



Designation: A787/A787M – 20

# Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing<sup>1</sup>

This standard is issued under the fixed designation A787/A787M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification covers round, square, rectangular, and special shape, electric-resistance-welded mechanical tubing, either zinc-coated (galvanized) after welding or produced from aluminum-coated, zinc-coated (galvanized), zinc-iron alloy-coated (galvannealed), 55 % aluminum-zinc alloy-coated, or zinc-aluminum-magnesium alloy-coated steel sheet. Tubing for use as electrical conduit (EMT) or intermediate metallic conduit (IMC) is not covered by this specification.

1.1.1 The product is available in various grades based on chemical requirements (Section 9).

1.1.2 The product is available in various Types (Section 3).

1.2 This specification covers mechanical tubing with outside diameters or maximum outside dimensions ranging from 1/2 to 15 in. [12.7 to 380.0 mm] and wall thickness from 0.028 to 0.180 in. [0.70 to 4.60 mm]. Indeterminate wall thicknesses may be ordered. In those cases the more stringent tolerances of Tables 3, 4, 5, 6, 12 and 13 shall apply.

1.3 When sizes within the ranges listed above are ordered, all other requirements of the specification shall be met.

1.4 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order specifies the applicable M specification designation (SI units), the inch-pound units shall apply. 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.

1.5 *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 Recom-*

*mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

A463/A463M Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A792/A792M Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

A924/A924M Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

A1046/A1046M Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process

B6 Specification for Zinc

## 3. Classification

3.1 The types of tubing covered by this specification are:

Type Number	Code Letters	Description
1	AWAC	electric-resistance-welded aluminum-coated carbon steel mechanical tubing
2	AWG	electric-resistance-welded galvanized carbon steel mechanical tubing
3	AWPG	electric-resistance-welded carbon steel mechanical tubing, post-hot dipped galvanized
4	AWGA	electric-resistance-welded carbon steel mechanical tubing, zinc-iron alloy-coated (galvannealed)
5	AWGZ	electric-resistance-welded carbon steel mechanical tubing, 55 % aluminum-zinc alloy-coated
6	AWZAM	electric-resistance-welded carbon steel mechanical tubing, zinc-aluminum-magnesium alloy-coated

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

Current edition approved July 1, 2020. Published July 2020. Originally approved in 1981. Last previous edition approved in 2015 as A787/A787M – 15a. DOI: 10.1520/A0787\_A0787M-20.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

#### 4. Ordering Information

4.1 The ordered wall thickness of the tubing shall be the total of the base metal and the metallic coating.

4.2 Orders for material under this specification shall include the following:

- 4.2.1 Quantity (feet, metres, or number of lengths),
- 4.2.2 Type, code letters, and description (Sections 1 and 3),
- 4.2.3 Applicable ASTM designation number(s),
- 4.2.4 Coating designation and type of coating,
- 4.2.5 Chemically treated or not chemically treated raw material,
- 4.2.6 Oiled or dry (Section 16),
- 4.2.7 Extra smooth coating (if required),
- 4.2.8 Customer application, including fabrication,
- 4.2.9 Flash condition (7.1),
- 4.2.10 Steel grade designation (Sections 5 and 9),
- 4.2.11 Report of chemical analysis if required (Sections 10 and 11),
- 4.2.12 Shape (round, square, rectangular, or special),
  - 4.2.12.1 Dimensions: round—any two of the following: inside diameter, outside diameter, or wall thickness; square or rectangular—outside dimension, wall thickness, and corner radii, if required. (See 12.1 and 13.1 and 13.2.)
- 4.2.13 Length: round tubing—mill lengths or definite cut lengths (see 12.2); square and rectangular tubing—mill cut lengths and specified length (see 13.4).
- 4.2.14 Squareness of cut: round tubing, if required (see 12.3); square and rectangular tubing, if required (see 13.7),
- 4.2.15 Burrs removed, if required (see 15.2),
- 4.2.16 Special packaging (Section 19),
- 4.2.17 Customer specification number, if applicable,
- 4.2.18 Special requirements,
- 4.2.19 Special marking (Section 18), and
- 4.2.20 Recoating of outside diameter weld and heat-affected area, on precoated steel, if required.

#### 5. Process

5.1 The steel shall be made from any process.

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

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

5.1.3 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.

5.2 For tubing produced from precoated steel sheet, the composition of the coating shall comply with the applicable specification.

5.2.1 *Specification A463/A463M*—Coating designation for aluminum coated-sheet.

5.2.2 *Specification A653/A653M*—Coating designation for galvanized and galvanized steel sheet.

5.2.3 *Specification A792/A792M*—Coating designation for 55 % aluminum-zinc alloy-coated steel sheet.

5.2.4 *Specification A1046/A1046M*—Coating designation for zinc-aluminum-magnesium alloy-coated steel sheet.

5.2.5 Other grades of coated steel sheet, as listed in **Table 1** and **Table 2**, may be used as the precoated material for the steel tubing upon agreement between the manufacturer and the purchaser. Such steel sheet shall meet the requirements of *Specification A463/A463M*, *A653/A653M*, *A792/A792M*, *A924/A924M*, and *A1046/A1046M* except for the chemical requirements.

#### 6. Manufacture

6.1 Tubes shall be made by the electric-resistance welding process and shall be made from hot or cold-rolled precoated steel except for Type 3.

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

6.2 Special manufacturing practices allow for post-hot dipped galvanizing of welded tubing. If this product is desired all sections of this specification will apply except **Table 3**. Wall thickness tolerances shall be determined by agreement between the producer and purchaser.

#### 7. Flash Conditions

7.1 The 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.

7.1.1 *Flash-In*—All tubing in which the inside diameter welding flash does not exceed the wall thickness or  $\frac{3}{32}$  in. [2.38 mm], whichever is less.

7.1.2 *Flash Controlled to 0.010 in. [0.25 mm], Maximum*—Tubing in which the height of the remaining welding flash is controlled so as not to exceed 0.010 in. [0.25 mm]. This condition is available in over 0.750 in. [19.0 mm] outside diameter and gauges consistent with **Tables 5 and 6**.

7.1.3 *Flash Controlled to 0.005 in. [0.13 mm], Maximum*—When the inside diameter flash is controlled to 0.005 in. [0.13 mm] maximum in tubing produced to outside diameter and

**TABLE 1 Chemical Requirements for Low-Carbon Steels<sup>A, B</sup>**

Grade Designation <sup>C</sup>	Composition, %			
	Carbon	Manganese	Phosphorus, max	Sulfur, max
MT1010	0.05 to 0.15	0.30 to 0.60	0.035	0.035
MT1015	0.10 to 0.20	0.30 to 0.60	0.035	0.035
MTX1015	0.10 to 0.20	0.60 to 0.90	0.035	0.035
MT1020	0.15 to 0.25	0.30 to 0.60	0.035	0.035
MTX1020	0.15 to 0.25	0.70 to 1.00	0.035	0.035

<sup>A</sup> Rimmed or capped steels that 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.

<sup>B</sup> Chemistry represents heat analysis. Product analysis, except for rimmed or capped steel, is to be in accordance with usual practice as shown in **Table 7**.

<sup>C</sup> The letters MT indicate mechanical tubing.

**TABLE 2 Chemical Requirements for Other Carbon Steels<sup>A</sup>**

Grade Designation	Composition, %			
	Carbon	Manganese	Phosphorus, max	Sulfur, max
1008	0.10 max	0.50	0.035	0.035
1010	0.08 to 0.13	0.30 to 0.60	0.035	0.035
1015	0.12 to 0.18	0.30 to 0.60	0.035	0.035
1016	0.12 to 0.19	0.60 to 0.90	0.035	0.035
1017	0.14 to 0.21	0.30 to 0.60	0.035	0.035
1018	0.14 to 0.21	0.60 to 0.90	0.035	0.035
1019	0.14 to 0.21	0.70 to 1.00	0.035	0.035
1021	0.17 to 0.24	0.60 to 0.90	0.035	0.035

<sup>A</sup> Chemistry represents heat analysis. Product analysis, except for rimmed or capped steel, is to be in accordance with usual practice as shown in [Table 7](#).

wall thickness, inside diameter and wall thickness, or outside diameter and inside diameter tolerances, the remaining inside diameter flash, if any, is part of the applicable inside diameter tolerance. This controlled flash is available in 0.750 in. [19.0 mm] outside diameter or greater.

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

7.3 Recoating of the outside diameter weld-heat-affected area on precoated steel tubing may be performed at the manufacturer's option, if not specifically requested by the purchaser.

## 8. Surface Finish

8.1 Special surface finishes as may be required for specific applications shall be provided in the purchase order by agreement between the producer and purchaser.

## 9. Base Metal Chemical Composition

9.1 The chemical composition of the sheet steel base metal shall conform to the requirements of [Table 1](#).

9.2 Copper-bearing steel, with 0.20 % minimum copper, may be ordered in any of the grades shown in [Table 1](#) or [Table 2](#).

9.3 An analysis of each heat of steel shall be made by the basic steel producer to determine the percentage of the elements specified. The heat analysis, as supplied by the steel melter, shall conform to the requirements of [Table 1](#) or [Table 2](#).

9.4 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](#) and [Table 2](#) is not permitted.

## 10. Coating Bath Chemical Composition

10.1 When tubing is produced from precoated sheet steel, the tubing manufacturer shall furnish, upon request, a report stating that the tubing has been manufactured from precoated sheet steel meeting one of the following specifications: [A463/A463M](#), [A653/A653M](#), [A792/A792M](#), [A924/A924M](#), and [A1046/A1046M](#).

10.2 For post-coated tubing the zinc used for coating shall be any grade of zinc conforming to Specification [B6](#).

## 11. Product Analysis

11.1 When requested on the purchase order, a product analysis shall be made by the supplier. The number and source of samples for a product analysis shall be based on the individual heat or lot identity of one of the following forms:

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

11.1.2 *Heat Identity Not Maintained*—One product analysis shall be made from each 2000 ft [600 m] or fraction thereof for sizes over 3 in. [75 mm] outside diameter, and from each 5000 ft [1525 m] or fraction thereof for sizes 3 in. [75 mm] outside diameter and under.

11.2 Samples for product spectrochemical analysis shall be taken in accordance with procedures established with the tube producer and the testing laboratory. The composition thus determined shall correspond to the requirements in [Table 1](#) or [Table 2](#) and be within the composition tolerances shown in [Table 7](#).

11.3 If the original test for product analysis fails, retests of two additional samples of flat-rolled stock or tubes shall be made. Both retests for the elements in question shall meet the requirements of [Table 1](#) or [Table 2](#), and [Table 7](#), of this 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 individually tested for acceptance. Any retested material not meeting the requirements of this specification shall be rejected.

## 12. Permissible Variations in Dimensions for Round Tubing

12.1 *Wall Thickness and Diameter*—Wall thickness tolerances for tubing made from precoated steel are shown in [Tables 3 and 4](#). All wall thickness tolerances include both the base steel and the coating (inside and outside surfaces). Variations in outside diameter and inside diameter of as-welded tubing made from precoated steel are shown in [Tables 5 and 6](#).

12.2 *Length*—Mechanical tubing is commonly furnished in mill lengths 5 ft [1.5 m] and over. Mill length tolerances are given in [Table 8](#). Definite cut lengths are furnished when specified by the purchaser. Tolerances for definite length round tubing shall be given in [Table 9](#) and [Table 10](#). Different types of cutting methods will affect the end cut.

12.3 *Squareness of Cut*—When specified, the tolerance for squareness of cut of round mechanical tubing is shown in [Table 11](#). Measurements are made with the use of an “L” square and feeler gauge. The contact length of the side leg of the square along the tube will be equal to or greater than the tube outside diameter, but not less than 1 in. [25 mm] nor greater than 4 in. [100 mm]. The other leg shall always be equal to or greater than the tube outside diameter.

12.4 *Straightness:*

12.4.1 *Precoated Tubing*—The straightness tolerance for round mechanical tubing shall be 0.030 in. [0.75 mm] maximum in any 3-ft [100-cm] length of tubing. The straightness



**TABLE 3 Wall Thickness Tolerance for Premetallic Coated As-Welded Tubing<sup>A</sup> (inch-pound units)  
Outside Diameter, in.**

Wall Thickness BWG <sup>B</sup> in.	1/2 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		
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	
22	0.028	0.002	0.006	0.006	0.002	0.006													
20	0.035	0.003	0.006	0.006	0.002	0.006	0.006												
18	0.049	0.004	0.007	0.008	0.003	0.008	0.008												
16	0.065	0.005	0.007	0.008	0.003	0.008	0.009	0.003	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.002	0.010	0.010
14	0.083	0.006	0.008	0.008	0.005	0.008	0.005	0.009	0.004	0.010	0.004	0.011	0.003	0.011	0.003	0.011	0.003	0.011	0.011
13	0.095	0.008	0.010	0.010	0.007	0.011	0.007	0.011	0.006	0.012	0.006	0.012	0.006	0.012	0.006	0.012	0.006	0.012	0.012
12	0.109	0.008	0.010	0.010	0.007	0.011	0.007	0.011	0.006	0.012	0.006	0.012	0.006	0.012	0.006	0.012	0.006	0.012	0.012
11	0.120	0.009	0.011	0.011	0.008	0.012	0.008	0.012	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.013
10	0.134	0.009	0.011	0.011	0.008	0.012	0.008	0.012	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.013
9	0.148	0.009	0.012	0.012	0.008	0.012	0.008	0.012	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.013
8	0.165	0.009	0.012	0.012	0.008	0.012	0.008	0.012	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.013
7	0.180	0.009	0.012	0.012	0.008	0.012	0.008	0.012	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.007	0.013	0.013

<sup>A</sup> Post-hot dipped galvanized welded tubing wall thickness tolerances shall be determined by agreement between the producer and purchaser (6.2).  
<sup>B</sup> Birmingham Wire Gauge.



**TABLE 4 Wall Thickness Tolerance for Premetallic Coated As-Welded Tubing<sup>A</sup> (SI Units)**  
**Outside Diameter, mm**

Wall Thickness mm	13 to 25, incl		Over 25 to 50, incl		Over 50 to 100, incl		Over 100 to 150, incl		Over 150 to 200, incl		Over 200 to 250, incl		Over 250 to 375, incl	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
1.0	0.04	0.08	0.08	0.20	0.08	0.20	0.05	0.25	0.05	0.25	0.05	0.25	0.08	0.28
1.5	0.10	0.18	0.10	0.15	0.08	0.23	0.10	0.25	0.10	0.25	0.10	0.25	0.10	0.35
2.0	0.15	0.20	0.15	0.20	0.13	0.23	0.10	0.25	0.10	0.25	0.10	0.30	0.10	0.40
2.5	0.20	0.25	0.20	0.25	0.18	0.28	0.15	0.30	0.15	0.30	0.10	0.40	0.10	0.40
3.0	0.22	0.27	0.23	0.28	0.20	0.30	0.18	0.33	0.18	0.33	0.10	0.40	0.10	0.40
3.5	0.23	0.28	0.23	0.28	0.20	0.30	0.18	0.33	0.18	0.33	0.10	0.40	0.10	0.40
4.0			0.23	0.30	0.20	0.30	0.18	0.33	0.18	0.33	0.15	0.40	0.15	0.40
4.5			0.23	0.30	0.20	0.30	0.18	0.33	0.18	0.33	0.15	0.40	0.15	0.40

<sup>A</sup>Post-hot dipped galvanized welded tubing wall thickness tolerances shall be determined by agreement between the producer and purchaser (6.2).

**TABLE 5 Diameter Tolerances for Metallic-Coated Round Tubing (inch-pound units)**

Outside Diameter Range <sup>E</sup> , in.	Wall Thickness		Tubing with Any Inside Flash Condition	Flash-Controlled to 0.005 in. Tubing Only <sup>A</sup>
	BWG <sup>B</sup>	in.	Outside <sup>C,D</sup> Diameter, Plus and Minus	Inside Diameter, Plus and Minus
Tolerances, in. <sup>F</sup>				
½ to 1⅛, incl	22 to 16	0.028/0.065	0.0035	0.019
Over 1⅛ to 2, incl	22 to 14	0.028/0.083	0.005	0.021
Over 1⅛ to 2, incl	13 to 10	0.095/0.134	0.005	0.027
Over 2 to 2½, incl	20 to 14	0.035/0.083	0.006	0.023
Over 2 to 2½, incl	13 to 10	0.095/0.134	0.006	0.029
Over 2½ to 3, incl	20 to 14	0.035/0.083	0.008	0.025
Over 2½ to 3, incl	13 to 10	0.095/0.134	0.008	0.031
Over 3 to 3½, incl	20 to 14	0.035/0.083	0.009	0.026
Over 3 to 3½, incl	13 to 10	0.095/0.134	0.009	0.032
Over 3½ to 4, incl	20 to 14	0.035/0.083	0.010	0.027
Over 3½ to 4, incl	13 to 10	0.095/0.134	0.010	0.033
Over 4 to 5, incl	16 to 14	0.065/0.083	0.020	0.037
Over 4 to 5, incl	13 to 10	0.095/0.134	0.020	0.043
Over 5 to 6, incl	16 to 14	0.065/0.083	0.020	0.037
Over 5 to 6, incl	13 to 10	0.095/0.134	0.020	0.043
Over 6 to 8, incl	16 to 10	0.065/0.134	0.025	0.048
Over 6 to 8, incl	9 to 7	0.148/0.180	0.025	0.059
Over 8 to 10, incl	16 to 10	0.065/0.134	0.030	0.043
Over 8 to 10, incl	9 to 7	0.148/0.180	0.030	0.059
Over 10 to 12, incl	16 to 10	0.065/0.134	0.035	0.041
Over 10 to 12, incl	9 to 7	0.148/0.180	0.035	0.045
Over 12 to 15, incl	12 to 10	0.109/0.134	0.040	0.058
Over 12 to 15, incl	9 to 7	0.148/0.180	0.040	0.060

<sup>A</sup> Flash controlled to 0.005 in. 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.

<sup>B</sup> Birmingham Wire Gauge.

<sup>C</sup> 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 ⅜ in., whichever is less.

<sup>D</sup> Flash controlled to 0.010 in. maximum tubing consists of tubing over ⅝ in. 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.

<sup>E</sup> The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in which cases see 12.5.

<sup>F</sup> Measured at least 2 in. from the cut end of the tubing.

tolerance on shorter lengths and on special requirements shall be agreed upon between the purchaser and producer.

12.4.2 *Post-Coated Tubing*—The straightness requirement for post-coated tubing shall be by agreement between the purchaser and producer.

12.5 *Ovality*—Ovality is the difference between maximum and minimum outside diameters measured at any one cross section. The ovality shall be within the tolerances of **Tables 5 and 6** except when the wall thickness is less than 3 % of the outside diameter. When the tube wall thickness is less than 3 % of the tube outside diameter the ovality may be 50 % greater than the outside diameter tolerances, but the mean diameter (average of maximum outside diameter and minimum outside diameter) shall be within the specified tolerance.

### 13. Permissible Variations in Dimensions of Square and Rectangular Tubing

13.1 *Diameter and Wall Thickness*—Permissible variations in outside dimensions for square and rectangular tubing are shown in **Table 12**. The wall thickness tolerance is  $\pm 10\%$  of the nominal wall thickness and is measured at the center width of the unwelded sides.

13.2 *Corner Radii*—Unless otherwise specified the inside and outside corners of square and rectangular tubing shall be slightly rounded, consistent with the tube wall thickness. A slight radius flattening can be expected and is more pronounced with heavier-walled tubing. However, the radii of the corners shall be in accordance with **Table 13**.

**TABLE 6 Diameter Tolerances for Metallic-Coated Round Tubing (SI units)**

Outside Diameter Range <sup>E</sup> , mm	Wall Thickness, mm	Tubing with Any Inside Flash Condition	Flash-Controlled to 0.13 mm Tubing Only <sup>A</sup>
		Outside <sup>B,C</sup> Diameter, Plus and Minus Tolerances, mm <sup>D</sup>	Inside Diameter Plus and Minus
13 to 25	0.70/1.50	0.09	0.48
Over 25 to 50, incl	0.70/1.50	0.13	0.53
Over 25 to 50, incl	2.50/3.50	0.13	0.69
Over 50 to 75, incl	1.00/1.50	0.17	0.58
Over 50 to 75, incl	2.50/3.50	0.17	0.74
Over 75 to 100, incl	1.00/1.50	0.23	0.66
Over 75 to 100, incl	2.50/3.50	0.23	0.81
Over 100 to 125, incl	1.00/1.50	0.51	0.94
Over 100 to 125, incl	2.50/3.50	0.51	1.09
Over 125 to 150, incl	1.00/1.50	0.51	0.94
Over 125 to 150, incl	2.50/3.50	0.51	1.09
Over 150 to 200, incl	1.00/1.50	0.63	1.22
Over 150 to 200, incl	2.50/3.50	0.63	1.50
Over 200 to 250, incl	1.50/2.50	0.76	1.22
Over 200 to 250, incl	2.50/3.50	0.76	1.50
Over 250 to 375, incl	1.50/2.50	1.00	1.22
Over 250 to 375, incl	2.50/3.50	1.00	1.50

<sup>A</sup>Flash controlled to 0.12 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 0.12 mm. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

<sup>B</sup>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 2.4 mm, whichever is less.

<sup>C</sup>Flash controlled to 0.25 mm maximum tubing consists of tubing over 16 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 0.25 mm.

<sup>D</sup>The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in which cases see 12.5.

<sup>E</sup>Measured at least 50 mm from the cut end of the tubing.

13.3 *Squareness of Sides*—Permissible variation of squareness of sides 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 dimension across flats in. [mm].

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

**TABLE 7 Tolerances for Product Analysis for Steels Shown in Table 1<sup>A</sup>**

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 over 0.15 to 0.40, incl over 0.40 to 0.55, incl	0.02 0.03 0.03	0.03 0.04 0.05
Manganese	to 0.60, incl over 0.60 to 1.00 incl	0.03 0.04	0.03 0.04
Phosphorus	...	...	0.01
Sulfur	...	...	0.01
Copper	...	0.02	...

<sup>A</sup> 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.

**TABLE 8 Mill Cut-Length Tolerances for Round, Square, and Rectangular Tubing**

Outside Diameter Size, in. [mm]	5 ft to Under 24 ft [1.5 to Under 7.3 m]	24 ft and Over <sup>A</sup> [7.3 m and Over]
½ to 15 [13 to 380], incl	+1.0, -0.0 in. [+25, -0.0 mm]	+4.0, -0.0 in. [+100, -0.0 mm]

<sup>A</sup> Manufacturing practices may limit the length available; therefore, when inquiring, it is essential to describe the product fully.

**TABLE 9 Cut Length Tolerances for Lathe-Cut Round Tubing**

Outside Diameter Size, in. [mm]	6 in. and Under 12 in. [150 and Under 300 mm]	12 in. and Under 48 in. [300 mm and Under 1.2 m]	48 in. and Under 10 ft [1.2 and Under 3.0 m]	10 ft to 24 ft, incl [3.0 and Under 6.0 m] <sup>A</sup>
½ to 3 [13 to 75], incl	±1/64 [0.4]	±1/32 [0.8]	±3/64 [1.2]	±1/8 [3.2]
Over 3 to 6 [75 to 150], incl	±1/32 [0.8]	±3/64 [1.2]	±1/16 [1.6]	±1/8 [3.2]
Over 6 to 8 [150 to 200], incl	±1/16 [1.6]	±1/16 [1.6]	±1/8 [3.2]	±1/8 [3.2]

<sup>A</sup> For each additional 10 ft or fraction thereof over 24 ft [3 to 7 m], an additional allowance should be made of ±1/16 in. [1.6 mm].

13.3.1 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.

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

13.4 *Length*—Tolerances for mill cut-length square and rectangular tubing shall not exceed the amounts shown in Tables 5 and 6. Tolerances for definite length square and rectangular tubing shall not exceed the amount shown in Table 14.

13.5 *Twist*—Twist tolerances are shown in Table 15. 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 the same side above the surface plate. Twist may also be measured by the use