1 *Heat Identity Maintained*—One product analysis per heat on either a billet, a length of flat rolled stock, or a tube.

8.3.2 *Heat Identity Not Maintained*—One product analysis from one tube per 2000 ft (610 m) or less for sizes over 3 in.

TABLE 1 Chemical Requirements^A

Grade Designation	Chemical Composition Limits, %			
	Carbon	Manganese	Phosphorus, max	Sulfur, max
MT 1010	0.05–0.15	0.30–0.60	0.04	0.045
MT 1015	0.10–0.20	0.30–0.60	0.04	0.045
MT X 1015	0.10–0.20	0.60–0.90	0.04	0.045
MT 1020	0.15–0.25	0.30–0.60	0.04	0.045
MT X 1020	0.15–0.25	0.70–1.00	0.04	0.045

^A Rimmed or capped steels which may be used for the above grades are characterized by a lack of uniformity in their chemical composition, and for this reason product analysis is not technologically appropriate unless misapplication is clearly indicated.

TABLE 2 Chemical Requirements for Other Carbon Grades^A

Grade Designation ^B	Chemical Composition Limits, %			
	Carbon	Manganese	Phosphorus, max	Sulfur, max
1008	0.10 max	0.50 max	0.040	0.045
1010	0.08–0.13	0.30–0.60	0.040	0.045
1012	0.10–0.15	0.30–0.60	0.040	0.045
1015	0.12–0.18	0.30–0.60	0.040	0.045
1016	0.12–0.18	0.60–0.90	0.040	0.045
1018	0.14–0.20	0.60–0.90	0.040	0.045
1019	0.14–0.20	0.70–1.00	0.040	0.045
1020	0.17–0.23	0.30–0.60	0.040	0.045
1021	0.17–0.23	0.60–0.90	0.040	0.045
1025	0.22–0.28	0.30–0.60	0.040	0.045
1026	0.22–0.28	0.60–0.90	0.040	0.045
1030	0.27–0.34	0.60–0.90	0.040	0.045
1035	0.31–0.38	0.60–0.90	0.040	0.045
1110	0.08–0.15	0.30–0.60	0.040	0.130 ^C
1115	0.13–0.20	0.60–0.90	0.040	0.130 ^C
1117	0.14–0.20	1.00–1.30	0.040	0.130 ^C

^A Rimmed or capped steels which may be used for the above grades are characterized by a lack of uniformity in their chemical composition, and for this reason product analysis is not technologically appropriate unless misapplication is clearly indicated.

^B Other analyses are available.

^C Grades 1110, 1115 and 1117 shall contain 0.08 min % sulfur.

TABLE 3 Tolerances for Product Analysis for Steels Shown in Table 1

Element	Limit, or Maximum of Specified Range, %	Variation, Over Maximum Limit or Under Minimum Limit	
		Under min, %	Over max, %
Carbon	To 0.15, incl	0.02	0.03
	Over 0.15	0.03	0.04
Manganeses	To 0.60, incl	0.03	0.03
	Over 0.60	0.04	0.04
Phosphorus	...	...	0.01
Sulfur	...	...	0.01

(76.2 mm), or one product analysis from one tube per 5000 ft (1524 m) or less for sizes under 3 in. (76.2 mm).

8.4 If the original test for product analysis fails, retests of 2 additional billets, 2 lengths of flat rolled stock, or 2 tubes shall be made. Both retests for the elements in question shall meet the requirements of this specification; otherwise all remaining material in the heat or lot shall be rejected, or at the option of the producer, each billet, length, flat rolled stock, or tube may be individually tested for acceptance.

8.5 Samples for product analysis, except for spectrochemical analysis, shall be taken in accordance with Practice E 59, and the composition thus determined shall correspond to the requirements in applicable section or table.

9. Permissible Variations in Dimensions of Round Tubing

9.1 Diameter and Wall Thickness:

9.1.1 Variations in outside diameter, inside diameter, and wall thickness shall not exceed the amounts prescribed in Table 4.

9.1.2 These variations apply to round, unannealed, and stress-relieved tubing.

9.1.3 Diameter tolerance includes ovality.

9.1.4 Sink tubing is normally ordered by outside diameter and nominal wall. Mandrel-drawn tubing is normally ordered by outside diameter and inside diameter and may be ordered by

TABLE 4 Diameter and Wall Thickness Tolerances for Round Tubing

Outside Diameter Range, in. (mm)	Outside Diameter, in. (mm)		Inside Diameter, in. (mm)		Wall Thickness, %	
	Over	Under	Over	Under	Over	Under
	Sunk					
Up to 1/2 (12.7), excl	0.004 (0.10)	0	...	...	15 ^A	15
1/2 to 1 1/2 (12.7 to 38.1), excl	0.005 (0.13)	0	...	...	10 ^A	10
1 1/2 to 3 (38.1 to 76.2), incl	0.010 (0.25)	0	...	...	10 ^A	10
	Mandrel Drawn					
Less than 0.156 (3.96) wall:						
Up to 1/2 (12.7), excl	0.004 (0.10)	0	0	0.010 (0.25)	12 1/2	12 1/2
1/2 to 1 1/2 (12.7 to 38.1), excl	0.005 (0.13)	0	0	0.005 (0.13) ^B	10	10
0.156 (3.96) wall and over:						
1/2 to 1 1/2 (12.7 to 38.1), excl	0.005 (0.13)	0	0	0.005 (0.13) ^B	7	7
Under 0.156 (3.96) wall:						
1 1/2 (38.1) and over	0.010 (0.25)	0	...	0.010 (0.25)	10	10
0.156 (3.96) wall and over:						
1 1/2 (38.1) and over	0.010 (0.25)	0	0	0.010 (0.25)	7	7

^A Except at the weld line, where the weld pad may exceed this figure.

^B Tubes with an inside diameter under 1/2 in. (12.7 mm) may require more than 0.005 in. (0.13 mm) inside diameter tolerance and the producer should be consulted.

outside diameter or inside diameter and wall thickness but not by all three dimensions.

9.2 *Length*—Random lengths between acceptable limits will be furnished, utilizing the full mill length. Tubing will be cut in half if specified. Full length random tubing will have a spread not exceeding 7 ft (2.1 m). Half-length random tubing will have a spread not exceeding 4 ft (1.2 m). Not more than 10 % of the total footage of a shipment may be furnished in lengths shorter than the minimum specified but not less than 6 ft (1.8 m).

9.2.1 When specified, multiple lengths will be furnished and should include allowances made for the customer's cutting tool width and grippage. Maximum and minimum lengths may be specified with the understanding that not more than 10 % of the total footage in a shipment may be furnished in individual multiples cut to the customer's specifications.

9.2.2 Variations from the specified length shall not exceed the amounts prescribed in Table 5.

9.3 *Straightness*:

9.3.1 A round tube shall be considered straight provided that no 3-ft (0.9-m) section departs from a straight line by more than 0.030 in. (0.76 mm).

9.3.2 The straightness of round tubes shorter than 3 ft (0.9 m) shall be proportionate to 0.010 in./ft (0.8 mm/m).

9.3.3 These straightness tolerances do not apply to soft-annealed tubing nor to long lengths of small diameter tubing.

10. **Permissible Variations in Dimensions of Square and Rectangular Tubing**

10.1 *Outside Dimensions and Wall Thickness*—Variations

TABLE 5 Permissible Variations in Length—Round Tubing

Lengths 4 ft (1.2 m) and under—up to 2 in. (50.8 mm) diameter	± 1/32 in. (0.8 mm)
Lengths 4 ft (1.2 m) and under—over 2 in. (50.8 mm) diameter	± 3/64 in. (1.2 mm)
Lengths 4 ft to 10 ft (1.2 to 3.0 m), incl—up to 2 in. (50.8 mm) diameter	± 3/64 in. (1.2 mm)
Lengths 4 ft to 10 ft (1.2 to 3.0 m), incl—over 2 in. (50.8 mm) diameter	± 1/16 in. (1.6 mm)
Lengths 10 ft to 24 ft (3.0 to 7.3 m), incl—all diameters	± 1/8 in. (3.2 mm)
Lengths over 24 ft (7.3 m)—all diameters	± 1/8 in. (3.2 mm) ^A

^A Plus an additional tolerance of ± 1/16 (1.6 mm) for each 10 ft (3.0 m) or fraction over 24 ft (7.3 m).

in largest outside dimensions across flats and wall thickness shall not exceed the amounts prescribed in Table 6.

10.2 *Corner Radii*—The corners of square and rectangular tubes shall be slightly rounded inside and slightly rounded outside consistent with wall thickness. The outside corners may be slightly flattened. The radii of corners for square and rectangular cold-finished butt-weld tubes shall be in accordance with Table 7. Special radii may be obtained.

10.3 *Squareness Tolerance*—Permissible variations for the side of square and rectangular tube shall be determined by the following equation:

$$\pm b = c \times 0.006, \text{ in. (mm)}$$

where:

b = tolerance for out-of-square, and

c = largest external dimensions across flats, in. (mm).

The squareness of sides is commonly determined by one of the following methods.

10.3.1 A square, with two adjustable contact points on each arm, is placed on two sides. A fixed feeler gage is then used to measure the maximum distance between the free contact point and the surface of the tubing.

10.3.2 A square, equipped with direct-reading vernier, may be used to determine the angular deviation which, in turn, may be related to distance to inches.

10.4 *Twist Tolerance*—Variation in twist for square and rectangular tubing shall not exceed the amounts prescribed in Table 8. The twist in square and rectangular tubing may be measured by holding one end of the tubing on a surface plate and noting the height of either corner of the opposite end of same side above the surface plate. Twist may also be measured by means of a beveled protractor equipped with a level. The angular deviation is measured on opposite ends or at any point throughout the length.

10.5 *Length*—Random lengths between acceptable limits will be furnished, utilizing the full mill length. Tubing will be cut in half if specified. Full length random tubing will have a spread not exceeding 7 ft (2.1 m). Half-length random tubing will have a spread not exceeding 4 ft (1.2 m). Not more than 10 % of the total footage of a shipment may be furnished in