



Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing¹

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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 ½ 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).

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 electroslog 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).

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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.



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.

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 Over 0.15	0.02 0.03	0.03 0.04
Manganeses	To 0.60, incl Over 0.60	0.03 0.04	0.03 0.04
Phosphorus	...	...	0.01
Sulfur	...	...	0.01

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

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).

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

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.

**TABLE 6 Outside Dimension and Wall Thickness Tolerances for Square and Rectangular Tubing**

Largest Outside Dimension Across Flats	Wall Thickness	Outside Dimension, Including Convexity or Concavity		Wall Thickness Tolerance, ±, %	
		Over	Under	Sink ^A	Mandrel
Inch-Pound Units					
in.	in.	in.	in.		
To ¾	over 0.065	0.010	0.010	15	12½
Over ¾ to 1¼	under 0.156	0.015	0.015	10	10
Over ¾ to 1¼	0.156 and over	0.015	0.015	10	7
Over 1¼ to 2½	under 0.156	0.020	0.020	10	10
Over 1¼ to 2½	0.156 and over	0.020	0.020	10	7
SI Units					
mm	mm	mm	mm		
To 19.0	over 1.65	0.25	0.25	15	12½
Over 19.0 to 31.8	under 3.96	0.38	0.38	10	10
Over 19.0 to 31.8	3.96 and over	0.38	0.38	10	7
Over 31.8 to 63.5	under 3.96	0.51	0.51	10	10
Over 31.8 to 63.5	3.96 and over	0.51	0.51	10	7

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

TABLE 7 Radii of Corners of Butt-Weld Square and Rectangular Tubing

Wall Thickness, in. (mm)	Maximum Radii of Corners, in. (mm) ^A
0.065 to 0.083 (1.65 to 2.11), incl	$\frac{9}{64}$ (3.6)
Over 0.083 to 0.095 (2.11 to 2.41), incl	$\frac{3}{16}$ (4.8)
Over 0.095 to 0.109 (2.41 to 2.76), incl	$\frac{13}{64}$ (5.2)
Over 0.109 to 0.134 (2.76 to 3.40), incl	$\frac{7}{32}$ (5.6)
Over 0.134 to 0.156 (3.40 to 3.96), incl	$\frac{1}{4}$ (6.4)
Over 0.156 to 0.188 (3.96 to 4.78), incl	$\frac{9}{32}$ (7.1)
Over 0.188 to 0.250 (4.78 to 6.35), incl	$\frac{11}{32}$ (8.7)
Over 0.250 to 0.313 (6.35 to 7.95), incl	$\frac{7}{16}$ (11.1)
Over 0.313 to 0.375 (7.95 to 9.52), incl	$\frac{1}{2}$ (12.7)
Over 0.375 to 0.500 (9.52 to 12.70), incl	$\frac{11}{16}$ (17.5)

^A These tolerances apply to grades MT 1010 and MT 1015 steel only. Tolerances on other grades shall be established between the manufacturer and the purchaser.

TABLE 8 Twist Tolerance, Square and Rectangular Mechanical Tubing

Largest Dimension, in. (mm)	Twist Tolerance in 3 ft, in. (in 1 m, mm)
Under $\frac{1}{2}$ (12.7)	0.050 (0.014)
$\frac{1}{2}$ to $1\frac{1}{2}$ (12.7 to 38.1), incl	0.075 (0.020)
Over $1\frac{1}{2}$ to $2\frac{1}{2}$ (38.1 to 63.5), incl	0.095 (0.026)
Over $2\frac{1}{2}$ (63.5)	0.125 (0.035)

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 lengths shorter than the minimum specified, but not less than 6 ft (1.8 m).

10.5.1 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.

10.5.2 Variations from the specified length shall not exceed the amounts prescribed in Table 9.

10.6 Straightness—The straightness tolerance for square and rectangular tubing shall be $\frac{1}{16}$ in. in 3 ft (1:576).

11. Workmanship, Finish, and Appearance

11.1 Tubes shall have a surface finish compatible with the conditions (Section 5) to which the tubes are ordered.

11.2 Special surface preparations as may be required for specific applications are not within the scope of this section. Such requirements shall be considered under the supplementary or basis of purchase provisions of this specification, and details shall be provided in the purchase order.

11.3 The tubing shall be free of injurious defects and shall have a workmanlike finish. Surface imperfections such as handling marks, straightening marks, light die marks, or shallow pits are not considered injurious.

11.4 The tubing shall be free of scale. In the case of thermally treated tubing, a slight amount of color will not be considered cause for rejection.

11.5 Saw cut tubes will be furnished without removing outside diameter and inside diameter burrs.

11.6 Lathe cut tubes will be furnished with outside diameter burr only removed.

11.7 Burr removal may be obtained by so specifying in the purchase order.

TABLE 9 Permissible Variation in Length—Square and Rectangular Tubing

Lengths 3 ft (0.9 m) and under	$\pm \frac{1}{16}$ in. (1.,6 mm)
Lengths over 3 to 12 ft (0.9 to 3.7 m), incl	$\pm \frac{1}{32}$ in. (2.4 mm)
Lengths over 12 to 20 ft (3.7 to 6.1 m), incl	$\pm \frac{1}{8}$ in. (3.2 mm)
Lengths over 20 to 30 ft (6.1 to 9.1 m), incl	$\pm \frac{3}{16}$ in. (4.8 mm)
Lengths over 30 to 40 ft (9.1 to 12.2 m), incl	$\pm \frac{3}{8}$ in. (9.5 mm)



12. Machining Allowance—Round Tubing

12.1 For the method of calculating the tube size required to clean up machining to a particular finished part, see Appendix X1.

13. Coating

13.1 Unless otherwise specified, the outside surface of the tubing shall be coated, before shipping, with a film of rust retarding oil. Unless otherwise specified, the inside surface of the tubing may also be coated with a film of rust retarding oil at the option of the manufacturer. When the order specifies that the tubing be shipped without rust retarding oil, the film of oils incidental to manufacturing will remain on the surfaces. If the order specifies no oil, the purchaser assumes responsibility for rust in transit.

14. Rejection

14.1 Tubes that fail to meet the requirements of the specification shall be set aside, and the manufacturer shall be notified.

15. Product Marking

15.1 *Civilian Procurement*—Each box, bundle, lift, or, when individual pieces are shipped, each piece shall be identified by a tag or stencil with the manufacturer's name or

brand, grade or material, purchaser's order number, and this specification number (ASTM designation).

15.2 *Bar Coding*—In addition to the requirements in 15.1 and 15.3 bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.

15.3 *Government Procurement*—When specified in the contract or order, and for direct procurement by or direct shipment to the government, marking for shipment, in addition to requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for Military agencies and in accordance with Fed. Std. No. 123 for civil agencies.

16. Packaging

16.1 *Civilian Procurement*—The manufacturer, at his option, will box, crate, carton, package in secured lifts, or bundle to ensure safe delivery. Special packaging requiring extra operations other than those normally used by the manufacturer must be specified on the order.

16.2 *Government Procurement*—When specified in the contract or order, and for direct procurement by or direct shipment to the government when Level A is specified, preservation, packaging, and packing shall be in accordance with the Level A requirements of MIL-STD-163.

17. Keywords

17.1 carbon steel tube; mechanical tubing; steel tube

SUPPLEMENTARY REQUIREMENTS

These requirements shall not be considered unless specified in the order, and the necessary tests shall be made at the mill. Mechanical property tests shall be performed in accordance with applicable portions of Test Methods and Definitions A 370.

S1. Hardness and Tension Tests—Round Tubing

S1.1 When hardness is specified in the order, the tubing shall conform to the hardness limits specified in Table S1.1 or Table S1.2, unless "Tensile Properties Required" is specified in the purchase order. When "Tensile Properties Required" is specified in the purchase order, the tubing shall conform to the tension test requirements and not necessarily the hardness limits shown in Table S1.1 or Table S1.2.

S1.2 *Number of Tests and Retests:*

TABLE S1.2 Tensile and Hardness Requirements for Soft Annealed Round Tubes

Grade	Tensile Strength, min, ksi (MPa)	Yield Strength, min, ksi (MPa)	Elongation in 2 in. or 50 mm, min, %	Rockwell Hardness
MT1010	40 (276)	20 (138)	35	B 40 to B 65
MT1015	43 (296)	25 (172)	34	B 40 min
MT1020	50 (345)	30 (207)	32	B 50 min
MT1025	55 (379)	35 (241)	32	B 55 min
MT1030	65 (448)	40 (276)	30	B 60 min

TABLE S1.1 Tensile and Hardness Requirements for Stress Relief Annealed Round Tubes

Grade	Tensile Strength, ksi (MPa)		(0.2 % Offset) Yield Strength, min, ksi (MPa)	Elongation in 2 in. or 50 mm, min, %	Rockwell Hardness	
	min	max			min	max
MT1010	63 (434)	100 (689)	58 (400)	15	B 70	B 90
1011	65 (448)	100 (689)	59 (407)	13	B 70	B 100
MT1015	66 (555)	100 (689)	60 (414)	14	B 70	B 100
1016	67 (462)	100 (689)	61 (421)	13	B 70	B 100
MT1017	67 (462)	100 (689)	62 (427)	13	B 72	B 100
1018	68 (469)	100 (689)	62 (427)	13	B 73	B 100
MT1020	71 (490)	130 (896)	65 (448)	11	B 75	C 20
1025	72 (496)	130 (896)	67 (462)	11	B 78	C 20
1030	80 (552)	130 (896)	70 (483)	10	B 80	C 20
1110	63 (434)	100 (689)	58 (400)	15	B 70	B 100
1115	68 (469)	100 (689)	62 (427)	13	B 70	B 100



S1.2.1 *Hardness*—One percent of all tubes per lot (Note S1.1),

S1.2.2 *Tension*:

S1.2.2.1 One test per lot (Note S1.1).

S1.2.2.2 The yield strength corresponding to a permanent offset of 0.2 % of the gage length of the specimen or to a total extension of 0.5 % of the gage length under load shall be determined.

S1.2.3 If the results of the mechanical tests do not conform to the requirements shown in Table S1.1 and Table S1.2, retests shall be made on additional tubes double the original number, each of which shall conform to the specified requirements.

NOTE S1.1—A lot shall consist of all tubes, before cutting to length, of the same size and wall thickness which are produced from the same heat of steel and, when heat treated, subjected to the same finishing treatment in a continuous furnace. When final heat treatment is in a batch-type furnace, the lot shall include only those tubes which are heat treated in the same furnace charge.

S2. Flattening Test—Soft-Annealed Round Tubing

S2.1 The weld shall be located 45° from the line of the direction of applied force. No cracks other than superficial surface ruptures shall appear in the weld until the distance between the flattening plates is less than three fourths of the outside diameter of the tube. Likewise, no cracks, other than superficial surface ruptures, shall appear in the metal of the tube other than the weld metal until the distance between the flattening plates is less than three fifths of the outside diameter of the tube.

S2.2 *Number of Tests and Retests*:

S2.2.1 One test per lot (Note S1.1).

S2.2.2 Two retests per lot (Note S1.1).

S3. Flaring Test—Round Tubing

S3.1 A tapered mandrel having a slope of 1 in 10 shall be driven into one end of a soft-annealed section cut to a suitable length and thus expanding the specimen until the outside diameter has been increased 5 %.

S3.2 *Number of Tests and Retests*:

S3.2.1 One test per lot (Note S1.1).

S3.2.2 Two retests per lot (Note S1.1).

S4. Nondestructive Electrical Test—Round Tubing

S4.1 The manufacturer shall test the tubing by an electrical method of nondestructive test for detection of harmful faults and soundness of weld. The equipment used shall be capable of indicating and rejecting all defects on the outside diameter or inside diameter greater than $\frac{1}{16}$ in. (1.6 mm) in length and to a depth greater than approximately one fourth the wall thickness.

S5. Certification for Government Orders

S5.1 A producer's or supplier's certification shall be furnished to the Government that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. This certificate shall include a report of heat analysis (product analysis when requested in the purchase order), and, when specified in the purchase order or contract, a report of test results shall be furnished.

APPENDIX

(Nonmandatory Information)

X1. MACHINING ALLOWANCES

X1.1 The minimum diameter stock allowance for removal of imperfections by machining from the outside of the tube when chucked concentrically on the tube outside diameter is given in Table X1.1.

X1.2 *Boring Mandrel Drawn Tubing*—When chucked concentrically with the outside diameter, mandrel drawn tubing will clean up concentrically with the outside diameter on a boring operation at a size derived from the following equation:

$$\text{Ordered inside diameter} = \text{finished inside diameter} - (0.075 \text{ in. (1.90 mm)} \times \text{original outside diameter} - \text{amount shown in Table X1.1}).$$

X1.2.1 To this equation, add 0.005 in. (0.13 mm) when the original outside diameter does not exceed 1 $\frac{1}{2}$ in. (38.1 mm);

TABLE X1.1 Machining Allowances^A

NOTE 1—1 in. = 25.4 mm.

Diameter, in.	Wall Thickness, in.	
	Up to 0.200	0.200 and Over
<i>Sink Drawn:</i>		
Up to 1 $\frac{1}{2}$	0.025	0.030
1 $\frac{1}{2}$ and over	0.030	0.035
<i>Mandrel Drawn:</i>		
Up to 1 $\frac{1}{2}$	0.020	0.025
1 $\frac{1}{2}$ and over	0.025	0.030

^A If a specific size is desired, these allowances plus normal size tolerances must be considered in calculating the size to be ordered.

add 0.010 in. (0.25 mm) when the original outside diameter is over 1 $\frac{1}{2}$ in. These equations apply to tubes chucked within 2 in. (50.8 mm) of the end being bored.



A 512 – 96 (2001)

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