Designation: A513/A513M – 20

Standard Specification for
Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing[1]

This standard is issued under the fixed designation A513/A513M; 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.

1. Scope*

1.1 This specification covers electric-resistance-welded carbon and alloy steel tubing for use as mechanical tubing.

1.2 This specification covers mechanical tubing made from hot- or cold-rolled steel.

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

Type	Size Range (Round Tubing)
Electric-Resistance-Welded Tubing from Hot-Rolled Steel	outside diameter from ½ to 15 in. [12.7 to 380 mm] wall from 0.065 to 0.650 in. [1.65 to 16.5 mm]
Electric-Resistance-Welded Tubing from Cold-Rolled Steel	outside diameter from ⅜ to 12 in. [9.5 to 300 mm] wall from 0.022 to 0.134 in. [0.56 to 3.40 mm]

1.4 This specification covers mechanical tubing in various Grades (see Section 5), Types (see 12.1), and Thermal Conditions (12.1).

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

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. The inch-pound units shall apply unless the "M" designation of this specification is specified in the order. In this specification hard or rationalized conversions apply to diameters, lengths and tensile properties. Soft conversion applies to other SI measurements.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

A1011/A1011M Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

A1039/A1039M Specification for Steel, Sheet, Hot Rolled, Carbon, Commercial, Structural, and High-Strength Low-Alloy, Produced by Twin-Roll Casting Process

A1040 Guide for Specifying Harmonized Standard Grade Compositions for Wrought Carbon, Low-Alloy, and Alloy Steels

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

E273 Practice for Ultrasonic Testing of the Weld Zone of Welded Pipe and Tubing

E309 Practice for Eddy Current Examination of Steel Tubular Products Using Magnetic Saturation

E570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products

2.2 *ASME Standard:*[3]

B46.1 Surface Texture

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

2.3 *Military Standards:*[4]

MIL-STD-129 Marking for Shipment and Storage

2.4 *Federal Standard:*[4]

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

3. Ordering Information

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

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of material (electric resistance-welded carbon or alloy steel mechanical tubing),

3.1.3 Types, conditions and code letters, (See Sections 1 and 12),

3.1.4 Thermal condition, (See 12.2),

3.1.5 Flash condition, (See 12.3),

3.1.6 Grade designation, if required, (See Section 5),

3.1.7 Report chemical analysis and product analysis, if required (See Sections 6 and 7),

3.1.8 Individual supplementary requirements, if required (S1 to S10, inclusive),

3.1.9 Cross section (round, square, rectangular and special shapes),

3.1.10 Dimensions, round, outside and inside and wall thickness (See 8.1 and 8.2) or square and rectangular, outside dimension and wall thickness and corner radii, if required (See 9.1 and 9.2),

3.1.11 Length, round, mill lengths or definite cut length (See 8.3), square and rectangular, specified length (See 9.4),

3.1.12 Squareness of cut, round tubing, if required, (See 8.4),

3.1.13 Burrs removed, if required (See 11.2),

3.1.14 Protective coating (See 14.1),

3.1.15 Special packaging (See 17.1),

3.1.16 Specification designation,

3.1.17 End use,

3.1.18 Special requirements,

3.1.19 Special marking (See Section 16), and

3.1.20 Straightness Test Method (See 8.5 and 9.6).

4. Materials and Manufacture

4.1 The steel may 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 electric-resistance-welded process and shall be made from hot- or cold-rolled steel as specified.

4.5.1 The weld shall not be located within the radius of the corners of any shaped tube unless specified by the purchaser.

5. Chemical Composition

5.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1 or Table 2 (See Specification A1040). If no grade is specified, Grades MT 1010 to MT 1020 may be furnished. Analyses of steels other than those listed are available. To determine their availability, the purchaser should contact the producer.

5.2 When a carbon steel 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 Tables 1 and 2 is not permitted.

5.3 Mechanical tubing with improved ductility may be produced from Drawing Steel (Types A and B), Deep Drawing Steel, or Extra Deep Drawing Steels identified in Specifications A1008/A1008M, A1011/A1011M, or A1039/A1039M. Those Specifications offer guidance in the form of nonmandatory Typical Ranges of Mechanical Properties.

6. Heat Analysis

6.1 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 employed, 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 analysis shall be furnished to the purchaser.

TABLE 1 Chemical Requirements for Standard Low-Carbon Steels[A]

NOTE 1— Chemistry represents heat analysis. Product analysis, except for rimmed or capped steel, is to be in accordance with usual practice as shown in Table 3.

Grade Designation	Chemical Composition Limits, %			
	Carbon	Manganese	Phosphorus, max	Sulfur, max
MT[B] 1010	0.02–0.15	0.30–0.60	0.035	0.035
MT 1015	0.10–0.20	0.30–0.60	0.035	0.035
MT X 1015	0.10–0.20	0.60–0.90	0.035	0.035
MT 1020	0.15–0.25	0.30–0.60	0.035	0.035
MT X 1020	0.15–0.25	0.70–1.00	0.035	0.035

[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] The letters MT under grade designation indicate Mechanical Tubing.

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

TABLE 2 Chemical Requirements for Other Carbon and Alloy Steels[A]

NOTE 1—Chemistry represents heat analysis. Product analysis, except for rimmed or capped steel, is to be in accordance with usual practice as shown in Table 3.

Grade Designation	Chemical Composition Limits, %							
	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Nickel	Chromium	Molybdenum
1006	0.08 max	0.45 max	0.030	0.035	...	...	...	...
1008	0.10 max	0.50 max	0.035	0.035	...	...	...	...
1009	0.15 max	0.60 max	0.035	0.035	...	...	...	...
1010	0.08–0.13	0.30–0.60	0.035	0.035	...	...	...	...
1012	0.10–0.15	0.30–0.60	0.035	0.035	...	...	...	...
1015	0.13–0.18	0.30–0.60	0.035	0.035	...	...	...	...
1016	0.13–0.18	0.60–0.90	0.035	0.035	...	...	...	...
1017	0.15–0.20	0.30–0.60	0.035	0.035	...	...	...	...
1018	0.15–0.20	0.60–0.90	0.035	0.035	...	...	...	...
1019	0.15–0.20	0.70–1.00	0.035	0.035	...	...	...	...
1020	0.18–0.23	0.30–0.60	0.035	0.035	...	...	...	...
1021	0.18–0.23	0.60–0.90	0.035	0.035	...	...	...	...
1022	0.18–0.23	0.70–1.00	0.035	0.035	...	...	...	...
1023	0.20–0.25	0.30–0.60	0.035	0.035	...	...	...	...
1024	0.18–0.25	1.30–1.65	0.035	0.035	...	...	...	...
1025	0.22–0.28	0.30–0.60	0.035	0.035	...	...	...	...
1026	0.22–0.28	0.60–0.90	0.035	0.035	...	...	...	...
1027	0.22–0.29	1.20–1.55	0.035	0.035	...	...	...	...
1030	0.28–0.34	0.60–0.90	0.035	0.035	...	...	...	...
1033	0.30–0.36	0.70–1.00	0.035	0.035	...	...	...	...
1035	0.32–0.38	0.60–0.90	0.035	0.035	...	...	...	...
1040	0.37–0.44	0.60–0.90	0.040	0.050	...	...	...	...
1050	0.48–0.55	0.60–0.90	0.040	0.050	...	...	...	...
1060	0.55–0.65	0.60–0.90	0.040	0.050	...	...	...	...
1340	0.38–0.43	1.60–1.90	0.035	0.040	0.15–0.35	...	...	...
1524	0.19–0.25	1.35–1.65	0.040	0.050	...	...	...	...
4118	0.18–0.23	0.70–0.90	0.035	0.040	0.15–0.35	...	0.40–0.60	0.08–0.15
4130	0.28–0.33	0.40–0.60	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
4140	0.38–0.43	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
5130	0.28–0.33	0.70–0.90	0.035	0.040	0.15–0.35	...	0.80–1.10	...
8620	0.18–0.23	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
8630	0.28–0.33	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25

[A] Where the ellipsis (...) appears in this table, there is no requirement.

7. Product Analysis

7.1 When requested on the purchase order, a product analysis shall be made by the supplier. 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:

7.1.1 *Heat Identity Maintained*—One product analysis per heat shall be made on either the flat-rolled stock or tube.

7.1.2 *Heat Identity Not Maintained*—A product from one tube per 2000 ft [600 m] or less for sizes over 3 in. [75 mm], and one tube per 5000 ft [1500 m] or less for sizes 3 in. [75 mm] and under.

7.2 Samples for product analysis shall be taken in accordance with Practice A751. The composition thus determined shall correspond to the requirements of Table 1 or Table 2.

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

TABLE 3 Tolerances for Product Analysis for Steels Shown in Tables 1 and 2[A,B]

Element	Limit, or Maximum of Specified Range, %	Variation, Over the Maximum Limit or Under the Minimum Limit	
		Under min, %	Over max, %
Carbon	to 0.15, incl	0.02	0.03
	over 0.15 to 0.40, incl	0.03	0.04
	over 0.40 to 0.55, incl	0.03	0.05
Manganese	to 0.60, incl	0.03	0.03
	over 0.60 to 1.15, incl	0.04	0.04
	over 1.15 to 1.65, incl	0.05	0.05
Phosphorus		...	0.01
Sulfur		...	0.01
Silicon	to 0.30, incl	0.02	0.03
	over 0.30 to 0.60	0.05	0.05
Nickel	to 1.00, incl	0.03	0.03
Chromium	to 0.90, incl	0.03	0.03
	over 0.90 to 2.10, incl	0.05	0.05
Molybdenum	to 0.20, incl	0.01	0.01
	over 0.20 to 0.40, incl	0.02	0.02

[A] Individual determinations may vary from the specified heat limits or ranges to the extent shown in this table, except that any element in a heat may not vary both above and below a specified range.
[B] Where the ellipsis (...) appears in this table, there is no requirement.

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individually tested for acceptance. Lengths of flat-rolled stock or tubes which do not meet the requirements of the specification shall be rejected.

8. Permissible Variations in Dimensions for Round Tubing

8.1 *Diameter and Wall Thickness (Hot-Rolled Steel)*—Variations from specified outside diameter for "as-welded" and "as-welded and annealed" tubing made from hot-rolled steel shall not exceed the amounts prescribed in Table 4. Permissible variations in outside diameter for tubing that has been sink-drawn for closer tolerance on outside diameter are shown in Table 5. Permissible variations in wall thickness for tubing that has been sink-drawn for closer tolerances on outside diameters are ±10 % of the nominal wall or ±0.010 in. [0.25 mm], whichever is greater. Permissible variations in wall thickness for tubing made from hot-rolled steel are shown in Tables 6 and 7. Permissible variation in outside diameter for tubing made from hot-rolled steel that has been Drawn Over a Mandrel (DOM) for closer tolerances are shown in Table 5 with wall tolerances shown in Tables 8 and 9.

8.2 *Diameter and Wall Thickness (Cold-Rolled Steel)*—Variations in outside diameter and inside diameter of "as-welded" and "as-welded and annealed" tubing made from cold-rolled steel are shown in Table 10. Outside diameter tolerances for cold-rolled steel tubing, sink drawn and DOM, are shown in Table 5. Wall thickness tolerances for "as-welded" tubing made from cold-rolled steel are shown in Tables 11 and 12. Permissible variations in wall thickness for round tubing, DOM for closer tolerances, are shown in Tables 8 and 9. Permissible variations in wall thickness for tubing that has been sink-drawn for closer tolerances on outside diameter are ±10 % of the nominal wall or ±0.010 in. [0.25 mm], whichever is greater.

8.3 *Length (Hot- and Cold-Rolled Steel)*—Mechanical tubing is commonly furnished in mill lengths 5 ft [1.5 m] and over. Definite cut lengths are furnished when specified by the purchaser. Tolerances for definite cut lengths round tubing shall be as given in Tables 13 and 14.

8.4 *Squareness of Cut (Hot- and Cold-Rolled Steel)*—When specified, tolerance for squareness of cut of round tubing shall be as given in Table 15. Measurements are made with use of an "L" square and feeler gauge. The long leg (blade) of the square to be equal to tube diameter plus a minimum of 1 in. [25.4 mm]. Outside diameter burr to be removed for measurement.

8.5 *Straightness*—The straightness tolerance for round tubing is 0.030 in./3 ft [0.75 mm/1 m] lengths to 8.000 in. [200 mm] outside diameter. For 8.000 in. [200 mm] outside diameter and above, straightness tolerance is 0.060 in./3 ft [1.5 mm/1 m] lengths. For lengths under 1 ft [305 mm] the straightness tolerance shall be agreed upon between the purchaser and producer. The test method for straightness measurement is at the manufacturer's option, unless a specific test method is specified in the purchase order.

8.6 *Ovality (Hot- and Cold-Rolled Steel)*—Ovality is the difference between maximum and minimum outside diameters measured at any one cross section. The ovality shall be within the tolerances except when the wall thickness is less than 3 % of the outside diameter.

8.6.1 In such cases for Types 1 and 2 (A.W.H.R. and A.W.C.R.) the ovality may be 50 % greater than the outside tolerances but the mean outside diameter shall be within the specified tolerance.

8.6.2 For Types 3, 4, 5, and 6 (S.D.H.R., S.D.C.R., DOM, and S.S.I.D.) the additional ovality shall be as follows but the mean outside diameter shall be within the specified tolerance:

Outside Diameter, in. [mm]	Additional Ovality Tolerance, in. [mm]
Up to 2 [50], incl	0.010 [0.25]
Over 2 to 3 [50 to 75], incl	0.015 [0.38]
Over 3 to 4 [75 to 100], incl	0.020 [0.51]
Over 4 to 5 [100 to 125], incl	0.025 [0.64]
Over 5 to 6 [125 to 150], incl	0.030 [0.76]
Over 6 to 7 [150 to 180], incl	0.035 [0.89]
Over 7 to 8 [180 to 205], incl	0.040 [1.02]
Over 8 to 9 [205 to 230], incl	0.045 [1.14]
Over 9 to 10 [230 to 255], incl	0.050 [1.27]
Over 10 to 11 [255 to 280], incl	0.055 [1.40]
Over 11 to 12 [280 to 305], incl	0.060 [1.52]
Over 12 to 12.500 [305 to 320], incl	0.065 [1.65]

9. Permissible Variations in Dimensions of Square and Rectangular Tubing

9.1 *Diameter and Wall Thickness*—Permissible variations in outside dimensions for square and rectangular tubing shall be as given in Table 16. The wall thickness tolerance is ±10 % of the nominal wall thickness.

9.2 *Corner Radii*—Unless otherwise specified, the corners of square and rectangular tubing shall be slightly rounded inside and outside, consistent with wall thickness. The outside corners may be slightly flattened. The radii of corners shall be as given in Table 17.

9.3 *Squareness*—Permissible variations for squareness shall be determined by the following equation:

$$\pm b = c \times 0.006 \ in. \ (0.15 \ mm)$$

where:

b = tolerance for out-of-square, and
c = largest external dimension across flats.

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

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

9.3.2 A square equipped with a direct reading vernier, may be used to determine the angular deviation which, in turn, may be related to distance in in. [mm].

9.4 *Length*—Variations from the specified length shall not exceed the amount prescribed in Table 18.

9.5 *Twist*—Twist tolerances are shown in Table 19. 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 the use of a beveled protractor equipped with a level, and noting the angular deviation on opposite ends, or at any point throughout the length.

TABLE 4 Diameter Tolerances for Type I (A.W.H.R.) Round Tubing

NOTE 1—Measurements for diameter are to be taken at least 2 in. [50 mm] from the ends of the tubes.

Outside Diameter Range in. [mm]	Wall Thickness		Flash-in-Tubing[A,B]	Flash Controlled to 0.010 in. [0.26 mm] max Tubing[B,C]	Flash Controlled to 0.005 in. [0.13 mm]. max Tubing[C,D]	
			Outside Diameter, ±	Outside Diameter, ±	Outside Diameter, ±	Inside Diameter, ±
	Bwg[E]	in. [mm]	Tolerances[F]			
			in. [mm]	in. [mm]	in. [mm]	in. [mm]
½ to 1⅛, incl [15 to 30]	16 to 10	0.065 to 0.134 [1.7 to 3.4]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.020 [0.51]
Over 1⅛ to 2, incl [30 to 50]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.021 [0.53]
Over 1⅛ to 2, incl [30 to 50]	13 to 7	0.095 to 0.180 [2.4 to 4.6]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.025 [0.64]
Over 1⅛ to 2, incl [30 to 50]	6 to 5	0.203 to 0.220 [5.2 to 5.6]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.029 [0.74]
Over 1⅛ to 2, incl [30 to 50]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.039 [0.99]
Over 2 to 2½, incl [50 to 65]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.022 [0.56]
Over 2 to 2½, incl [50 to 65]	13 to 5	0.095 to 0.220 [2.4 to 5.6]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.024 [0.61]
Over 2 to 2½, incl [50 to 65]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.040 [1.02]
Over 2½ to 3, incl [65 to 75]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.024 [0.61]
Over 2½ to 3, incl [65 to 75]	13 to 5	0.095 to 0.220 [2.4 to 5.6]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.026 [0.66]
Over 2½ to 3, incl [65 to 75]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.040 [1.02]
Over 2½ to 3, incl [65 to 75]	2 to 0.320 [8.1]	0.284 to 0.320 [7.2 to 8.1]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.048 [1.22]
Over 3 to 3½, incl [75 to 90]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.025 [0.64]
Over 3 to 3½, incl [75 to 90]	13 to 5	0.095 to 0.220 [2.4 to 5.6]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.027 [0.69]
Over 3 to 3½, incl [75 to 90]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.043 [1.09]
Over 3 to 3½, incl [75 to 90]	2 to 0.360 [9.1]	0.284 to 0.360 [7.2 to 9.1]	0.012 [0.30]	0.012 [0.30]	0.012 [0.30]	0.050 [1.27]
Over 3½ to 4, incl [90 to 100]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.026 [0.66]
Over 3½ to 4, incl [90 to 100]	13 to 5	0.095 to 0.220 [2.4 to 5.6]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.028 [0.72]
Over 3½ to 4, incl [90 to 100]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.044 [1.12]
Over 3½ to 4, incl [90 to 100]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.015 [0.38]	0.015 [0.38]	0.015 [0.38]	0.053 [1.35]
Over 4 to 5, incl [100 to 130]	16 to 14	0.065 to 0.083 [1.7 to 2.1]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.036 [0.91]
Over 4 to 5, incl [100 to 130]	13 to 5	0.095 to 0.220 [2.4 to 5.6]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.045 [1.14]
Over 4 to 5, incl [100 to130]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.054 [1.37]
Over 4 to 5, incl [100 to 130]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.058 [1.47]
Over 5 to 6, incl [130 to 150]	16 to 10	0.065 to 0.134 [1.7 to 3.4]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.036 [0.91]
Over 5 to 6, incl [130 to 150]	9 to 5	0.148 to 0.220 [3.8 to 5.6]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.040 [10.02]
Over 5 to 6 incl [130 to 150]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.054 [1.37]
Over 5 to 6, incl [130 to 150]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.058 [1.47]
Over 6 to 8, incl [150 to 200]	11 to 10	0.120 to 0.134 [3.0 to 3.4]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.043 [1.09]
Over 6 to 8, incl [150 to 200]	9 to 5	0.148 to 0.220 [3.8 to 5.6]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.045 [1.14]
Over 6 to 8, incl [150 to 200]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.059 [1.50]
Over 6 to 8, incl [150 to 200]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.063 [1.60]
Over 8 to 10, incl [200 to 250]	14 to 12	0.083 to 0.109 [2.1 to 2.8]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.041 [1.04]
Over 8 to 10, incl [200 to 250]	11 to 10	0.120 to 0.134 [3.0 to 3.4]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.043 [1.09]
Over 8 to 10, incl [200 to 250]	9 to 5	0.148 to 0.220 [3.8 to 5.6]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.045 [1.14]
Over 8 to 10, incl [200 to 250]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.059 [1.50]
Over 8 to 10, incl [200 to 250]	2 to 0.500 [12.7]	0.248 to 0.500 [7.2 to 12.7]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.063 [1.60]
Over 10 to 12, incl [250 to 300]	14 to 12	0.083 to 0.109 [2.1 to 2.8]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.041 [1.04]
Over 10 to 12, incl [250 to 300]	11 to 10	0.120 to 0.134 [3.0 to 3.4]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.043 [1.09]
Over 10 to 12, incl [250 to 300]	9 to 5	0.148 to 0.220 [3.8 to 5.6]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.045 [1.14]
Over 10 to 12, incl [250 to 300]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.059 [1.50]
Over 10 to 12, incl [250 to 300]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.063 [1.60]
Over 12 to 15, incl [300 to 380]	14 to 12	0.083 to 0.109 [2.1 to 2.8]	0.040 [1.02]	0.040 [1.02]	0.040 [1.02]	0.058 [1.47]
Over 12 to 15, incl [300 to 380]	11 to 10	0.120 to 0.134 [3.0 to 3.4]	0.040 [1.02]	0.040 [1.02]	0.040 [1.02]	0.058 [1.47]
Over 12 to 15, incl [300 to 380]	9 to 5	0.148 to 0.220 [3.8 to 5.6]	0.040 [1.02]	0.040 [1.02]	0.040 [1.02]	0.060 [1.52]
Over 12 to 15, incl [300 to 380]	4 to 3	0.238 to 0.259 [6.0 to 6.6]	0.040 [1.02]	0.040 [1.02]	0.040 [1.02]	0.074 [1.88]
Over 12 to 15, incl [300 to 380]	2 to 0.500 [12.7]	0.284 to 0.500 [7.2 to 12.7]	0.040 [1.02]	0.040 [1.02]	0.040 [1.02]	0.086 [2.18]

[A] Flash-In-Tubing is produced only to outside diameter tolerances and wall thickness tolerances and the inside diameter welding flash does not exceed the wall thickness or ³⁄₃₂ in. [2.4 mm], whichever is less.

[B] Flash Controlled to 0.010 in. [0.25 mm] maximum tubing consists of tubing which is commonly produced only to outside diameter tolerances and wall thickness tolerances, in which the height of the remaining welding flash is controlled not to exceed 0.010 in.

[C] Flash Controlled to 0.005 in. [0.13 mm] maximum tubing is produced to outside diameters and wall thickness tolerance, inside diameter and wall thickness tolerances, or outside diameters and inside diameter tolerances, in which the height of the remaining flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

[D] No Flash tubing is further processed by DOM for closer tolerances, produced to outside diameter and wall, inside diameter and wall, or outside diameter and inside diameter, with no dimensional indication of inside diameter flash, and is available in Types 5 and 6.
[E] Birmingham Wire Gauge.
[F] The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in such cases see 8.6.1.

TABLE 5 Diameter Tolerances for Types 3, 4, 5, and 6 (S.D.H.R., S.D.C.R., DOM, and S.S.I.D) Round Tubing

NOTE 1—Measurements for diameter are to be taken at least 2 in. [50 mm] from the ends of the tubes.

OD Size Range[A] in. [mm]	Wall % of OD	Types 3, 4, (Sink Drawn)[A,B] and 5, 6, (DOM)[B,C] OD		Types 5 and 6 (DOM)[B,C] ID	
		Over in. [mm]	Under in. [mm]	Over in. [mm]	Under in. [mm]
Up to 0.499 [12.67]	all	0.004 [0.10]	0.000 [0.00]	. . .	. . .
0.500 to 1.699 [12.70 to 43.15]	all	0.005 [0.13]	0.000 [0.00]	0.000 [0.00]	0.005 [0.13]
1.700 to 2.099 [43.18 to 53.31]	all	0.006 [0.15]	0.000 [0.00]	0.000 [0.00]	0.006 [0.15]
2.100 to 2.499 [53.34 to 63.47]	all	0.007 [0.18]	0.000 [0.00]	0.000 [0.00]	0.007 [0.18]
2.500 to 2.899 [63.50 to 73.63]	all	0.008 [0.20]	0.000 [0.00]	0.000 [0.00]	0.008 [0.20]
2.900 to 3.299 [73.66 to 83.79]	all	0.009 [0.23]	0.000 [0.00]	0.000 [0.00]	0.009 [0.23]
3.300 to 3.699 [83.82 to 93.95]	all	0.010 [0.25]	0.000 [0.00]	0.000 [0.00]	0.010 [0.25]
3.700 to 4.099 [93.98 to 104.11]	all	0.011 [0.28]	0.000 [0.00]	0.000 [0.00]	0.011 [0.28]
4.100 to 4.499 [104.14 to 114.27]	all	0.012 [0.30]	0.000 [0.00]	0.000 [0.00]	0.012 [0.30]
4.500 to 4.899 [114.30 to 124.43]	all	0.013 [0.33]	0.000 [0.00]	0.000 [0.00]	0.013 [0.33]
4.900 to 5.299 [124.46 to 134.59]	all	0.014 [0.36]	0.000 [0.00]	0.000 [0.00]	0.014 [0.36]
5.300 to 5.549 [134.62 to 140.94]	all	0.015 [0.38]	0.000 [0.00]	0.000 [0.00]	0.015 [0.38]
5.550 to 5.999 [140.97 to 152.37]	under 6	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]
	6 and over	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]
6.000 to 6.499 [152.40 to 165.07]	under 6	0.013 [0.33]	0.013 [0.33]	0.013 [0.33]	0.013 [0.33]
	6 and over	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]
6.500 to 6.999 [165.10 to 177.77]	under 6	0.015 [0.38]	0.015 [0.38]	0.015 [0.38]	0.015 [0.38]
	6 and over	0.012 [0.30]	0.012 [0.30]	0.012 [0.30]	0.012 [0.30]
7.000 to 7.499 [177.80 to 190.47]	under 6	0.018 [0.46]	0.018 [0.46]	0.018 [0.46]	0.018 [0.46]
	6 and over	0.013 [0.33]	0.013 [0.33]	0.013 [0.33]	0.013 [0.33]
7.500 to 7.999 [190.50 to 203.17]	under 6	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]
	6 and over	0.015 [0.38]	0.015 [0.38]	0.015 [0.38]	0.015 [0.38]
8.000 to 8.499 [203.20 to 215.87]	under 6	0.023 [0.58]	0.023 [0.58]	0.023 [0.58]	0.023 [0.58]
	6 and over	0.016 [0.41]	0.016 [0.41]	0.016 [0.41]	0.016 [0.41]
8.500 to 8.999 [215.90 to 228.57}	under 6	0.025 [0.64]	0.025 [0.66]	0.025 [0.66]	0.025 [0.64]
	6 and over	0.017 [0.43]	0.017 [0.43]	0.017 [0.43]	0.017 [0.43]
9.000 to 9.499 [228.60 to 241.27]	under 6	0.028 [0.71]	0.028 [0.71]	0.028 [0.71]	0.028 [0.71]
	6 and over	0.019 [0.48]	0.019 [0.48]	0.019 [0.48]	0.019 [0.48]
9.500 to 9.999 [241.30 to 253.97]	under 6	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]
	6 and over	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]
10.000 to 10.999 [254.00 to 279.37]	all	0.034 [0.85]	0.034 [0.85]	0.034 [0.85]	0.034 [0.85]
11.000 to 11.999 [279.40 to 304.77]	all	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]
12.000 to 12.999 [304.80 to 330.17]	all	0.036 [0.91]	0.036 [0.91]	0.036 [0.94]	0.036 [0.91]
13.000 to 13.999 [330.20 to 355.57]	all	0.037 [0.94]	0.037 [0.94]	0.037 [0.94]	0.037 [0.94]
14.000 to 14.999 [355.60 to 380.97]	all	0.038 [0.97]	0.038 [0.97]	0.038 [0.97]	0.038 [0.97]

[A] Tubing, flash in or flash controlled which is further processed without mandrel to obtain tolerances closer than those shown in Tables 4 and 10.
[B] The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in such cases see 8.6.2.
[C] Tubing produced to outside diameter and wall thickness, or inside diameter and wall thickness, or outside diameter and inside diameter, by DOM to obtain tolerances closer than those shown in Tables 4 and 10 and no dimensional indication of inside diameter flash.

9.6 *Straightness*—The straightness tolerance is 1/16 in./3 ft [1.7 mm/1 m]. The test method for straightness measurement is at the manufacturer's option, unless a specific test method is specified in the purchase order.

10. Tubing Sections Other Than Square and Rectangular

10.1 In addition to square and rectangular tubing, many producers supply a variety of special sections, such as oval, streamlined, hexagonal, octagonal, round inside and hexagonal or octagonal outside, ribbed inside or out, triangular, rounded rectangular and D shapes. Manufacturing practices limit the size range and section available from the various producers.

These special sections may be made through turkshead rolls or through a die with or without use of a mandrel. Since the sections are special, dies and other tools are not held available. Therefore, when inquiring for shapes other than square and rectangular, it is essential to give full details as to dimensions and finish.

11. Workmanship, Finish, and Appearance

11.1 The tubing shall be free of injurious defects and shall have a workmanlike finish.

11.2 When burrs must be removed from one or both ends, it shall be specified in the purchase order.

TABLE 6 Wall Thickness Tolerance for Type I (A.W.H.R.) Round Tubing (Inch Units)

Wall Thickness in.[A]	Bwg[A]	3/4 to 1, incl +	−	Over 1 to 1 15/16, incl +	−	Over 1 15/16 to 3 3/4, incl +	−	Over 3 3/4 to 4 1/2, incl +	−	Over 4 1/2 to 6, incl +	−	Over 6 to 8, incl +	−	Over 8 to 10, incl +	−	Over 10 to 12, incl +	−	Over 12 to 15, incl +	−
0.065	16	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012	0.002	0.012	…	…	…	…	…	…
0.072	15	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012	0.002	0.012	0.003	0.013	…	…	…	…
0.083	14	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.095	13	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.109	12	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.120	11	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.134	10	0.006	0.010	0.005	0.011	0.004	0.013	0.004	0.014	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.148	9	…	…	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.165	8	…	…	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.180	7	…	…	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.203	6	…	…	…	…	0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017
0.220	5	…	…	…	…	0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017
0.238	4	…	…	…	…	0.012	0.020	0.011	0.021	0.010	0.022	0.010	0.022	0.010	0.022	0.010	0.022	0.010	0.022
0.259	3	…	…	…	…	0.013	0.021	0.012	0.022	0.011	0.023	0.011	0.023	0.011	0.023	0.011	0.023	0.011	0.023
0.284	2	…	…	…	…	0.014	0.022	0.013	0.023	0.012	0.024	0.012	0.024	0.012	0.024	0.012	0.024	0.012	0.024
0.300	1	…	…	…	…	0.015	0.023	0.014	0.024	0.013	0.025	0.013	0.025	0.013	0.025	0.013	0.025	0.013	0.025
0.320		…	…	…	…	0.016	0.024	0.015	0.025	0.014	0.026	0.014	0.026	0.014	0.026	0.014	0.026	0.014	0.026
0.344		…	…	…	…	0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.360		…	…	…	…	0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.375		…	…	…	…	…	…	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.406		…	…	…	…	…	…	0.017	0.027	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.438		…	…	…	…	…	…	0.017	0.027	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.469		…	…	…	…	…	…	…	…	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.500		…	…	…	…	…	…	…	…	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028

Wall Thickness Tolerances, in., ±[B]

[A] Birmingham Wire Gauge.

[B] Where the ellipsis (…) appears in this table, the tolerance is not addressed.

TABLE 7 Wall Thickness Tolerance for Type I (A.W.H.R.) Round Tubing (SI Units)

Outside Diameter, mm

Wall Thickness Tolerances, mm, ±[A]

Wall Thickness mm	20 to 25 mm, incl		Over 25 to 50 mm, incl		Over 50 to 95 mm, incl		Over 95 to 115 mm incl		Over 115 to 150 mm incl		Over 150 to 200 mm Incl		Over 200 to 250 mm incl		Over 250 to 305 mm Incl		Over 305 to 380 mm, incl	
	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
1.65	0.13	0.23	0.10	0.25	0.08	0.28	0.05	0.30	0.05	0.30	0.05	0.30	...	...	...	...	...	...
1.83	0.13	0.23	0.10	0.25	0.08	0.28	0.05	0.30	0.05	0.30	0.05	0.30	...	...	...	...	...	...
2.11	0.15	0.25	0.13	0.28	0.10	0.30	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33
2.41	0.15	0.25	0.13	0.28	0.10	0.30	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33
2.77	0.15	0.25	0.13	0.28	0.10	0.30	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33
3.05	0.15	0.25	0.13	0.28	0.10	0.30	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33	0.08	0.33
3.40	0.15	0.01	0.15	0.30	0.13	0.33	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36
3.76	...	...	0.15	0.30	0.13	0.33	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36
4.19	...	...	0.16	0.30	0.13	0.33	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36	0.10	0.36
4.57	...	...	...	...	0.18	0.38	0.15	0.41	0.13	0.43	0.13	0.43	0.13	0.43	0.13	0.43	0.13	0.43
5.16	...	...	...	...	0.30	0.51	0.28	0.53	0.13	0.43	0.13	0.43	0.13	0.43	0.13	0.43	0.13	0.43
5.59	...	...	...	...	0.33	0.53	0.30	0.56	0.25	0.56	0.25	0.56	0.25	0.56	0.25	0.56	0.25	0.56
6.05	...	...	...	...	0.36	0.56	0.33	0.58	0.28	0.58	0.28	0.58	0.28	0.58	0.28	0.58	0.28	0.58
6.58	...	...	...	...	0.38	0.58	0.36	0.61	0.30	0.61	0.30	0.61	0.30	0.61	0.30	0.61	0.30	0.61
7.21	...	...	...	...	0.41	0.61	0.38	0.64	0.33	0.64	0.33	0.64	0.33	0.64	0.33	0.64	0.33	0.64
7.62	...	...	...	...	0.43	0.64	0.41	0.66	0.36	0.66	0.36	0.66	0.36	0.66	0.36	0.66	0.36	0.66
8.13	...	...	...	...	0.43	0.64	0.41	0.66	0.36	0.66	0.36	0.66	0.36	0.66	0.36	0.66	0.36	0.66
8.74	...	...	...	...	...	...	0.41	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69
9.14	...	...	...	...	...	...	0.43	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69
9.53	...	...	...	...	...	...	0.43	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69	0.38	0.69
10.31	...	...	...	...	...	...	...	...	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71
11.13	...	...	...	...	...	...	...	...	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71
11.91	...	...	...	...	...	...	...	...	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71
12.70	...	...	...	...	...	...	...	...	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71	0.41	0.71

[A] Where the ellipsis (...) appears in this table, the tolerance is not addressed.

TABLE 8 Wall Thickness Tolerances of Types 5 and 6 (DOM and S.S.I.D.) Round Tubing (Inch Units)

Wall Thickness		Outside Diameter, in.[A]							
		⅜ to ⅞, incl		Over ⅞ to 1⅞, incl		Over 1⅞ to 3¾, incl		Over 3¾ to 15, incl	
		Wall Thickness Tolerances, in.,[A,B] ±							
in.[A]	Bwg[A]	+	−	+	−	+	−	+	−
0.035	20	0.002	0.002	0.002	0.002	0.002	0.002	...	...
0.049	18	0.002	0.002	0.002	0.003	0.002	0.003	...	...
0.065	16	0.002	0.002	0.002	0.003	0.002	0.003	0.004	0.004
0.083	14	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.005
0.095	13	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.005
0.109	12	0.002	0.003	0.002	0.004	0.003	0.003	0.005	0.005
0.120	11	0.003	0.003	0.002	0.004	0.003	0.003	0.005	0.005
0.134	10	...	...	0.002	0.003	0.003	0.003	0.005	0.005
0.148	9	...	...	0.002	0.004	0.003	0.003	0.005	0.005
0.165	8	...	...	0.003	0.004	0.003	0.004	0.005	0.006
0.180	7	...	...	0.004	0.004	0.003	0.005	0.006	0.006
0.203	6	...	...	0.004	0.005	0.004	0.005	0.006	0.007
0.220	5	...	...	0.004	0.006	0.004	0.006	0.007	0.007
0.238	4	...	...	0.005	0.006	0.005	0.006	0.007	0.007
0.259	3	...	...	0.005	0.006	0.005	0.006	0.007	0.007
0.284	2	...	...	0.005	0.006	0.005	0.006	0.007	0.007
0.300	1	...	...	0.006	0.006	0.006	0.006	0.008	0.008
0.320		...	...	0.007	0.007	0.007	0.007	0.008	0.008
0.344		...	...	0.008	0.008	0.008	0.008	0.009	0.009
0.375		...	...	...	...	0.009	0.009	0.009	0.009
0.400		...	...	...	...	0.010	0.010	0.010	0.010
0.438		...	...	...	...	0.011	0.011	0.011	0.011
0.460		...	...	...	...	0.012	0.012	0.012	0.012
0.480		...	...	...	...	0.012	0.012	0.012	0.012
0.531		...	...	...	...	0.013	0.013	0.013	0.013
0.563		...	...	...	...	0.013	0.013	0.013	0.013
0.580		...	...	...	...	0.014	0.014	0.014	0.014
0.600		...	...	...	...	0.015	0.015	0.015	0.015
0.625		...	...	...	...	0.016	0.016	0.016	0.016
0.650		...	...	...	...	0.017	0.017	0.017	0.017

[A] Birmingham Wire Gauge.
[B] Where the ellipsis (...) appears in this table, the tolerance is not addressed.

TABLE 9 Wall Thickness Tolerances of Types 5 and 6 (DOM and S.S.I.D.) Round Tubing (SI Units)

Wall Thickness mm	Outside Diameter, mm							
	10 to 20, incl		Over 20 to 50, incl		Over 50 to 100, incl		Over 100 to 380, incl	
	Wall Thickness Tolerances, mm[A]							
	+	−	+	−	+	−	+	−
0.89	0.05	0.05	0.05	0.05	0.05	0.05	...	...
1.24	0.05	0.05	0.05	0.08	0.05	0.08	...	...
1.65	0.05	0.05	0.05	0.08	0.05	0.08	0.10	0.10
2.11	0.05	0.05	0.05	0.08	0.08	0.08	0.10	0.13
2.41	0.05	0.05	0.05	0.08	0.08	0.08	0.10	0.13
2.77	0.05	0.08	0.05	0.10	0.08	0.08	0.13	0.13
3.05	0.08	0.08	0.05	0.10	0.08	0.08	0.13	0.13
3.40	...	...	0.05	0.10	0.08	0.08	0.13	0.13
3.76	...	...	0.05	0.10	0.08	0.08	0.13	0.13
4.19	...	...	0.08	0.10	0.08	0.10	0.13	0.15
4.57	...	...	0.10	0.10	0.08	0.13	0.15	0.15
5.16	...	...	0.10	0.13	0.10	0.13	0.15	0.18
5.59	...	...	0.10	0.15	0.10	0.15	0.18	0.18
6.05	...	...	0.13	0.15	0.13	0.15	0.18	0.18
6.58	...	...	0.13	0.15	0.13	0.13	0.18	0.18
7.21	...	...	0.13	0.15	0.13	0.15	0.18	0.18
7.62	...	...	0.15	0.15	0.15	0.15	0.20	0.20
8.13	...	...	0.18	0.18	0.18	0.18	0.20	0.20
8.74	...	...	0.20	0.20	0.20	0.20	0.23	0.23
9.53	...	...	...	...	0.23	0.23	0.23	0.23
10.16	...	...	...	...	0.25	0.25	0.25	0.25
11.13	...	...	...	...	0.28	0.28	0.28	0.28
11.68	...	...	...	...	0.30	0.30	0.30	0.30
12.19	...	...	...	...	0.30	0.30	0.30	0.30
13.49	...	...	...	...	0.33	0.33	0.33	0.33
14.3	...	...	...	...	0.33	0.33	0.33	0.33
14.73	...	...	...	...	0.36	0.36	0.36	0.36
15.24	...	...	...	...	0.38	0.38	0.38	0.38
15.88	...	...	...	...	0.41	0.41	0.41	0.016
16.51	...	...	...	...	0.43	0.43	0.43	0.43

[A] Where the ellipsis (...) appears in this table, the tolerance is not addressed.

12. Types and Conditions

12.1 The types of tubing covered by this specification are:

Type Number	Code Letters	Description
1a	A.W.H.R.	"as-welded" from hot-rolled steel (with mill scale)
1b	A.W.P.O.	"as-welded" from hot-rolled pickled and oiled steel (mill scale removed)
2	A.W.C.R.	"as-welded" from cold-rolled steel
3	S.D.H.R.	"sink-drawn" hot-rolled steel
4	S.D.C.R.	"sink-drawn," cold-rolled steel
5	DOM	Drawn Over a Mandrel
6	S.S.I.D.	special smooth inside diameter

12.2 The thermal conditions under which tubing may be furnished are:

Code	Description
NA	Not Annealed; in the as-welded or as-drawn condition
SRA	Stress Relieved Annealed (at a temperature below the lower critical temperature)
N	Normalized or Annealed (at a temperature above the upper critical temperature)

12.2.1 When the thermal condition is not specified, the tube may be supplied in the NA condition.

12.2.2 When a final thermal treatment is specified, a tight oxide is normal. When an oxide-free surface is specified, the tube may be bright annealed or pickled at the manufacturer's option.

12.3 Flash conditions under which tubing may be furnished are as follows. The flash shall be removed from the outside diameter of tubing covered by this specification. Tubing furnished to this specification may have the following conditions of welding flash on the inside diameter.

12.3.1 *Flash-In*—Tubing in which the inside diameter welding flash does not exceed the wall thickness or ³⁄₃₂ in. [2.38 mm], whichever is less. This condition is available in Types 1a, 1b, 2, 3, and 4.

12.3.2 *Flash Controlled to 0.010 in. [0.26 mm], maximum*—Tubing in which the height of the remaining welding flash is controlled so as not to exceed 0.010 in. This condition is available in Types 1a, 1b, and 2 over 1⅛-in. [28.5-mm] outside diameter and Types 3 and 4.

12.3.3 *Flash Controlled to 0.005 in. [0.13 mm], maximum*—Tubing produced to outside diameter and wall thickness, inside diameter and wall thickness, or outside diameter and inside diameter tolerances which are so controlled that the height of the remaining inside diameter flash does not exceed 0.005 in. Any remaining inside diameter flash is part of the applicable inside diameter tolerance. This condition is available in Types 1a, 1b, 2, 3, and 4.

12.3.4 *No Flash*—Tubing further processed by DOM for closer tolerances, produced to outside diameter and wall thickness, inside diameter and wall thickness, or outside

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TABLE 10 Diameter Tolerances for Type 2 (A.W.C.R.) Round Tubing

NOTE 1—Measurements for diameter are to be taken at least 2 in. [50 mm] from the ends of the tubes.

Outside Diameter Range in. [mm]	Wall Thickness		Flash-in-Tubing[A]	Flash Controlled to 0.010 in. [0.26 mm] max Tubing[B]	Flash Controlled[C] to 0.005 in. [0.13 mm] max Tubing	
			Outside Diameter, ±	Outside Diameter, ±	Outside Diameter, ±	Inside Diameter, ±
	Bwg[A]	in.[D] [mm]	Tolerances[E,F]			
			in. [mm]	in. [mm]	in. [mm]	in. [mm]
³⁄₈ to ⁵⁄₈, incl [10 to 15]	24 to 16	0.022 to 0.065 [0.56 to 1.65]	0.003 [0.08]	...	...	...
Over ⁵⁄₈ to 1⅛, incl [15 to 30]	24 to 19	0.022 to 0.042 [0.56 to 1.07]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.013 [0.33]
Over ⁵⁄₈ to 1⅛, incl [15 to 30]	18	0.049 [1.24]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.015 [0.38]
Over ⁵⁄₈ to 1⅛, incl [15 to 30]	16 to 14	0.065 to 0.083 [1.65 to 2.11]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.019 [0.48]
Over ¾ to 1⅛, incl [20 to 50]	13	0.095 [2.41]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.019 [0.48]
Over ⅞ to 1⅛, incl [20 to 30]	12 to 11	0.109 to 0.120 [2.77 to 3.05]	0.0035 [0.09]	0.0035 [0.09]	0.0035 [0.09]	0.021 [0.53]
Over 1⅛ to 2, incl [30 to 50]	22 to 18	0.028 to 0.049 [0.71 to 1.24]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.015 [0.38]
Over 1⅛ to 2, incl [30 to 50]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.019 [0.48]
Over 1⅛ to 2, incl [30 to 50]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]	0.022 [0.56]
Over 2 to 2½, incl [50 to 65]	20 to 18	0.035 to 0.049 [0.89 to 1.24]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.016 [0.41]
Over 2 to 2½, incl [50 to 65]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.020 [0.51]
Over 2 to 2½, incl [50 to 65]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.006 [0.15]	0.006 [0.15]	0.006 [0.15]	0.023 [0.58]
Over 2½ to 3, incl [65 to 75]	20 to 18	0.035 to 0.049 [0.89 to 1.24]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.018 [0.46]
Over 2½ to 3, incl [65 to 75]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.022 [0.56]
Over 2½ to 3, incl [65 to 75]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.008 [0.20]	0.008 [0.20]	0.008 [0.20]	0.025 [0.64]
Over 3 to 3½, incl [75 to 90]	20 to 18	0.035 to 0.049 [0.89 to 1.24]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.019 [0.48]
Over 3 to 3½, incl [75 to 90]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.023 [0.58]
Over 3 to 3½, incl [75 to 90]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.009 [0.23]	0.009 [0.23]	0.009 [0.23]	0.026 [0.66]
Over 3½ to 4, incl [90 to 100]	20 to 18	0.035 to 0.049 [0.89 to 1.24]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.020 [0.51]
Over 3½ to 4, incl [90 to 100]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.024 [0.61]
Over 3½ to 4, incl [90 to 100]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]	0.027 [0.69]
Over 4 to 6, incl [100 to 150]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.034 [0.85]
Over 4 to 6, incl [100 to 150]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.037 [0.94]
Over 6 to 8, incl [150 to 200]	14 to 13	0.083 to 0.095 [2.11 to 2.41]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.039 [0.99]
Over 6 to 8, incl [150 to 200]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.025 [0.64]	0.025 [0.64]	0.025 [0.64]	0.042 [1.07]
Over 8 to 10, incl [200 to 250]	16 to 13	0.065 to 0.095 [1.65 to 2.41]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.044 [1.12]
Over 8 to 10, incl [200 to 250]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.049 [1.24]
Over 10 to 12, incl [250 to 300]	14 to 13	0.083 to 0.095 [2.11 to 2.41]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.049 [1.24]
Over 10 to 12, incl [250 to 300]	12 to 10	0.109 to 0.134 [2.77 to 3.40]	0.035 [0.89]	0.035 [0.89]	0.035 [0.89]	0.054 [1.37]

[A]Flash-In-Tubing is produced to outside diameter tolerances and wall thickness tolerances only, and the height of the inside welding flash does not exceed the wall thickness or ³⁄₃₂ in. [2.38 mm], whichever is less.

[B]Flash Controlled to 0.010 in. [0.26 mm] maximum tubing consists of tubing over ⁵⁄₈ in. [15 mm] outside diameter which is commonly produced to outside diameter tolerances and wall thickness tolerances only, in which the height of the remaining inside welding flash is controlled not to exceed 0.010 in.

[C]Flash Controlled to 0.005 in. [0.13 mm] maximum tubing is produced to outside diameter tolerances and wall thickness tolerances, inside diameter tolerances and wall thickness tolerances, or outside diameter tolerances and inside diameter tolerances, in which the height of the remaining inside welding flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

[D]Birmingham Wire Gauge.

[E]The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in such cases see 8.6.1.

[F]Where the ellipsis (...) appears in this table, the tolerance is not addressed.

diameter and inside diameter to tolerances, with no dimensional indication of inside diameter flash, is available in Types 5 and 6.

12.4 Tubes shall be furnished in the following shapes, as specified by the purchaser: round, square, rectangular, or special shapes (as negotiated).

13. Surface Finish

13.1 Tubes shall have a surface finish compatible with the conditions (See Section 12) to which they are ordered (See Appendix X1).

TABLE 11 Wall Thickness Tolerances for Type 2 (A.W.C.R.) Round Tubing (Inch Units)

Wall Thickness		Outside Diameter, in.[A]														
in.[A]	Bwg[A]	3/8 to 7/8, incl		Over 7/8 to 1 7/8, incl		Over 1 7/8 to 3 3/4, incl		Over 3 3/4 to 5, incl		Over 5 to 6, incl		Over 6 to 8, incl		Over 8 to 10, incl		Over 10 to 12, incl	
		+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
		Wall Thickness Tolerances, in.,[A,B] ±															
0.022	24	0.001	0.005	0.001	0.005	…	…	…	…	…	…	…	…	…	…	…	…
0.028	22	0.001	0.005	0.001	0.005	…	…	…	…	…	…	…	…	…	…	…	…
0.035	20	0.002	0.005	0.001	0.005	0.001	0.005	…	…	…	…	…	…	…	…	…	…
0.042	19	0.002	0.006	0.001	0.006	0.001	0.006	…	…	…	…	…	…	…	…	…	…
0.049	18	0.003	0.006	0.002	0.006	0.002	0.006	…	…	…	…	…	…	…	…	…	…
0.065	16	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008	…	…
0.083	14	0.006	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008	0.004	0.008	0.004	0.008
0.095	13	0.006	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008	0.004	0.008	0.004	0.008
0.109	12	…	…	0.006	0.008	0.005	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009
0.120	11	…	…	0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009
0.134	10	…	…	0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009

[A] Birmingham Wire Gauge.
[B] Where the ellipsis appears in this table, the tolerance is not addressed.