

American National Standard Dimensional Tolerances for Aluminum Mill Products

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American National Standard

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American National Standard Dimensional Tolerances for Aluminum Mill Products

Secretariat

The Aluminum Association, Inc.
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American National Standards Institute

Contents

1.	Definitions	7
2.	Standard Limits for Expressing Tolerances.....	7
3.	Section Intentionally Blank.....	8
4.	Section Intentionally Blank.....	8
5.	Section Intentionally Blank.....	8
6.	Section Intentionally Blank.....	8
7.	Sheet and Plate	9
	Sheet and Plate—Tables 7.7a–7.18	10
	Special Finished Sheet and Plate Products—Tables 7.26–7.43.....	14
	Commercial Roofing and Siding—Tables 7.26–7.30.....	14
	Duct Sheet—Tables 7.31–7.34.....	15
	Tread Sheet and Plate—Tables 7.36–7.43	15
8.	Fin Stock	17
	Fin Stock—Tables 8.2–8.3.....	17
9.	Foil	18
	Foil—Tables 9.2–9.24	18
	Unmounted Foil—Tables 9.2–9.8	18
	Laminated Foil—Tables 9.9–9.16	19
	Printed Foil—Tables 9.17–9.24	20
10.	Wire, Rod, and Bar—Rolled or Cold Finished	21
	Wire, Rod and Bar—Rolled or Cold-Finished—Tables 10.5–10.20	21
11.	Wire, Rod, Bar and Profiles—Extruded	24
	Wire, Rod, Bar and Profiles—Tables 11.2–11.14	24
12.	Tube and Pipe	31
	Tube and Pipe—Tables 12.2–12.55.....	32
	Extruded Tube—Tables 12.2–12.14.....	32
	Extruded Coiled Tube—Tables 12.16–12.18.....	36
	Drawn Tube—Tables 12.20–12.32.....	37
	Heat Exchanger Tube—Tables 12.34–12.39	40
	Welded Tube—Tables 12.41–12.47	41
	Pipe—Tables 12.49–12.55.....	43
13.	Structural Profiles	46
14.	Forging Stock	47
	Forging Stock—Tables 14.1–14.4.....	47
15.	Forgings	48
	Hand Forgings—Table 15.3.....	48
16.	Electrical Conductors	49
	Electrical Conductors—Tables 16.7–16.35.....	49
	Wire, Rod and Bar—Rolled or Cold Finished—Tables 16.7–16.21 ..	49
	Extruded Rod and bar—Tables 16.22–16.29	51
	Pipe—Tables 16.31–16.35.....	53

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Foreword

This Standard is a revision of “American National Standard Dimensional Tolerances for Aluminum Mill Products” issued in 2009 (ANSI H35.2-2009).

The tolerances included in this Standard were developed by the Technical Committee of The Aluminum Association. They are broadly accepted both within the aluminum industry itself and by users of the metal. They are the basis of the dimensional tolerances specified in U.S. government, technical society, and other specifications for aluminum products. They represent the maximum deviation from specified dimensions that may be expected in any individual piece. For most pieces the deviation from specified dimensions will be less than the tolerance shown.

Work on the tolerances began in The Aluminum Association in 1949, five years before its Technical Committee was established. In that year a special committee was appointed by the Association’s Extruded Products Division to develop drafting standards for these products. One of the committee’s assignments was to develop standard tolerances for aluminum extrusions. The committee completed its work later in 1949, and the Association issued the first edition of its Drafting Standards for Extruded and Tubular Products, including the tolerances, in October of that year.

By 1954, the Association’s technical activities had grown to the point that a standing Technical Committee was needed. One of the first jobs undertaken by this committee was the compilation of mechanical property data for commonly used aluminum alloys and dimensional tolerances for other aluminum mill products. This work was completed later in 1954, and the resulting data were published in the first edition of the Association’s “Standards for Aluminum Mill Products” in June 1955. Successive editions of the “Standards for Aluminum Mill Products” have been revised to include new data and to keep the manual abreast of industry advances. In 1968 the title was changed to “Aluminum Standards and Data” to reflect the adoption of a revised format.

Many refinements have been made in the tolerances as experience was gained in their use. In addition, tolerances have been developed for products not covered initially, and the data have been extended to embrace the larger sizes now being produced. All of these additions and refinements have been incorporated into this Standard. Included also are definitions of the various products as given in “Aluminum Standards and Data” published by The Aluminum Association, and standard limits for expressing the tolerances.

This Standard was originally developed and subsequently revised using the “canvass” method and published under the proprietary sponsorship of The Aluminum Association. At the request of The Aluminum Association, the establishment of Standards Committee H35 on Aluminum and Aluminum Alloys was authorized by the American National Standards Institute on 17 February 1970, with the Association serving as Secretariat.

The 1971 revision of ANSI H35.2 was the first revision developed by Standards Committee H35, under the “Standards Committee” procedures, and the 1972, 1975, 1978, and 1982 revisions were developed under the auspices of that Committee.

Standards Committee H35 was transferred to an Accredited Standards Committee on December 28, 1983, and this revision was developed under the Accredited Standards Committee method.

This latest (2013) revision consists of modification to the column heading for extruded and drawn pipe to harmonize with ANSI/ASME standard; editorial corrections and clarifications to tolerance table for drawn tube; clarification on tolerance calculation for wall thickness (eccentricity) of extruded tube; editorial corrections and clarifications to table headings and footnotes.

American National Standard

Dimensional Tolerances for Aluminum Mill Products

1. Definitions

Bar—A solid wrought product that is long in relation to its cross section which is square or rectangular (excluding plate and flattened wire) with sharp or rounded corners or edges, or is a regular hexagon or octagon, and in which at least one perpendicular distance between parallel faces is 0.375 inch or greater.

Fin Stock—Coiled sheet or foil in specific alloys, tempers, and thickness ranges suitable for manufacture of fins for heat-exchanger applications.

Foil—Generally, a rolled product rectangular in cross section of thickness equal to or less than 0.0079 inch (Formerly 0.006 inch, changed to 0.0079 inch for international harmonization). There is an overlap in the thickness range 0.006-0.0079 inch defined for foil and sheet. Foil products in this gage range are supplied to foil product specifications.

Forging Stock—A wrought or cast rod, bar or other section suitable for forging.

Pipe—Tube in standardized combinations of outside diameter and wall thickness, commonly designated by "Nominal Pipe Sizes" and "ANSI Schedule Numbers." (Note: Larger sizes usually greater than 1 inch are typically extruded while smaller sizes are typically drawn.)

Plate—A rolled product that is rectangular in cross section and with thickness not less than 0.250 inch with sheared or sawed edges.

Tread Plate—Sheet or plate having a raised figured pattern on one surface to provide improved traction.

Profile—A wrought product that is long in relation to its cross-sectional dimensions which is of a form other than that of sheet, plate, rod, bar, tube, wire or foil.

Structural Profile—A profile in certain standard alloys, tempers, sizes, and sections, such as angles, channels, tees, zees, I-beams, and H-sections, commonly used for structural purposes. For channels and I-beams there are two standards, namely Aluminum Association Standard and American Standard.

Rod—A solid wrought product that is long in relation to its circular cross section, which is not less than 0.375 inch diameter.

Shape—This term is no longer recommended. The term "Profile" is preferred. See "Profile."

Sheet—Generally, a rolled product that is rectangular in cross section with thickness greater than 0.006 inch and less than 0.250 inch and with slit, sheared or sawed edges. There is an overlap in the thickness range of 0.006-0.0079 inch defined for foil and sheet. Sheet products in this gage range are supplied to sheet product specifications.

Alclad Sheet—Composite sheet comprised of an aluminum alloy core having on both surfaces (if on one side only, Alclad One Side Sheet) a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

Brazing Sheet—Sheet of a brazing alloy, or sheet clad with a brazing alloy on one or both sides.

Duct Sheet—Coiled or flat sheet in specific tempers, widths and thicknesses, suitable for duct applications.

Tube—A hollow wrought product that is long in relation to its cross section, which is symmetrical and is round, a regular hexagon or octagon, elliptical, or square or rectangular with sharp or rounded corners, and that has uniform wall thickness except as affected by corner radii.

Heat-Exchanger Tube—A tube for use in apparatus in which fluid inside the tube will be heated or cooled by fluid outside the tube. The term usually is not applied to coil tube or tubes for use in refrigerators or radiators. (Note: This product is typically seamless drawn tube.)

Welded Tube—A tube produced by forming and seam-welding sheet longitudinally.

Wire—A solid wrought product that is long in relation to its cross section, which is square or rectangular with sharp or rounded corners or edges, or is round, hexagonal, or octagonal, and whose diameter or greatest perpendicular distance between parallel faces is less than 0.375 inch.

2. Standard Limits for Expressing Tolerances

2.1 Standard limits for expressing the tolerances depend on the type of instrument ordinarily used in measuring the particular dimension. Where instruments permitting the required degree of accuracy generally are used, the tolerances are expressed in decimals as follows (except for foil):

Tolerance less than 0.005 in. Multiple of 0.0005
Tolerance of 0.005 in. and greater 0.XXX

For measurements commonly made with instruments not permitting such accuracy, the tolerances are expressed in fractions.

2.2 Rounding For purposes of determining conformance to the dimensional tolerances, a measured value is not rounded off. To determine applicable limits when a dimension is specified to more decimal places than are used in these standards, it shall be rounded off to the same number of places in conformance with ASTM E29, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

3. *Section intentionally blank*

4. *Section intentionally blank*

5. *Section intentionally blank*

6. *Section intentionally blank*

7. Sheet and Plate

Tables 7.1 – 7.6 intentionally blank

TABLE 7.7a Sheet and Plate Thickness Tolerances ^① (Applicable to All Alloys Not Included in the Aerospace Alloys Table 7.7b or Not Specified for Aerospace Applications)

NOTE: ALSO APPLICABLE TO ALLOYS WHEN SUPPLIED AS ALCLAD.

SPECIFIED THICKNESS, in.		SPECIFIED WIDTH—in.							
		Up thru 39.37	Over 39.37 Thru 59.06	Over 59.06 Thru 78.74	Over 78.74 Thru 98.43	Over 98.43 Thru 118.11	Over 118.11 Thru 137.80	Over 137.80 Thru 157.48	Over 157.48 Thru 177.17
Over	Thru	TOLERANCES—in. plus and minus							
0.0059	0.010	0.0010	0.0015	..	..	..	..	..	..
0.010	0.016	0.0010	0.0015	..	..	..	..	..	..
0.016	0.025	0.0015	0.0020	0.0030	0.0035	..	..	..	..
0.025	0.032	0.0020	0.0025	0.0035	0.0040	..	..	..	..
0.032	0.039	0.0020	0.0030	0.0035	0.0045	0.006	..	..	..
0.039	0.047	0.0025	0.0035	0.0045	0.006	0.007	0.008	..	..
0.047	0.063	0.0030	0.0035	0.0050	0.006	0.007	0.009	..	..
0.063	0.079	0.0035	0.0040	0.006	0.007	0.008	0.010	..	..
0.079	0.098	0.0035	0.0045	0.006	0.007	0.009	0.011	..	..
0.098	0.126	0.0045	0.006	0.007	0.009	0.011	0.013	..	..
0.126	0.158	0.006	0.007	0.009	0.011	0.013	0.015	..	..
0.158	0.197	0.007	0.009	0.011	0.013	0.015	0.018	..	..
0.197	0.248	0.009	0.011	0.013	0.015	0.018	0.022	0.027	..
0.248	0.315	0.012	0.014	0.015	0.018	0.022	0.027	0.035	0.043
0.315	0.394	0.015	0.017	0.020	0.023	0.027	0.033	0.041	0.051
0.394	0.630	0.023	0.023	0.027	0.032	0.035	0.043	0.053	0.065
0.630	0.984	0.031	0.031	0.037	0.043	0.047	0.058	0.070	0.085
0.984	1.575	0.039	0.039	0.047	0.055	0.065	0.075	0.090	0.105
1.575	2.362	0.055	0.055	0.060	0.070	0.085	0.100	0.115	..
2.362	3.150	0.075	0.075	0.085	0.100	0.105	0.125	..	..
3.150	3.937	0.100	0.100	0.115	0.125	0.130	0.160	..	..
3.937	6.299	0.130	0.130	0.145	0.165	..	..	..	..
6.300	8.000	0.160	0.160	0.160	0.165	..	..	..	..

TABLE 7.7b Sheet and Plate Thickness Tolerances ^① (Applicable to All Alloys Specified for Aerospace Applications)

(INCLUDES AEROSPACE ALLOYS 2014, 2024, 2124, 2219, 2324, 2419, 7050, 7075, 7150 and 7475)

NOTE: ALSO APPLICABLE TO ALLOYS WHEN SUPPLIED AS ALCLAD.

SPECIFIED THICKNESS		SPECIFIED WIDTH—in.											
		Up thru 39.37	Over 39.37 thru 47.24	Over 47.24 thru 55.12	Over 55.12 thru 59.06	Over 59.06 thru 70.87	Over 70.87 thru 78.74	Over 78.74 thru 86.61	Over 86.61 thru 98.43	Over 98.43 thru 118.11	Over 118.11 thru 137.80	Over 137.80 thru 157.48	Over 157.48 thru 177.17
Over	Thru	TOLERANCE—in. plus and minus											
0.0059	0.010	0.0010	0.0020	0.0020	0.0020	..	..	..	..	..	..	..	..
0.010	0.016	0.0015	0.0025	0.0025	0.0025	..	..	..	..	..	..	..	..
0.016	0.025	0.0015	0.0025	0.0025	0.0025	..	..	..	..	..	..	..	..
0.025	0.032	0.0015	0.0015	0.0020	0.0030	0.0030	..	..	..	..	..	..	..
0.032	0.039	0.0015	0.0015	0.0020	0.0030	0.0030	0.0035	0.0035	0.007	..	..	..	..
0.039	0.047	0.0020	0.0020	0.0020	0.0030	0.0030	0.0035	0.0035	0.008	0.010	0.011	..	..
0.047	0.063	0.0020	0.0020	0.0030	0.0030	0.0030	0.0035	0.0035	0.009	0.011	0.013	..	..
0.063	0.079	0.0020	0.0020	0.0030	0.0035	0.0035	0.0035	0.0035	0.010	0.013	0.015	..	..
0.079	0.098	0.0025	0.0025	0.0035	0.0040	0.0040	0.0045	0.0045	0.011	0.015	0.018	..	..
0.098	0.126	0.0035	0.0035	0.0035	0.0045	0.0045	0.0045	0.0045	0.013	0.016	0.020	..	..
0.126	0.158	0.0040	0.0040	0.0045	0.007	0.007	0.009	0.009	0.015	0.018	0.022	..	..
0.158	0.197	0.006	0.007	0.007	0.009	0.009	0.011	0.011	0.018	0.022	0.026	..	..
0.197	0.248	0.009	0.012	0.012	0.012	0.017	0.017	0.021	0.021	0.025	0.029	..	..
0.248	0.315	0.012	0.015	0.015	0.015	0.019	0.019	0.024	0.024	0.029	0.033	0.041	0.051
0.315	0.394	0.017	0.018	0.018	0.018	0.022	0.022	0.028	0.028	0.033	0.039	0.047	0.059
0.394	0.630	0.023	0.023	0.023	0.023	0.028	0.028	0.033	0.033	0.039	0.047	0.059	0.070
0.630	0.984	0.031	0.031	0.031	0.031	0.037	0.037	0.043	0.043	0.051	0.060	0.070	0.085
0.984	1.575	0.039	0.039	0.039	0.039	0.047	0.047	0.055	0.055	0.065	0.075	0.090	0.105
1.575	2.362	0.055	0.055	0.055	0.055	0.060	0.060	0.070	0.070	0.090	0.100	0.115	..
2.362	3.150	0.075	0.075	0.075	0.075	0.085	0.085	0.100	0.100	0.110	0.125	..	..
3.150	3.937	0.100	0.100	0.100	0.100	0.115	0.115	0.130	0.130	0.150	0.160	..	..
3.937	6.299	0.130	0.130	0.130	0.130	0.145	0.145	0.165	0.165	..	..	..	..
6.300	8.000	0.160	0.160	0.160	0.160	0.160	0.160	0.165	0.165	..	..	..	..

Note: Capability to provide tighter tolerances may vary with supplier.

^① When a dimension tolerance is specified other than as equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimension permissible under the tolerance for the dimension under consideration.

Aluminum Mill Products

TABLE 7.8 Width Tolerances—Sheared Flat Sheet and Plate

SPECIFIED THICKNESS in.	SPECIFIED WIDTH—in.					
	Up thru 6	Over 6 thru 24	Over 24 thru 60	Over 60 thru 96	Over 96 thru 132	Over 132 thru 168
	TOLERANCES ②—in.					
0.006–0.124	$\pm \frac{1}{16}$	$\pm \frac{3}{32}$	$\pm \frac{1}{8}$	$\pm \frac{1}{8}$	$\pm \frac{5}{32}$	..
0.125–0.249	$\pm \frac{3}{32}$	$\pm \frac{3}{32}$	$\pm \frac{1}{8}$	$\pm \frac{5}{32}$	$\pm \frac{3}{16}$	..
0.250–0.499	$+\frac{1}{4}$	$+\frac{5}{16}$	$+\frac{3}{8}$	$+\frac{3}{8}$	$+\frac{7}{16}$	$+\frac{1}{2}$

TABLE 7.9 Length Tolerances—Sheared Flat Sheet and Plate

SPECIFIED THICKNESS in.	SPECIFIED LENGTH—in.							
	Up thru 30	Over 30 thru 60	Over 60 thru 120	Over 120 thru 240	Over 240 thru 360	Over 360 thru 480	Over 480 thru 600	Over 600 thru 720
	TOLERANCES ②—in.							
0.006–0.124	$\pm \frac{1}{16}$	$\pm \frac{3}{32}$	$\pm \frac{1}{8}$	$\pm \frac{5}{32}$	$\pm \frac{3}{16}$	$\pm \frac{7}{32}$	$\pm \frac{9}{32}$	..
0.125–0.249	$\pm \frac{3}{32}$	$\pm \frac{3}{32}$	$\pm \frac{1}{8}$	$\pm \frac{5}{32}$	$\pm \frac{7}{32}$	$\pm \frac{1}{4}$	$\pm \frac{5}{16}$	..
0.250–0.499	$+\frac{1}{4}$	$+\frac{3}{8}$	$+\frac{7}{16}$	$+\frac{1}{2}$	$+\frac{9}{16}$	$+\frac{5}{8}$	$+\frac{11}{16}$	$+\frac{3}{4}$

TABLE 7.10 Width and Length Tolerances—Sawed Flat Sheet and Plate

SPECIFIED THICKNESS in.	SPECIFIED WIDTH AND LENGTH—in.							
	Up thru 30	Over 30 thru 60	Over 60 thru 120	Over 120 thru 240	Over 240 thru 360	Over 360 thru 480	Over 480 thru 600	Over 600 thru 720
	TOLERANCES ②—in.							
0.080–0.249	$\pm \frac{1}{8}$	$\pm \frac{1}{8}$	$\pm \frac{3}{16}$	$\pm \frac{1}{4}$	$\pm \frac{1}{4}$	$\pm \frac{5}{16}$	$\pm \frac{3}{8}$	$\pm \frac{7}{16}$
0.250–8.000	$+\frac{1}{4}$	$+\frac{5}{16}$	$+\frac{3}{8}$	$+\frac{1}{2}$	$+\frac{9}{16}$	$+\frac{5}{8}$	$+\frac{3}{4}$	$+\frac{7}{8}$

TABLE 7.11 Width Tolerances ①—Slit Coiled Sheet

SPECIFIED THICKNESS in.	SPECIFIED WIDTH—in.					
	Up thru 6	Over 6 thru 12	Over 12 thru 24	Over 24 thru 48	Over 48 thru 60	Over 60 thru 96
	TOLERANCES ②—in. plus and minus					
0.006–0.125	0.010	$\frac{1}{64}$	$\frac{1}{32}$	$\frac{3}{64}$	$\frac{1}{16}$	$\frac{1}{8}$
0.126–0.186	0.012	$\frac{1}{32}$	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{3}{32}$	..
0.187–0.249	0.016	$\frac{1}{32}$	$\frac{9}{64}$	$\frac{3}{32}$	$\frac{1}{8}$	..

For all numbered footnotes, see page 12.

TABLE 7.12 Lateral Bow Tolerances ①—Coiled Sheet

SPECIFIED THICKNESS in.	SPECIFIED WIDTH—in.				
	$\frac{1}{2}$ thru 1	Over 1 thru 2	Over 2 thru 4	Over 4 thru 10	Over 10
	TOLERANCE—in. in 6 ft. Allowable Deviation of a Side Edge from a Straight Line				
0.006–0.064	$\frac{3}{4}$	$\frac{9}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{16}$
0.065–0.125	..	..	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{16}$

TABLE 7.13 Lateral Bow Tolerances—Flat Sheet and Plate

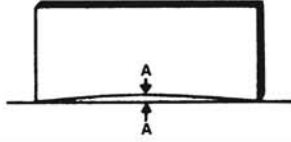
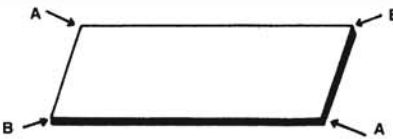
SPECIFIED THICKNESS in.	SPECIFIED WIDTH in.	ALLOWABLE DEVIATION OF A SIDE EDGE FROM A STRAIGHT LINE						
								
		Maximum allowable value of AA						
		SPECIFIED LENGTH—in.						
		Up thru 60	Over 60 thru 90	Over 90 thru 120	Over 120 thru 150	Over 150 thru 180	Over 180 thru 210	Over 210 thru 240
TOLERANCE—in.								
0.006–0.125	Up thru 4	0.250	0.563	1.000	1.563	2.250	3.000	4.000 ⑤
	Over 4 thru 10	0.094	0.219	0.375	0.563	0.875	1.156	1.500 ⑤
	Over 10 thru 35	0.063	0.125	0.188	0.250	0.375	0.500	0.750 ⑤
	Over 35	0.032	0.063	0.125	0.188	0.250	0.375	0.500 ⑤
0.126–0.249	Over 4 thru 15	0.063	0.125	0.250	0.375	0.563	0.750	1.000 ⑤
	Over 15	0.032	0.063	0.125	0.188	0.250	0.375	0.500 ⑤
0.250–8.000	Up thru 10	0.250	0.563	1.000	1.563	2.250	3.000	4.000 ⑤
	Over 10 thru 18	0.063	0.125	0.250	0.406	0.594	0.781	1.000 ⑤
	Over 18	0.032	0.094	0.125	0.219	0.312	0.438	0.562 ⑤

TABLE 7.14 Squareness Tolerances—Flat Sheet and Plate

SPECIFIED LENGTH ft.	SPECIFIED WIDTH—ft.	
	Up thru 3	Over 3
	ALLOWABLE DIFFERENCE IN LENGTH OF DIAGONALS ④ —Inches	
		
	Maximum difference between AA and BB	
Up thru 12	$\frac{3}{32} \times \text{width, ft } ③$	$\frac{5}{64} \times \text{width, ft } ③$
Over 12	$\frac{7}{64} \times \text{width, ft } ③$	$\frac{7}{64} \times \text{width, ft } ③$

① When a dimension tolerance is specified other than as an equal bilateral tolerance, the maximum value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

② Tolerances applicable at ambient mill temperatures. A change in dimension of 0.013 in. per 100 in. per 10°F must be recognized.

③ If specified width is other than an exact multiple of 12 in., tolerance is determined by using the next largest exact multiple. For example, if specified width is 53 in. and specified length is 72 in., the tolerance is $\frac{5}{64}$ in. $\times 5 = \frac{25}{64}$ in. This result is then rounded to $\frac{7}{16}$ in. in accordance with footnote ④.

④ Use values for calculating only. Round result upward to nearest $\frac{1}{16}$ in.

⑤ Also applicable to any 240-inch increment of longer sheet or plate.

Aluminum Mill Products

TABLE 7.15 Diameter Tolerances—Sheared or Blanked Sheet and Plate Circles ①

SPECIFIED THICKNESS in.	SPECIFIED DIAMETER				
	Up thru 18	Over 18 thru 36	Over 36 thru 96	Over 96 thru 132	Over 132 thru 168
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER in. plus and minus  Difference between AA and specified diameter				
0.006–0.249	1/32	3/64	1/16	1/8	3/16
0.250–0.375	..	1/16	1/8	3/16	1/4
0.376–0.625	..	1/8	3/16	1/4	3/8
0.626–0.875	..	3/16	1/4	3/8	1/2
0.876–1.250	..	1/4	3/8	1/2	5/8

TABLE 7.16 Diameter Tolerances—Sawed Sheet and Plate Circles ①

SPECIFIED THICKNESS in.	SPECIFIED DIAMETER			
	Up thru 18	Over 18 thru 60	Over 60 thru 132	Over 132 thru 168
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER in. plus and minus  Difference between AA and specified diameter			
0.080–1.000	1/8	3/16	1/4	1/2
1.001–3.000	1/4	3/8	1/2	3/4

TABLE 7.17 Flatness Tolerances—Flat Sheet ②

Alloy (Includes Alclads)	Specified Thickness in.	Longitudinal or Transverse Distance (ft.) Center to Center of Buckles or Edge Waves ③				
		Up thru 2	Over 2 thru 3	Over 3 thru 4	Over 4 thru 6	Over 6
		TOLERANCES, in. ④ ⑤ ⑥				
1060, 1100, 1350, 3003, 3005, 3105, 5005, 5050, 5X57	0.020 thru 0.064 0.065 thru 0.249	1/8 1/8	3/16 3/16	5/16 5/16	5/16 3/8	3/8 1/2
3004, 5052, 5083, 5086, 5252, 5X54, 5456, brazing sheet, and all heat treatable alloys	0.020 thru 0.064 0.065 thru 0.249	3/16 3/16	3/16 5/16	5/16 3/8	3/8 1/2	1/2 9/16

① When a dimension tolerance is specified other than as an equal bilateral tolerance, the maximum value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

② Not applicable to cut-to-length sheet, panel flat sheet, coiled sheet, or sheet over 60 in. wide. Flatness tolerances, including coil set flatness tolerances, for these excluded products, should be as agreed upon in advance

between producer and purchaser. (See Section 5, Terminology, for a definition of Sheet, Coiled Cut-to-Length).

③ Also applicable to overall length or width of sheet if only one longitudinal and/or transverse buckle or edge wave is present.

④ Allowable deviation from flat with the sheet positioned on flat horizontal surface to minimize deviation.

⑤ Not applicable to O, F and HX8 and harder tempers.

⑥ Not applicable to end or corner turnup.

TABLE 7.18 Flatness Tolerances—Sawed or Sheared Plate**LONGITUDINAL FLATNESS**

SPECIFIED THICKNESS, in.	TOLERANCE ① in.—Allowable Deviation from Flat	
	TX51 tempers ②	Other than TX51 tempers ② ⑦
0.250–3.000	$\frac{3}{16}$ in any 6 ft ③	$\frac{1}{4}$ in any 6 ft or less
3.001–8.000	$\frac{1}{8}$ in any 6 ft or less	$\frac{1}{4}$ in any 6 ft or less

TRANSVERSE FLATNESS

SPECIFIED THICKNESS, in.	TOLERANCE ① in.—Allowable Deviation from Flat				Widths 2 ft and less
	Widths over 4 ft thru 6 ft ④		Widths over 2 ft thru 4 ft		
	TX51 tempers ②	Other than TX51 tempers ② ⑦	TX51 tempers ②	Other than TX51 tempers ② ⑦	
0.250–0.624	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{8}$	Only short-span flatness tolerance applies
0.625–1.500	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	
1.501–3.000	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{16}$	
3.001–8.000	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{3}{16}$	

SHORT-SPAN FLATNESS ⑤

SPECIFIED THICKNESS, in.	TOLERANCE ⑥ in.—Allowable Deviation from Flat	
	TX51 tempers ②	Other than TX51 tempers ② ⑦
0.250–0.624	.100	.125
0.625–8.000	.075	.090

① As measured with plate resting on a flat surface concave side upward, using a straightedge and a feeler gauge, dial gauge or scale.

② TX51 is a general designation for the following stress-relieved tempers: T351, T451, T651, T851, T7351, T7451 and T7651.

③ For pieces ordered to less than 6 ft length, the tolerance is $\frac{1}{8}$ in. for the total length.

④ For widths over 6 ft, these tolerances apply for any 6 ft of total width.

⑤ Short-span flatness is the deviation from flat over full span for spans 2 ft and less.

⑥ As measured with the plate resting on a flat surface.

⑦ Not applicable to O, F, and HX8 and harder tempers.

Tables 7.19 – 7.25 intentionally blank**TABLE 7.26 Thickness Tolerances ①—Commercial Roofing and Siding**

NOMINAL THICKNESS in.	NOMINAL WIDTH—in.	
	Up thru 36	Over 36 thru 54
	TOLERANCE—in, plus and minus	
0.024	.0025	.004
0.032	.0025	.005
0.036	.0025	.005
0.040	.003	.005
0.050	.004	.006

TABLE 7.29 Parallelness of Corrugations—Commercial Roofing and Siding

PRODUCT	PARALLELNESS OF CORRUGATIONS
Corrugated roofing and siding	Capable of being lapped at either end.
V-beam roofing and siding	Capable of being lapped at either end.
Ribbed roofing	Capable of being lapped at either end and ribs are parallel to each other and to edges of sheet within $\pm\frac{1}{8}$ in.
Ribbed siding	Capable of being lapped at either end.

TABLE 7.27 Depth of Corrugation Tolerances—Commercial Roofing and Siding

Allowable deviation from nominal depth of corrugation: $\pm\frac{1}{32}$ in.

TABLE 7.30 Squareness Tolerance—Commercial Roofing and Siding

Allowable difference in length of diagonals: $\pm\frac{1}{2}$ in.

TABLE 7.28 Length Tolerances ②—Commercial Roofing and Siding

Allowable deviation from specified length: $\pm\frac{1}{2}$ in.

① Applicable to flat sheet prior to painting, corrugating or embossing.

② Applicable to lengths of 3 feet through 30 feet for all products except ribbed siding. For ribbed siding, tolerances are applicable to lengths of 3 feet through 36 $\frac{1}{2}$ feet.

Aluminum Mill Products

TABLE 7.31 Thickness Tolerances—Duct Sheet

STANDARD THICKNESS in.	TOLERANCE—in. plus and minus	
	STANDARD WIDTHS—in.	
	24, 30, 36	48
0.016	0.0015	0.002
0.018, 0.020, 0.022, 0.025	0.002	0.0025
0.032	0.002	0.0025
0.040	0.0025	0.003
0.050, 0.063	0.003	0.004

TABLE 7.32 Width Tolerances—Flat Duct Sheet

STANDARD THICKNESS	TOLERANCE—in. plus and minus	
	STANDARD WIDTHS—in.	
	24, 30, 36	48
All	$\frac{3}{32}$	$\frac{1}{8}$

TABLE 7.33 Width Tolerances—Coiled Duct Sheet and Coiled Duct Sheet Cut to Length

STANDARD THICKNESS in.	TOLERANCE—in. plus and minus	
	STANDARD WIDTHS—in.	
	24	30, 36, 48
All	$\frac{1}{32}$	$\frac{3}{64}$

TABLE 7.34 Length Tolerances—Coiled Duct Sheet Cut to Length and Flat Duct Sheet

STANDARD LENGTH	STANDARD WIDTH	TOLERANCE, in.
All	All	$\pm \frac{1}{4}$

Table 7.35 intentionally blank

TABLE 7.36 Weights per Square Foot—Tread Plate

The following nominal weights per square foot are based on alloy 6061, which has a density of 0.098 pounds per cubic inch:

THICKNESS in.	NOMINAL WEIGHT lb/sq. ft
0.100	1.55
0.125	1.90
0.156	2.34
0.188	2.79
0.250	3.67
0.375	5.43
0.500	7.20
0.625	8.96

TABLE 7.38 Width Tolerances—Tread Plate

Allowable deviation from specified width: $\pm \frac{3}{16}$ in.

TABLE 7.39 Length Tolerances—Tread Plate

SPECIFIED LENGTH in.	TOLERANCE in.—plus
Up thru 144	$\frac{3}{8}$
Over 144 thru 240	$\frac{7}{16}$
Over 240	$\frac{1}{2}$

TABLE 7.40 Height of Pattern Tolerance—Tread Plate

Minimum height of raised pattern: 0.040 inch.
(Maximum height is controlled by weight tolerance.)

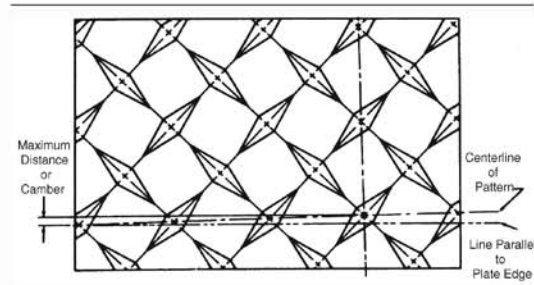
TABLE 7.37 Thickness Tolerances—Tread Plate

Specified ① Thickness—in.	Tolerances—in.	
	Plus ②	Minus
0.100	0.008	0.012
0.125	0.010	0.015
0.156	0.011	0.019
0.188	0.013	0.023
0.250	0.018	0.030
0.375	0.025	0.045
0.500	0.035	0.060
0.625	0.044	0.075

① Specified thickness does not include height of pattern.

② In case of dispute, allowed plus tolerance shall be determined by weight. The allowed deviation from nominal weight shall not exceed plus 8 percent.

Dimensional Tolerances for

**TABLE 7.41 Camber of Pattern Line ④
Tolerances—Tread Plate**


SPECIFIED LENGTH in.	TOLERANCE—in.	
	SPECIFIED WIDTH—in.	
	Up thru 48	Over 48 thru 72
Up thru 24	$\frac{1}{8}$	$\frac{1}{8}$
Over 24 thru 72	$\frac{1}{2}$	$\frac{1}{2}$
Over 72 thru 144	$\frac{3}{4}$	1
Over 144	1	$1\frac{1}{2}$

**TABLE 7.42 Lateral Bow ③ Tolerances—
Tread Plate**

SPECIFIED WIDTH in.	TOLERANCE—in.
	ALLOWABLE DEVIATION OF A SIDE EDGE FROM A STRAIGHT LINE
	SPECIFIED THICKNESS—in.
	0.100–0.625
Up thru 4	1 in any 10 ft.
Over 4 thru 72	$\frac{1}{8}$ in any 10 ft.

**TABLE 7.43 Squareness Tolerances ⑤—
Tread Plate**

SPECIFIED LENGTH in.	TOLERANCE—in.
	ALLOWABLE DIFFERENCE IN LENGTH OF DIAGONALS
Up thru 144	$\frac{3}{8}$
Over 144 thru 240	$\frac{7}{16}$
Over 240	$\frac{1}{2}$

③ Applicable only to lengths up through 240 inches.

④ The camber of a pattern line is the maximum distance between the center of any figure in a pattern line and a line parallel with the edge of the plate that passes through the center of the figure in the same pattern line nearest to the edge of the floor plate.

⑤ Not resquared.

8. Fin Stock

Table 8.1 intentionally blank

TABLE 8.2 Thickness Tolerances—Fin Stock

SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus
0.004–0.0104	0.0005
0.0105–0.0169	0.001
0.017–0.030	0.0015

TABLE 8.3 Width and Lateral Bow
Tolerances^①—Fin Stock

Same as for coiled sheet.
See Tables 7.11 and 7.12

Note: The Olsen Cup and similar tests frequently used as measures of formability are not sufficiently reproducible to permit the establishment of standards for acceptance or rejection of material. Cup test values, when used, are acceptable only as general guidelines for rating comparative formability.

^① Tolerances for thicknesses of 0.004–0.0059 inch are the same as those specified for thickness of 0.006 inch.

9. Foil

Table 9.1 intentionally blank

TABLE 9.2 Covering Area—Unmounted Foil

SPECIFIED THICKNESS in.	COVERING AREA— $\times 10^3$ sq. in. per lb. ① ②			SPECIFIED THICKNESS in.	COVERING AREA— $\times 10^3$ sq. in. per lb. ① ②		
	Nominal	Minimum ③	Maximum ③		Nominal	Minimum ③	Maximum ③
0.00017	60.3	54.8	67.0	0.00095	10.8	9.81	12.0
0.00020	51.3	46.6	57.0	0.0010	10.3	9.32	11.4
0.00025	41.0	37.3	45.6	0.0015	6.84	6.22	7.60
0.00030	34.2	31.1	38.0	0.0020	5.13	4.66	5.70
0.00035	29.3	26.6	32.6	0.0025	4.10	3.73	4.56
0.00040	25.6	23.3	28.5	0.0030	3.42	3.11	3.80
0.00045	22.8	20.7	25.3	0.0035	2.93	2.66	3.26
0.00050	20.5	18.6	22.8	0.0040	2.56	2.33	2.85
0.00055	18.6	17.0	20.7	0.0045	2.28	2.07	2.53
0.00060	17.1	15.5	19.0	0.0050	2.05	1.86	2.28
0.00065	15.8	14.3	17.5	0.0055	1.86	1.70	2.07
0.00070	14.7	13.3	16.3	0.0060	1.71	1.55	1.90
0.00075	13.7	12.4	15.2	0.0065	1.58	1.43	1.75
0.00080	12.8	11.7	14.2	0.0070	1.47	1.33	1.63
0.00085	12.1	11.0	13.4	0.0075	1.37	1.24	1.52
0.00090	11.4	10.4	12.7	0.0079	1.28	1.17	1.42

① The nominal covering area for 0.00017 inch thick foil is 60.3×10^3 or 60,300 sq. in. per lb.

② Based on a density of 0.0975 lb/cu in., the density of 1145 and 1235 aluminum. Covering area in sq. in./lb is calculated using the following formula:

$$\text{Covering Area} = \frac{1}{\text{thickness in in.} \times \text{density in lb./in.}^3}$$

Alloy	Density
1100	0.098
1145	0.0975
1235	0.0975
3003	0.099
5052	0.097
5056	0.095

③ Based on the standard thickness tolerance of plus and minus 10% per roll or shipment.

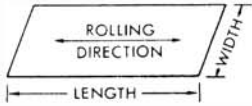
TABLE 9.3 Roll Width—Unmounted Foil

SPECIFIED WIDTH in.	TOLERANCE—in. plus and minus	
	Unmounted Foil	Colored, Embossed and Coated Foil
Up thru 12	$\frac{1}{64}$	$\frac{1}{32}$
Over 12	$\frac{1}{32}$	$\frac{1}{32}$

TABLE 9.4 Inside Diameter—Core, Unmounted Foil

SPECIFIED INSIDE DIAMETER in.	TOLERANCE—in. plus and minus	
	Fiber Cores	Metal Cores
$1\frac{1}{16}$	$\frac{1}{32}$	0.012
3.000	$\frac{1}{32}$	0.015

TABLE 9.5 Length and Width—Flat Sheets of Unmounted Foil

SPECIFIED LENGTH OR WIDTH in.	TOLERANCE—in. plus and minus
	
All	$\frac{1}{32}$

Aluminum Mill Products

TABLE 9.6 Splices—^① Unmounted Foil, Maximum Number Per Roll

ROLL DIAMETER in.	FOIL THICKNESS—in.			
	0.00035–0.001		Over 0.001	
	FOIL WIDTH—in.			
	Up thru 52½ ②	Over 52½	Up thru 52½ ②	Over 52½
Up thru 9½	3	4	1	1
Over 9½–13½	5	7	2	3
Over 13½–18	8	11	4	5
Over 18–22	10	13	6	7
Maximum Average Number Per Roll in Total Shipment				
Up thru 9½	2	2	½	½
Over 9½–13½	3	5	1	1
Over 13½–18	5	8	2	2
Over 18–22	7	10	3	4

^① Standard splices are lap or butt made with foil or plastic tape. Other types are subject to special inquiry.

^② Maximum for 90% of shipment; remainder will not exceed maximums listed for widths over 52½ inches.

TABLE 9.7 Coating Weights—Unmounted Foil

COATING TYPE	TOLERANCE percent plus and minus
Heat seal, Clear Polyethylene Elvax	20 or ¼ lb ^① 15 30

^① Whatever is greater.

TABLE 9.8 Quantity Tolerance—Unmounted Foil

SPECIFIED QUANTITY Per Item or Order	TOLERANCE percent plus and minus
All	10

Laminated Foil

TABLE 9.9 Roll Width—Laminated Foil

SPECIFIED WIDTH in.	TOLERANCE—in. plus and minus	
	Laminated Foil	Colored, Embossed and Coated Foil
Up thru 12	¼	½
Over 12	½	½

TABLE 9.10 Inside Diameter—Core, Laminated Foil

SPECIFIED INSIDE DIAMETER in.	TOLERANCE—in. plus and minus	
	Fiber Cores	Metal Cores
1½/8	½	0.012
3.000	½	0.015

TABLE 9.11 Length and Width—Flat Sheets of Unmounted Foil

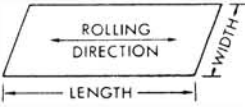
SPECIFIED LENGTH OR WIDTH in.	TOLERANCE—in. plus and minus
	
All	½

TABLE 9.12 Coating Weights—Laminated Foil

COATING TYPE	TOLERANCE percent plus and minus
Heat seal, Clear Polyethylene Elvax	20 or ¼ lb ^① 15 30

^① Whatever is greater.

TABLE 9.13 Covering Area (Yield)—Laminated Foil

NOMINAL COVERING AREA sq. in. per lb.	TOLERANCE ^① percent plus and minus
All	10

^① Average per roll or shipment.

TABLE 9.14 Adhesive Weight—Laminated Foil

ADHESIVE TYPE	TOLERANCE percent plus and minus
Solid Glue, Asphalt Thermoplastic	20 or ¼ lb ^①
Wax	20
Polyethylene	15

^① Whatever is greater.

**TABLE 9.15 Paper Weight (Ream Basis)^①—
Laminated Foil**

PAPER TYPE ^②	TOLERANCE percent plus and minus
All	5

^① Standard ream is 500 sheets 24 in. x 36 in.

^② Some papers may require a greater tolerance.

**TABLE 9.16 Quantity Tolerance—
Laminated Foil**

SPECIFIED QUANTITY Per Item or Order	TOLERANCE percent plus and minus
All	10

Printed Foil**TABLE 9.17 Border Width—Cut Labels**

TYPE OF CUT	NOMINAL BORDER WIDTH in., min.
Rectangular Rhomboid or Die	$\frac{1}{8}$

TABLE 9.18 Overall Size—Cut Labels

SPECIFIED SIZE in.	TOLERANCE—in. plus and minus	
	Within a Shipment	Within a Pack
All	$\frac{1}{32}$	$\frac{1}{64}$

TABLE 9.19 Border Variation—Cut Labels

TYPE OF LABEL	TOLERANCE in. plus and minus
Unembossed or Full Embossed	$\frac{1}{32}$
Embossed to Register	$\frac{3}{64}$

TABLE 9.20 Width—Rolls

SPECIFIED WIDTH in.	TOLERANCE in. plus and minus
All	$\frac{1}{32}$

TABLE 9.21 Minimum Type Size—Rotogravure

TYPE	LINE CYLINDER	TOPE OR PROCESS
Relief	4 point	6 point
Reverse	6 point	8 point

TABLE 9.22 Quantity Tolerance^①

SPECIFIED QUANTITY Million Sq. Inches	TOLERANCE Percent
Up to 1	+100, -50
1 to 10	±40
10 to 20	±30
20 to 35	±20
35 to 50	±15
50 and over	±10

^① For body and neck labels ordered in equal sets and produced on combination cylinders see Table 9.24 for additional tolerance.

TABLE 9.23 Covering Area (Yield)^①

NOMINAL COVERING AREA sq. in. per lb.	TOLERANCE percent plus and minus
All	10

^① Average per roll or shipment

**TABLE 9.24 Quantity Variation Between
Body and Neck Labels**

When ordered in equal sets, the allowable deviation in the number of body and neck labels when produced on combination cylinders is 10 percent.

Aluminum Mill Products

10. Wire, Rod, and Bar—Rolled or Cold-finished

Tables 10.1 – 10.4 intentionally blank

TABLE 10.5 Diameter—Round Wire and Rod

SPECIFIED DIAMETER in.	TOLERANCE—in. plus and minus Except as noted			
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER			
	Drawn Wire	Cold Finished Rod	Rolled Rod	
			Plus	Minus
Up thru 0.035	.0005	...	...	...
0.036–0.064	.001	...	...	...
0.065–0.374	.0015	...	...	...
0.375–0.500	...	.0015	.020	.020
0.501–1.000	...	.002	.025	.025
1.001–1.500	...	.0025	...	...
1.501–2.000	...	.004	...	...
2.001–3.000	...	.006	...	...
3.001–3.499	...	.008	...	...
3.500–5.000	...	.012	...	...
5.001–6.000	...	.020	...	...
6.001–7.000	...	.025	...	...
7.001–8.000	...	.030	...	...

TABLE 10.6 Diameter—Centerless Ground Round Wire and Rod

SPECIFIED DIAMETER in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
0.125–0.625	.0005
0.626–1.500	.0010
1.501–2.000	.0025

TABLE 10.7 Diameter—Rivet and Cold Heading Wire and Rod

SPECIFIED DIAMETER in.	TOLERANCE			
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER			
	Rivet Wire		Rivet Rod	
	in. plus	in. minus	in. plus	in. minus
Up thru 0.061	.0005	.0005	...	...
0.062–0.123	.001	.0005	...	...
0.124–0.154	.001	.001	...	...
0.155–0.374	.002	.001	...	...
0.375–0.500	...	...	.002	.001
0.501–1.000	...	...	.003	.001

TABLE 10.8 Diameter—Drawing Stock

SPECIFIED DIAMETER in.	TOLERANCE—in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
0.375–0.500	.020
0.501–1.000	.025

TABLE 10.9 Thickness and Width—Rectangular Wire and Bar

SPECIFIED THICKNESS OR WIDTH in.	TOLERANCE in. plus and minus			
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS AND WIDTH			
	Drawn Wire and Cold Finished Bar		Rolled Bar	
	Thickness	Width	Thickness	Width
Up thru 0.035	.001	..	..	..
0.036–0.064	.0015	..	..	..
0.065–0.500	.002	.002	.006	..
0.501–0.750	.0025	.0025	.008	.016
0.751–1.000	.0025	.0025	.012	.016
1.001–1.500	.003	.003	.016	.016
1.501–2.000	.005	.005	.016	.031
2.001–3.000	.008	.008	.020	.031
3.001–4.000	..	.010	.020	.031
4.001–6.000	..	..	..	.047
6.001–10.000	..	..	..	.062

TABLE 10.10 Distance across Flats—Square, Hexagonal and Octagonal Wire and Bar

SPECIFIED DISTANCE ACROSS FLATS in.	TOLERANCE in. plus and minus		
	ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS		
	Drawn Wire	Cold Finished Bar	Rolled Bar
Up thru 0.035	.001	..	..
0.036–0.064	.0015	..	..
0.065–0.374	.002	..	..
0.375–0.500	..	.002	..
0.501–1.000	..	.0025	..
1.001–1.500	..	.003	..
1.501–2.000	..	.005	.016
2.001–3.000	..	.008	.020
3.001–4.000	..	..	.020

Dimensional Tolerances for

TABLE 10.11 Thickness and Width—Flattened Wire (Round Edge)

SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus	SPECIFIED WIDTH in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS		ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS
Up thru 0.020	.001	Up thru 0.875	.007
0.021–0.060	.0015	0.876–2.000	.010
0.061–0.187	.002		

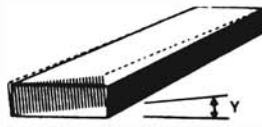
TABLE 10.12 Thickness and Width—Flattened and Slit Wire

SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus	SPECIFIED WIDTH in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS		ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
0.018–0.020	0.001	0.500–0.625	0.0025
0.021–0.060	0.0015	0.626–1.500	0.004
0.061–0.080	0.002	1.501–4.750	0.006

TABLE 10.13 Length—Specific and Multiple—Rolled or Cold Finished Wire, Rod, and Bar

SPECIFIED DIAMETER, WIDTH OR DISTANCE ACROSS FLATS in.	TOLERANCE ⑤—in. plus			
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
	SPECIFIED LENGTH—ft.			
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50
Up thru 2.999	1/8	1/4	3/8	1
3.000–7.999	3/16	5/16	7/16	1
8.000 and over	1/4	3/8	1/2	1

TABLE 10.14 Twist^①—Rolled or Cold Finished Bar and Straight Lengths

PRODUCT	TEMPER	SPECIFIED WIDTH (RECTANGLES): SPECIFIED DISTANCE ACROSS FLATS: (SQUARES, HEXAGONS AND OCTAGONS) in.	TOLERANCE ① ③—DEGREES	
			ALLOWABLE DEVIATION FROM STRAIGHT	
				
			Y (max.) in degrees	
			IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
Square, Rectangular and Octagonal Bar	All except O and TX51 ②	Up thru 1.499 1.500–2.999 3.000 and over	1 × Measured length, ft ½ × Measured length, ft ¼ × Measured length, ft	7 5 3
	TX51 ②	0.500–2.999 3.000 and over	1½ × Measured length, ft ½ × Measured length, ft	7 5
Hexagonal Bar	All except O	Up thru 1.499 1.500–2.999 3.000 and over	1 × Measured length, ft ½ × Measured length, ft ¼ × Measured length, ft	7 5 3

① For TX51 tempers, tolerance is applicable only to thicknesses of 0.500 in. and over.

② TX51 is a general designation for the following stress-relieved tempers: T351, T451, T651, T851, and T7351.

③ When weight of piece on flat surface minimizes deviation.

④ Twist is normally measured by placing the bar on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the bar and the flat surface. From this measurement, the actual deviation from straightness of the bar at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
1/4	0.004
1/2	0.009
1	0.017
1 1/2	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

⑤ For wire, rod and bar ordered as standard screw machine stock, the length tolerance is plus 3/4 in.

Aluminum Mill Products

TABLE 10.15 Straightness—Rolled or Cold Finished Rod and Bar in Straight Lengths Other than Screw Machine Stock

PRODUCT	TEMPER	SPECIFIED DIAMETER (ROD): SPECIFIED DISTANCE ACROSS FLATS: (SQUARES, HEXAGONS AND OCTAGONS) SPECIFIED THICKNESS (RECTANGLES) in.	TOLERANCE ①—in.
			ALLOWABLE DEVIATION (D) FROM STRAIGHT  IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
ROLLED			
Rod and Hexagonal, Square, Rectangular and Octagonal Bar	All except O	All	0.050 × Measured length, ft.
COLD FINISHED			
Rod and Hexagonal Bar	All except O and TX51 ②	All	0.025 × Measured length, ft.
	TX51 ②	0.500 and over	0.025 × Measured length, ft.
Square, Rectangular and Octagonal Bar	All except O and TX51 ②	All	0.025 × Measured length, ft.
	TX51 ②	0.500 and over	0.050 × Measured length, ft.

TABLE 10.16 Straightness—Screw Machine Stock

SPECIFIED DIAMETER, (ROD); SPECIFIED DISTANCE ACROSS FLATS (HEXAGONAL BAR) in.	TEMPER	TOLERANCE ① in.	
		ALLOWABLE DEVIATION FROM STRAIGHT	
		In any foot or less of length	In 12 feet
All	All Except TX51 ②	0.0125	0.100
0.500 and over	TX51 ②	0.0125	0.100

TABLE 10.18 Angularity—Rolled or Cold Finished Rod and Bar

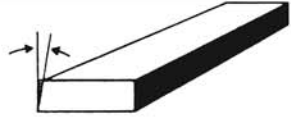
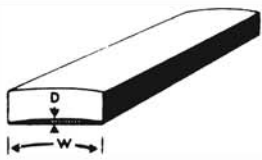

Allowable deviation from nominal angle: ±1 degree

TABLE 10.17 Flatness—Flat Surfaces—Rolled or Cold Finished Rod and Bar

SURFACE WIDTH in.	TOLERANCE, in.
	 Maximum Allowable Deviation D
Up thru 1	0.004
Over 1	0.004 × W (inches)
In any 1 in. of width	0.004

① When weight of piece on flat surface minimizes deviation.

② TX51 is a general designation for the following stress-relieved tempers: T351, T451, T851, and T7351.

TABLE 10.19 Squareness of Saw Cuts—Rolled or Cold Finished Rod and Bar

Allowable deviation from square: 1 degree

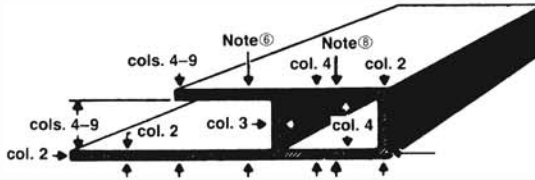
TABLE 10.20 Corner Radii Bar—Rolled or Cold Finished Rod and Bar

Thickness, inches	Corner Radii inches, max.
Up thru 0.500	0.016
0.501–2.000	0.032
2.001 and thicker	0.050

11. Wire, Rod, Bar, and Profiles—Extruded

Table 11.1 intentionally blank

TABLE 11.2 Cross-Sectional Dimension Tolerances—Profiles ^①EXCEPT FOR T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPERS ^⑦

																	
SPECIFIED DIMENSION	TOLERANCE ② ③—in. plus and minus																
	METAL DIMENSIONS				SPACE DIMENSIONS												
	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE 75 PERCENT OR MORE OF THE DIMENSION IS METAL ⑨ ⑩				ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE MORE THAN 25 PERCENT OF THE DIMENSION IS SPACE ⑤ ⑧												
	in.	All Except Those Covered by Column 3	Wall Thickness ④ Completely ⑤ Enclosing Space 0.11 sq. in. and Over (Eccentricity)	At Dimensioned Points 0.250–0.624 inches from Base of Leg	At Dimensioned Points 0.625–1.249 inches from Base of Leg	At Dimensioned Points 1.250–2.499 inches from Base of Leg	At Dimensioned Points 2.500–3.999 inches from Base of Leg	At Dimensioned Points 4.000–5.999 inches from Base of Leg	At Dimensioned Points 6.000–8.000 inches from Base of Leg								
Col. 1	Col. 2	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 3	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 4	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 5	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 6	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 7	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 8	Precision Tolerance, All Except 5XXX Alloys ⑪	Col. 9	Precision Tolerance, All Except 5XXX Alloys ⑪	
CIRCUMSCRIBING CIRCLE SIZES LESS THAN 10 INCHES IN DIAMETER																	
Up thru 0.124	0.006	0.004	±10% of specified dimension; ±0.060 max. ±0.010 min.	±10% of specified dimension; ±0.060 max. ±0.010 min.	0.010	0.007	0.012	0.008	0.016	0.011	0.020	0.013	0.015	0.017	0.018	0.020	
0.125–0.249	0.007	0.005			0.012	0.008	0.014	0.009	0.018	0.012	0.022	0.014	0.016	0.018	0.020	0.022	0.024
0.250–0.499	0.008	0.005			0.014	0.009	0.016	0.011	0.018	0.012	0.022	0.014	0.016	0.018	0.020	0.022	0.024
0.500–0.749	0.009	0.006			0.016	0.011	0.018	0.012	0.020	0.013	0.022	0.014	0.016	0.018	0.020	0.022	0.024
0.750–0.999	0.010	0.007			0.018	0.012	0.020	0.013	0.022	0.015	0.025	0.017	0.020	0.022	0.024	0.026	0.028
1.000–1.499	0.012	0.008	±10% of specified dimension; ±0.060 max. ±0.015 min.	±10% of specified dimension; ±0.060 max. ±0.015 min.	0.021	0.014	0.023	0.015	0.026	0.017	0.030	0.020	0.035	0.023	0.030	0.033	
1.500–1.999	0.014	0.009			0.024	0.016	0.026	0.017	0.031	0.020	0.036	0.024	0.042	0.028	0.035	0.038	0.041
2.000–3.999	0.024	0.016			0.034	0.022	0.038	0.025	0.048	0.032	0.057	0.038	0.068	0.045	0.055	0.058	0.061
4.000–5.999	0.034	0.022			0.044	0.029	0.050	0.033	0.064	0.042	0.078	0.051	0.094	0.062	0.075	0.078	0.081
6.000–7.999	0.044	0.029			0.054	0.036	0.062	0.041	0.082	0.054	0.099	0.065	0.120	0.079	0.100	0.103	0.106
8.000–9.999	0.054	0.036			0.064	0.042	0.074	0.049	0.100	0.066	0.120	0.079	0.145	0.096	0.120	0.123	0.126
CIRCUMSCRIBING CIRCLE SIZES 10 INCHES IN DIAMETER AND OVER																	
Up thru 0.124	0.014	0.009	±15% of specified dimension; ±0.090 max. ±0.025 min.	±15% of specified dimension; ±0.090 max. ±0.025 min.	0.018	0.012	0.020	0.013	0.028	0.018	0.040	0.026	0.060	0.040	0.045	0.050	
0.125–0.249	0.015	0.010			0.019	0.013	0.022	0.015	0.030	0.020	0.050	0.033	0.070	0.046	0.060	0.065	0.070
0.250–0.499	0.016	0.011			0.020	0.013	0.024	0.016	0.030	0.020	0.050	0.033	0.070	0.046	0.060	0.065	0.070
0.500–0.749	0.017	0.011			0.022	0.015	0.027	0.018	0.040	0.026	0.060	0.040	0.090	0.059	0.070	0.073	0.076
0.750–0.999	0.018	0.012			0.023	0.015	0.030	0.020	0.050	0.033	0.070	0.046	0.090	0.059	0.070	0.073	0.076
1.000–1.499	0.019	0.013	±15% of specified dimension; ±0.090 max. ±0.025 min.	±15% of specified dimension; ±0.090 max. ±0.025 min.	0.024	0.016	0.034	0.022	0.060	0.040	0.080	0.053	0.100	0.066	0.080	0.085	
1.500–1.999	0.024	0.016			0.034	0.022	0.044	0.029	0.070	0.046	0.090	0.059	0.110	0.073	0.100	0.103	0.106
2.000–3.999	0.034	0.022			0.044	0.029	0.054	0.036	0.080	0.053	0.100	0.066	0.120	0.079	0.100	0.103	0.106
4.000–5.999	0.044	0.029			0.054	0.036	0.064	0.042	0.090	0.059	0.110	0.073	0.130	0.086	0.100	0.103	0.106
6.000–7.999	0.054	0.036			0.064	0.042	0.074	0.049	0.100	0.066	0.120	0.079	0.140	0.092	0.100	0.103	0.106
8.000–9.999	0.064	0.042	±15% of specified dimension; ±0.090 max. ±0.025 min.	±15% of specified dimension; ±0.090 max. ±0.025 min.	0.074	0.049	0.084	0.055	0.110	0.073	0.130	0.086	0.150	0.099	0.120	0.123	
10.000–11.999	0.074	0.049			0.084	0.055	0.094	0.062	0.120	0.079	0.140	0.092	0.160	0.106	0.120	0.123	0.126
12.000–13.999	0.084	0.055			0.094	0.062	0.104	0.069	0.130	0.086	0.150	0.099	0.170	0.112	0.120	0.123	0.126
14.000–15.999	0.094	0.062			0.104	0.069	0.114	0.075	0.140	0.092	0.160	0.106	0.180	0.119	0.120	0.123	0.126
16.000–17.999	0.104	0.069			0.114	0.075	0.124	0.082	0.150	0.099	0.170	0.112	0.190	0.125	0.120	0.123	0.126
18.000–19.999	0.114	0.075	±15% of specified dimension; ±0.090 max. ±0.025 min.	±15% of specified dimension; ±0.090 max. ±0.025 min.	0.124	0.082	0.134	0.088	0.160	0.106	1.800	1.188	0.200	0.132	0.260	0.172	
20.000–21.999	0.124	0.082			0.134	0.088	0.144	0.095	0.170	0.112	0.190	0.125	0.210	0.139	0.270	0.178	0.181
22.000–24.000	0.134	0.088			0.144	0.095	0.154	0.102	0.180	0.119	0.200	0.132	0.220	0.145	0.280	0.185	0.188

Footnotes for Tables 11.2 through 11.4

^① These Standard and Precision Tolerances are applicable to the average profile. The extrusion conditions required to produce the wide variety of alloy-temper and profile combinations require close review between customer and producer to determine critical characteristics and tolerance capability. Aggressive profile characteristics may require wider than standard tolerance and closer than precision tolerance may be feasible for other characteristics.

^② The tolerance applicable to a dimension composed of two or more component dimensions is the sum of the tolerances of the component dimensions if all of the component dimensions are indicated.

^③ When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

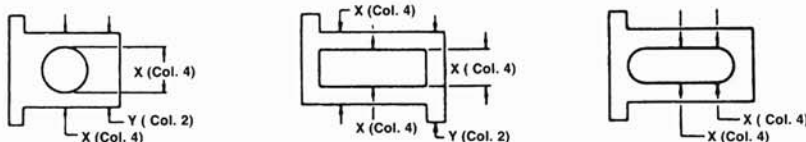
^④ Where dimensions specified are outside and inside, rather than wall thickness itself, the allowable deviation (eccentricity) given in Column 3 applies to mean wall thickness. (Mean wall thickness is the average of two wall thickness measurements taken at opposite sides of the void.)

(Continued on bottom of next page)

Aluminum Mill Products

Examples Illustrating Use of Table 11.2, page 24

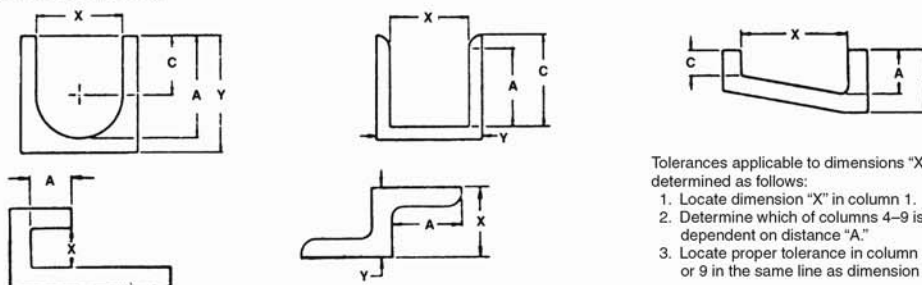
Closed-Space Dimensions



All dimensions designated "Y" are classed as "metal dimensions," and tolerances are determined from column 2.

Dimensions designated "X" are classed as "space dimensions through an enclosed void," and the tolerances applicable are determined from column 4 unless 75 percent or more of the dimension is metal, in which case column 2 applies.

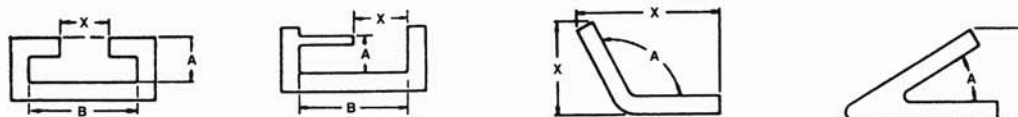
Open-Space Dimensions



Tolerances applicable to dimensions "X" are determined as follows:

1. Locate dimension "X" in column 1.
2. Determine which of columns 4-9 is applicable, dependent on distance "A."
3. Locate proper tolerance in column 4, 5, 6, 7, 8 or 9 in the same line as dimension "X."

Dimensions "Y" are "metal dimensions"; tolerances are determined from column 2. Distances "C" are shown merely to indicate incorrect values for determining which of columns 4-9 apply.



Tolerances applicable to dimensions "X" are determined as follows:

1. Locate distance "B" in column 1.
2. Determine which of columns 4-9 is applicable, dependent on distance "A."
3. Locate proper tolerance in column 4, 5, 6, 7, 8 or 9 in the same line as value chosen in column 1.

Tolerances applicable to dimensions "X" are not determined from Table 11.2; tolerances are determined by standard tolerances applicable to angles "A."

Footnotes for Tables 11.2 through 11.4 (Continued)

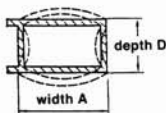
⑤ In the case of Class 1 Hollow Profiles the standard wall thickness tolerance for extruded round tube is applicable. (A Class 1 Hollow Profile is one whose void is round and one inch or more in diameter and whose weight is equally distributed on opposite sides of two or more equally spaced axes.)

⑥ At points less than 0.250 inch from base of leg the tolerances in Col. 2 are applicable.

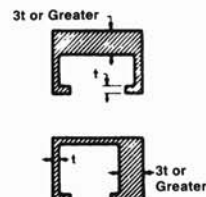
⑦ Tolerances for extruded profiles in T3510, T4510, T6510, T73510, T76510 and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.

⑧ The following tolerances apply where the space is completely enclosed (hollow profiles); For the width (A), the balance is the value shown in Col. 4 for the depth dimension (D). For the depth (D), the tolerance is the value shown in Col. 4 for the width dimension (A). In no case is the tolerance for either width or depth less than the metal dimensions (Col. 2) at the corners.

Example—Alloy 6061 hollow profile having 1 × 3 rectangular outside dimensions; width tolerance is ±0.021 inch and depth tolerance ±0.034 inch. (Tolerances at corners, Col. 2, metal dimensions, are ±0.024 inch for the width and ±0.012 inch for the depth.) Note that the Col. 4 tolerance of 0.021 inch must be adjusted to 0.024 inch so that it is not less than the Col. 2 tolerance.



⑨ These tolerances do not apply to space dimensions such as dimensions "X" and "Z" of the example (right), even when "Y" is 75 percent or more of "X." For the tolerance applicable to dimensions "X" and "Z," use Col. 4, 5, 6, 7, 8 or 9, dependent on distance "A."



⑩ The wall thickness tolerance for hollow or semihollow profiles shall be as agreed upon between purchaser and vendor at the time the contract or order is entered when the nominal thickness of one wall is three times or greater than that of the opposite wall.

⑪ For those 5xxx alloys with a magnesium content of greater than or equal to 4.0% nominal, tolerances are 150% of those values shown in the standard tolerance columns.

TABLE 11.3 Diameter or Distance Across Flats—Round Wire and Rod - Square, Hexagonal and Octagonal Wire and Bar^①

SPECIFIED DIMENSION in.	TOLERANCE ^③ —in. plus and minus							
	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION ACROSS FLATS OR DIAMETER							
	ROUND WIRE AND ROD		SQUARE WIRE AND BAR		HEXAGONAL WIRE AND BAR		OCTAGONAL WIRE AND BAR	
	Standard Tolerance, All Except 5XXX Alloys ^①	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ^①	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ^①	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ^①	Precision Tolerance, All Except 5XXX Alloys
Up thru 0.124	0.006	0.004	0.006	0.004	0.006	0.004	0.006	0.004
0.125–0.249	0.007	0.005	0.007	0.005	0.007	0.005	0.007	0.005
0.250–0.499	0.008	0.005	0.008	0.005	0.008	0.005	0.008	0.005
0.500–0.749	0.009	0.006	0.009	0.006	0.009	0.006	0.009	0.006
0.750–0.999	0.010	0.007	0.010	0.007	0.010	0.007	0.010	0.007
1.000–1.499	0.012	0.008	0.012	0.008	0.012	0.008	0.012	0.008
1.500–1.999	0.014	0.009	0.014	0.009	0.014	0.009	0.014	0.009
2.000–3.999	0.024	0.016	0.024	0.016	0.024	0.016	0.024	0.016
4.000–5.999	0.034	0.022	0.034	0.022	0.034	0.022	0.034	0.022
6.000–7.070	0.044	0.029	0.044	0.029	0.044	0.029	0.044	0.029
7.071–7.999	0.044	0.029	0.054	0.036	0.044	0.029	0.044	0.029
8.000–8.659	0.054	0.036	0.064	0.042	0.054	0.036	0.054	0.036
8.660–8.999	0.054	0.036	0.064	0.042	0.064	0.042	0.054	0.036
9.000–9.238	0.054	0.036	0.064	0.042	0.064	0.042	0.054	0.036
9.239–9.999	0.054	0.036	0.064	0.042	0.064	0.042	0.064	0.042
10.000–11.999	0.074	0.049	0.074	0.049	0.074	0.049	0.074	0.049
12.000–13.999	0.084	0.055	0.084	0.055	0.084	0.055	0.084	0.055
14.000–15.999	0.094	0.062	0.094	0.062	0.094	0.062	0.094	0.062

Note: Shaded tolerances denote products with a circumscribing circle size of 10 inches in diameter and over.

For numbered footnotes, see two preceding pages.

TABLE 11.4 Thickness or Width (Distance Across Flats)—Rectangular Wire and Bar^①

SPECIFIED DIMENSION IN.	TOLERANCE—in. plus and minus			
	ALLOWABLE DEVIATION FROM SPECIFIED WIDTH OR THICKNESS ACROSS FLATS			
	Standard Tolerance, All Except, 5XXX Alloys ^①	Precision Tolerance, All Except, 5XXX Alloys	Standard Tolerance, All Except, 5XXX Alloys ^①	Precision Tolerance, All Except, 5XXX Alloys
Up thru 0.124	0.006	0.004	0.014	0.009
0.125–0.249	0.007	0.005	0.015	0.010
0.250–0.499	0.008	0.005	0.016	0.011
0.500–0.749	0.009	0.006	0.017	0.011
0.750–0.999	0.010	0.007	0.018	0.012
1.000–1.499	0.012	0.008	0.019	0.013
1.500–1.999	0.014	0.009	0.024	0.016
2.000–3.999	0.024	0.016	0.034	0.022
4.000–5.999	0.034	0.022	0.044	0.029
6.000–7.999	0.044	0.029	0.054	0.036
8.000–9.999	0.054	0.036	0.064	0.042
10.000–11.999	..	..	0.074	0.049
12.000–13.999	..	..	0.084	0.055
14.000–15.999	..	..	0.094	0.062
16.000–17.999	..	..	0.104	0.069
18.000–19.999	..	..	0.114	0.075
20.000–21.999	..	..	0.124	0.082
22.000–24.000	..	..	0.134	0.088

Note: Shaded tolerances denote products with a circumscribing circle size of 10 inches in diameter and over.

For all numbered footnotes, see two preceding pages.

Aluminum Mill Products

TABLE 11.5 Length^①—Wire, Rod, Bar and Profiles

SPECIFIED DIAMETER (WIRE AND ROD): SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER ^④ : (PROFILES) in.	TOLERANCE—in. plus			
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
	SPECIFIED LENGTH—ft.			
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50
Up thru 2.999	1/8	1/4	3/8	1
3.000–7.999	3/16	5/16	7/16	1
8.000 and over	1/4	3/8	1/2	1

TABLE 11.6 Straightness^①—Rod, Bar and Profiles

PRODUCT	TEMPER	SPECIFIED DIAMETER (ROD): SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER ^④ : (PROFILES) in.	SPECIFIED THICKNESS (RECTANGLES): MINIMUM THICKNESS: (PROFILES) in.	TOLERANCE ^③ —in.
				ALLOWABLE DEVIATION (D) FROM STRAIGHT ^⑤
				IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
Rod and Square, Hexagonal and Octagonal Bar	All except O TX510 ^② TX511 ^②	All	..	.0125 × Measured length, ft.
	O	0.500 and over	..	.050 × Measured length, ft.
	TX510 ^②	0.500 and over	..	.050 × Measured length, ft.
	TX511 ^②	0.500 and over	..	.0125 × Measured length, ft.
Rectangular Bar	All except O TX510 ^② TX511 ^②	Up thru 1.499	Up thru 0.094 ^⑦ 0.095 and over	.050 × Measured length, ft. .0125 × Measured length, ft.
		1.500 and over	All	.0125 × Measured length, ft.
	O	Over 0.500	0.500 and over	.050 × Measured length, ft.
	TX510 ^②	Over 0.500	0.500 and over	.050 × Measured length, ft.
	TX511 ^②	Over 0.500	0.500 and over	.0125 × Measured length, ft.
Profiles	All except O TX510 ^② ^⑤ TX511 ^②	Up thru 1.499	Up thru 0.094 ^⑦ 0.095 and over	.050 × Measured length, ft. .0125 × Measured length, ft.
		1.500 and over	All	.0125 × Measured length, ft.
	O	0.500 and over	Up thru 0.094 ^⑦ 0.095 and over	.200 × Measured length, ft. .050 × Measured length, ft.
	TX511 ^②	0.500 and over	Up thru 0.094 ^⑦ 0.095 and over	.050 × Measured length, ft. .0125 × Measured length, ft.

Footnotes for Tables 11.5 through 11.8

① These Standard Tolerances are applicable to the average profile; wider tolerances may be required for some profiles, and closer tolerances may be possible for others.

② TX510 and TX511 are general designations for the following stress relieved tempers: T3510, T4510, T61510, T6510, T8510, T73510, T76510 and T3511, T4511, T61511, T6511, T8511, T73511, T76511, respectively.

③ When weight of piece on the flat surface minimizes deviation.

④ The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the cross section of the extruded product.

⑤ Tolerances for T3510, T4510, T6510, T73510, T76510, and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.

⑥ Twist is normally measured by placing the extruded section on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the extruded section and the flat surface. From this measurement, the actual deviation from straightness of the extruded section at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
1/4	0.004
1/2	0.009
1	0.017
1 1/2	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

⑦ Applies only if the thickness along at least 1/3 of the total perimeter is 0.094 or less. Otherwise use the tolerance shown for 0.095 and over.

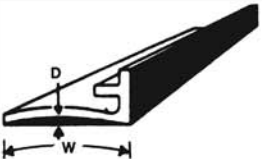
⑧ Tolerance for "O" temper material is four times the standard tolerances shown.

⑨ Straightness must be met in all orientations, including orientations which are not self-supporting.

TABLE 11.7 Twist ^{① ⑥}—Bar and Profiles

PRODUCT	TEMPER	SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER ^① : (PROFILES) in.	SPECIFIED THICKNESS (RECTANGLES): MINIMUM THICKNESS: (PROFILES) in.	TOLERANCE ^③ —Degrees	
				ALLOWABLE DEVIATION FROM STRAIGHT	
				IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
Bar	All except O TX510 ^② TX511 ^②	Up thru 1.499 1.500–2.999 3.000 and over	All All All	1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 5 3
	O	0.500–1.499 1.500–2.999 3.000 and over	0.500 and over 0.500 and over 0.500 and over	3 × Measured length, ft. 1½ × Measured length, ft. ¾ × Measured length, ft.	21 15 9
	TX510 ^②	0.500–2.999 3.000 and over	0.500 and over 0.500 and over	1½ × Measured length, ft. ¾ × Measured length, ft.	7 5
	TX511 ^②	0.500–1.499 1.500–2.999 3.000 and over	0.500 and over 0.500 and over 0.500 and over	1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 5 3
	All except O TX510 ^{② ⑤} TX511 ^②	Up thru 1.499 1.500–2.999 3.000 and over	All All All	1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 5 3
	O	0.500 and over 0.500–1.499 1.500–2.999 3.000 and over	Up thru 0.094 ^⑦ 0.095 and over 0.095 and over 0.095 and over	3 × Measured length, ft. 3 × Measured length, ft. 1½ × Measured length, ft. ¾ × Measured length, ft.	21 21 15 9
Profiles	TX511 ^②	0.500 and over 0.500–1.499 1.500–2.999 3.000 and over	Up thru 0.094 ^⑦ 0.095 and over 0.095 and over 0.095 and over	1 × Measured length, ft. 1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 7 5 3

TABLE 11.8 Flatness (Flat Surfaces) ^①—Bar, Solid Profiles and Semihollow ProfilesEXCEPT FOR PROFILES IN O ^⑥, T3510, T4510, T6510, T73510, T76510 and T8510 TEMPER ^⑤

					SURFACES WIDTHS UP THRU 1 INCH OR ANY 1 INCH INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE FACTOR (in.)						
					WIDTHS OVER 1 INCH Maximum Allowable Deviation D = TOLERANCE FACTOR × W (in.)						
MINIMUM THICKNESS OF METAL FORMING THE SURFACE in.	SURFACE WIDTH—in.										
	UP TO 5.999	6.000 TO 7.999	8.000 TO 9.999	10.000 TO 11.999	12.000 TO 13.999	14.000 TO 15.999	16.000 TO 17.999	18.000 TO 19.999	20.000 TO 21.999	22.000 TO 23.999	24.000 AND UP
	TOLERANCE FACTOR										
	Up thru 0.124	.004	.006	.010	.014	..	..	..	..	..	..
	0.125–0.187	.004	.006	.008	.012	.014	.014	.014	..	..	..
0.188–0.249	.004	.006	.008	.010	.012	.012	.012	.014	.014	..	..
0.250–0.374	.004	.006	.006	.008	.010	.010	.012	.012	.012	.014	..
0.375–0.499	.004	.004	.006	.008	.008	.008	.010	.010	.010	.012	.014
0.500–0.749	.004	.004	.006	.006	.008	.008	.008	.008	.010	.010	.012
0.750–0.999	.004	.004	.006	.006	.008	.008	.008	.008	.008	.008	.010
1.000–1.499	.004	.004	.004	.006	.006	.008	.008	.008	.008	.008	.008
1.500–1.999	.004	.004	.004	.004	.006	.006	.006	.008	.008	.008	.008
2.000 and up	.004	.004	.004	.004	.004	.006	.006	.006	.008	.008	.008

For all numbered footnotes, see page 27.

Aluminum Mill Products

TABLE 11.9 Flatness (Flat Surfaces)^①—Hollow Profiles (EXCEPT FOR PROFILES IN O^②, T3510, T4510, T6510, T73510, T76510 and T8510 TEMPER^③)

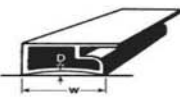
 MINIMUM THICKNESS OF METAL FORMING THE SURFACE in.	SURFACES WIDTHS UP THRU 1 INCH OR ANY 1 INCH INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE FACTOR(in.)										
	WIDTHS OVER 1 INCH Maximum Allowable Deviation D = TOLERANCE FACTOR × W (in.)										
	SURFACE WIDTH—in.										
	UP TO 5.999	6.000 TO 7.999	8.000 TO 9.999	10.000 TO 11.999	12.000 TO 13.999	14.000 TO 15.999	16.000 TO 17.999	18.000 TO 19.999	20.000 TO 21.999	22.000 TO 23.999	24.000 AND UP
	TOLERANCE FACTOR										
Up thru 0.124	.006	.008	.012	.016	..	..	..	..	..	..	..
0.125–0.187	.006	.008	.010	.014	.016	..	..	..	..	..	..
0.188–0.249	.004	.006	.010	.012	.014	.014	.014	.016	..	..	..
0.250–0.374	.004	.006	.008	.010	.012	.012	.012	.014	.014	.016	..
0.375–0.499	.004	.006	.008	.010	.010	.010	.012	.012	.012	.014	.016
0.500–0.749	.004	.004	.006	.008	.008	.008	.010	.010	.012	.012	.014
0.750–0.999	.004	.004	.006	.006	.008	.008	.008	.008	.010	.010	.012
1.000 and up	.004	.004	.004	.006	.006	.008	.008	.008	.008	.008	.008

TABLE 11.10 Surface Roughness^{① ⑧}—Extruded Wire, Rod, Bar, and Profiles

SPECIFIED SECTION THICKNESS in.	ALLOWABLE DEPTH OF CONDITIONS ^② in. max.
Up thru 0.063	0.0015
0.064–0.125	0.002
0.126–0.188	0.0025
0.189–0.250	0.003
0.251–0.500	0.004
0.501- and over	0.008

TABLE 11.13 Corner and Fillet Radii^①—Extruded Bar and Profiles

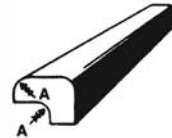
SPECIFIED RADIUS ^⑧ in.	TOLERANCE—in.
	ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
 Difference between radius A and specified radius	Sharp corners
	0.016–0.187
	0.188 and over
	+1/64 ±1/64 ±10%

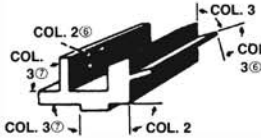
TABLE 11.11 Contour (Curved Surfaces)^{① ③}—Extruded Profiles

Temper	
All except O, TX510 ^④	Allowable deviation from specified contour: 0.005 inch per inch of chord length; 0.005 inch minimum. Not applicable to contours with chord length 6 inch and over.
O	Allowable deviation from specified contour: 0.015 inch per inch of chord length; 0.015 inch minimum. Not applicable to contours with chord length 6 inches and over.

TABLE 11.12 Squareness of Cut Ends^①—Extruded Rod, Bar and Profiles

Allowable deviation from square: 1 degree

TABLE 11.14 Angularity^{① ⑤}—Extruded Bar and Profiles

TEMPER	MINIMUM SPECIFIED LEG THICKNESS in.	TOLERANCE Degrees plus and minus	
		ALLOWABLE DEVIATION FROM SPECIFIED ANGLE	
		 RATIO: ⑥ ⑦ LEG OR SURFACE LENGTH TO LEG OR METAL THICKNESS	
		1 and less	Over 1 thru 40
All except O, TX510 ^④	Up thru 0.187	1	2
	0.188–0.749	1	1½
	0.750 and over	1	1
O	Up thru 0.187	3	6
	0.188–0.749	3	4½
	0.750 and over	3	3

For all numbered footnotes, see page 30.

Footnotes for Tables 11.9 through 11.14

① These Standard Tolerances are applicable to the average profile; wider tolerances may be required for some profiles, and closer tolerances may be possible for others.

② Conditions include die lines and handling marks.

③ As measured with a contour gauge whose surface is limited to a maximum subtended angle of 90 degrees. Extruded curved surfaces comprising more than a 90-degree subtended angle are checked by sliding the gauge across the surface, thus checking two or more 90-degree portions of the surface. Extruded profile surfaces comprising arcs formed by two or more radii require the use of a separate contour gauge for each portion of the surface formed by an individual radius.

④ Tolerances for T3510, T4510, T6510, T73510, T76510 and T8510 tempers shall be as agreed upon between the purchaser and vendor and at the time the contract or order is entered.

⑤ Angles are measured with protractors or with gauges. As illustrated, a four-point contact system is used, two contact points being as close to the angle vertex as practical, and the others near the ends of the respective surfaces forming the angle. Between these points of measurement surface flatness is the controlling tolerance.



⑥ When the area between the surface forming an angle is all metal, values in column 2 apply if the larger surface length to metal thickness ratio is 1 or less.

⑦ When two legs are involved the one having the larger ratio determines the applicable column.

⑧ Not applicable to 2219 alloy extrusions. Most profiles in 2219 alloy will have die lines about twice the depth shown in the table; however, for each profile the supplier should be contacted for the roughness value to apply.

⑨ If unspecified, the radius shall be $\frac{1}{32}$ in. maximum including tolerances.

⑩ Tolerance for "O" temper material is four times the standard tolerances shown.

12. Tube and Pipe

Table 12.1 intentionally blank

TABLE 12.2 Diameter—Round Extruded TubeEXCEPT FOR T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPER^⑦

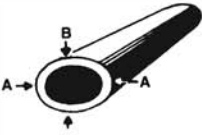
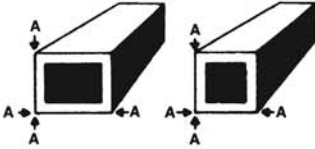
SPECIFIED DIAMETER ^① in.	TOLERANCE ^② —in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN DIAMETER ^③ FROM SPECIFIED DIAMETER (Size)		ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER ^④	
	 Difference between $\frac{1}{2} (AA+BB)$ and specified diameter		 Difference between AA or BB and specified diameter	
Col. 1	Col. 2		Col. 3	
	5xxx ≥ 4.0 nominal Mg ^⑮	Other Alloys	5xxx ≥ 4.0 nominal Mg ^⑮	Other Alloys
0.500–0.999	.015	.010	.030	.020
1.000–1.999	.018	.012	.038	.025
2.000–3.999	.023	.015	.045	.030
4.000–5.999	.038	.025	.075	.050
6.000–7.999	.053	.035	.113	.075
8.000–9.999	.068	.045	.150	.100
10.000–11.999	.083	.055	.188	.125
12.000–13.999	.098	.065	.225	.150
14.000–15.999	.113	.075	.263	.175
16.000–17.999	.128	.085	.300	.200
18.000–19.999	.143	.095	.338	.225
20.000–21.999	.158	.105	.375	.250
22.000–23.999	.173	.115	.413	.275

TABLE 12.3 Width and Depth—Square, Rectangular, Hexagonal and Octagonal TubeEXCEPT FOR T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPER^⑦

SPECIFIED WIDTH OR DEPTH in.	TOLERANCE ^② —in. plus and minus				
	ALLOWABLE DEVIATION OF WIDTH OR DEPTH AT CORNERS FROM SPECIFIED WIDTH OR DEPTH		ALLOWABLE DEVIATION OF WIDTH OR DEPTH NOT AT CORNERS FROM SPECIFIED WIDTH OR DEPTH ^④		
	 Difference between AA and specified width or depth		 Difference between AA and specified width, depth, or distance across flats		
	SQUARE, RECTANGULAR		SQUARE HEXAGONAL, OCTAGONAL		RECTANGULAR
Col. 1	Col. 2		Col. 3		Col. 4
	5xxx ≥ 4.0 nominal Mg ^⑮	Other Alloys	5xxx ≥ 4.0 nominal Mg ^⑮	Other Alloys	All Alloys
0.500–0.749	.018	.012	.030	.020	The tolerance for the width is the value in the previous column for a dimension equal to the depth, and conversely, but in no case is the tolerance less than at the corners. Example: The width tolerance of a 1 x 3 inch alloy 6061 rectangular tube is ± 0.025 inch and the depth tolerance ± 0.035 inch.
0.750–0.999	.021	.014	.030	.020	
1.000–1.999	.027	.018	.038	.025	
2.000–3.999	.038	.025	.053	.035	
4.000–4.999	.053	.035	.068	.045	
5.000–5.999	.068	.045	.083	.055	
6.000–6.999	.083	.055	.098	.065	
7.000–7.999	.098	.065	.108	.075	
8.000–8.999	.113	.075	.123	.085	
9.000–9.999	.128	.085	.143	.095	
10.000–10.999	.143	.095	.158	.105	
11.000–12.999	.158	.105	.173	.115	

For all numbered footnotes, see page 35.

Aluminum Mill Products

TABLE 12.4 Wall Thickness—Round Extruded Tube

SPECIFIED WALL THICKNESS ⑥ in.	TOLERANCE ① ②—in. plus and minus								ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM MEAN WALL THICKNESS ⑤ (Eccentricity) 
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ⑤ FROM SPECIFIED WALL THICKNESS 								
	Difference between 1/2 (AA + BB) and specified wall thickness								
	OUTSIDE DIAMETER—mm								
	Under 1.250		1.250-2.999		3.000-4.999		5.000 and over		
	Col. 2		Col. 3		Col. 4		Col. 5		Col. 6
Col. 1	5xxx ≥4.0 nominal Mg ⑩	Other Alloys	5xxx ≥4.0 nominal Mg ⑩	Other Alloys	5xxx ≥4.0 nominal Mg ⑩	Other Alloys	5xxx ≥4.0 nominal Mg ⑩	Other Alloys	All Alloys
Under 0.047	.009	.006	..	..	..	..	..	..	10% of mean wall thickness with a minimum of 0.010 and a maximum of 0.060
0.047-0.061	.011	.007	.012	.008	.012	.008	.015	.010	
0.062-0.077	.012	.008	.012	.008	.014	.009	.018	.012	
0.078-0.124	.014	.009	.014	.009	.015	.010	.023	.015	
0.125-0.249	.014	.009	.014	.009	.020	.013	.030	.020	
0.250-0.374	.017	.011	.017	.011	.024	.016	.038	.025	
0.375-0.499	..	..	.023	.015	.032	.021	.053	.035	0.120
0.500-0.749	..	..	.030	.020	.042	.028	.068	.045	
0.750-0.999	..	..	..	..	.053	.035	.083	.055	
1.000-1.499	..	..	..	..	.068	.045	.098	.065	
1.500-2.000	..	..	..	..	..	..	.113	.075	
2.001-2.499	..	..	..	..	..	..	.128	.085	0.120
2.500-2.999	..	..	..	..	..	..	.143	.095	
3.000-3.499	..	..	..	..	..	..	.158	.105	
3.500-4.000	..	..	..	..	..	..	.173	.115	

TABLE 12.5 Wall Thickness—Other-Than-Round Extruded Tube

SPECIFIED WALL THICKNESS ⑥ in.	TOLERANCE ① ②—in. plus and minus							
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ③ FROM SPECIFIED WALL THICKNESS				ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM MEAN WALL THICKNESS ⑤ (Eccentricity)			
								
	Difference between $\frac{1}{2}$ (AA + BB) and specified wall thickness				Difference between AA and mean wall thickness			
	CIRCUMSCRIBING CIRCLE DIAMETER ⑩—in.							
Col. 1	Under 5.000		5.000 and over		Under 5.000		5.000 and over	
	Col. 2		Col. 3		Col. 4		Col. 5	
	5xxx≥4.0 nominal Mg ⑩	Other Alloys	5xxx≥4.0 nominal Mg ⑩	Other Alloys	All Alloys	All Alloys	All Alloys	All Alloys
Under 0.047	.008	.005	.012	.008	.005	10% of mean wall thickness with a minimum of 0.010 and a maximum of 0.060		
0.047–0.061	.009	.006	.014	.009	.007			
0.062–0.124	.011	.007	.015	.010	.010			
0.125–0.249	.012	.008	.023	.015	.015			
0.250–0.374	.017	.011	.030	.020	.025			
0.375–0.499	.021	.014	.045	.030	.030			
0.500–0.749	.038	.025	.060	.040	.040			
0.750–0.999	.053	.035	.075	.050	.050			
1.000–1.499	.068	.045	.090	.060	.060			
1.500–2.000	..	..	.105	.070	..			

For all numbered footnotes, see page 35.

TABLE 12.6 Length—Extruded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH	TOLERANCE—in. plus excepted as noted							
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH							
	STRAIGHT				COILED			
	SPECIFIED LENGTH—ft.							
in.	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50	Up thru 100	Over 100 thru 250	Over 250 thru 500	Over 500
0.500–1.249	⅛	¼	⅜	1	+5%, –0%	±10%	±15%	±20%
1.250–2.999	⅛	¼	⅜	1	..	..	..	..
3.000–7.999	⅜	⅝	⅞	1	..	..	..	..
8.000 and over	¼	⅜	½	1	..	..	..	..

TABLE 12.7 Twist ⁽¹⁾—Other-than-Round Extruded Tube

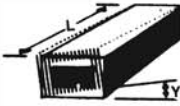
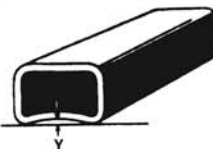
TEMPER	SPECIFIED WIDTH in.	SPECIFIED THICKNESS in.	TOLERANCE ⁽³⁾ —Degrees	
			ALLOWABLE DEVIATION FROM STRAIGHT	
			 Y (max.) in degrees	
			IN TOTAL LENGTH OR IN ANY SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
All except O, TX510, TX511 ⁽⁸⁾	0.500 thru 1.499 1.500–2.999 3.000 and over	All All All	1 × Measured length, ft. 1/2 × Measured length, ft. 1/4 × Measured length, ft.	7 5 3
O, TX510 ⁽⁸⁾	0.500 and over	0.095 and over	⁽⁷⁾	⁽⁷⁾
O, TX511 ⁽⁸⁾	0.500–1.499 1.500–2.999 3.000 and over	0.095 and over 0.095 and over 0.095 and over	1 × Measured length, ft. 1/2 × Measured length, ft. 1/4 × Measured length, ft.	7 5 3

TABLE 12.8 Straightness—Extruded Tube in Straight Lengths

TEMPER	SPECIFIED WIDTH in.	TOLERANCE ⁽⁹⁾ ⁽¹²⁾ —in.
		ALLOWABLE DEVIATION (D) FROM STRAIGHT
		 IN TOTAL LENGTH OR IN ANY SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
All except O, TX510 ⁽⁸⁾	0.500–5.999 6.000 and over	.010 × Measured length, ft. .020 × Measured length, ft.
O, TX510 ⁽⁸⁾	0.500 and over	⁽⁷⁾

TABLE 12.9 Flatness (Flat Surfaces)—Extruded Tube

EXCEPT FOR O, T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPER ⁽⁷⁾

MINIMUM THICKNESS OF METAL FORMING THE SURFACE in.	TOLERANCE—in.	
	 Maximum Allowable Deviation Y	
	WIDTHS UP THRU 1 IN. OR ANY 1 IN. INCREMENT OF WIDER SURFACES	WIDTHS OVER 1 IN. THRU 5.999 IN.
Up thru 0.187	0.006	0.006 × W (inches)
0.188 and over	0.004	0.004 × W (inches)

For all numbered footnotes, see page 35.

Aluminum Mill Products

TABLE 12.10 Squareness of Cut Ends—Extruded Tube

Allowable deviation from square: 1 degree.

TABLE 12.11 Corner and Fillet Radii—Extruded Tube

SPECIFIED RADIUS ^⑧ in.	TOLERANCE—in.
	ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
	
Sharp corners	+1/64
0.016–0.187	±1/64
0.188 and over	±10%

TABLE 12.12 Angularity—Extruded Tube

Allowable deviation from square: ±2 degrees.

TABLE 12.13 Surface Roughness ^⑭ ^⑰—Extruded Tube

Specified Outside Diameter in.	Specified Wall Thickness in.	Allowable Depth of Conditions ^⑮ in., max.
Up thru 12.750	Up thru 0.063	0.0025
	0.064–0.125	0.003
	0.126–0.188	0.0035
	0.189–0.250	0.004
	0.251–0.500	0.005
12.751–15.000	0.501 and over	0.008
	Up thru 0.500	0.010
15.001–20.000	0.501 and over	0.012
	Up thru 0.500	0.015
20.001 and over	0.501 and over	0.015
	Up thru 0.500	0.020

TABLE 12.14 Dents ^⑮—Extruded Tube

Depth of dents shall not exceed twice the tolerances specified in Table 12.2 for diameter at any point from specified diameter, except for tube having a wall thickness less than 2.5 percent of the outside diameter, in which case the following multipliers apply:

2% to 2½% exclusive—2.5 × tolerance (max.)
 1½% to 2% exclusive—3.0 × tolerance (max.)
 1% to 1½% exclusive—4.0 × tolerance (max.)

Footnotes for Tables 12.2 through 12.14

- ① When outside diameter, inside diameter, and wall thickness (or their equivalent dimensions in other than round tube) are all specified, standard tolerances are applicable to any two of these dimensions, but not to all three. When both outside and inside diameters or inside diameter and wall thickness are specified, the tolerance applicable to the specified or calculated O.D. dimension shall also apply to the I.D. dimension.
- ② When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applied to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.
- ③ Mean diameter is the average of two diameter measurements taken at right angles to each other at any point along the length.
- ④ Not applicable in the annealed (O) temper or if wall thickness is less than 2½ percent of outside diameter of a circle having a circumference equal to the perimeter of the tube.
- ⑤ The mean wall thickness of round tube is the average of two measurements taken opposite each other. The mean wall thickness of other-than-round tube is the average of two measurements taken opposite each other at approximate center line of tube and perpendicular to the longitudinal axis of the cross section.
- ⑥ When dimensions specified are outside and inside, rather than wall thickness itself, allowable deviation at any point (eccentricity) applies to mean wall thickness.
- ⑦ Tolerances for O, T3510, T4510, T6510, T73510, T76510 and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.
- ⑧ TX510 and TX511 are general designations for the following stress-relieved tempers: T3510, T4510, T6510, T8510, T73510, T76510; and T3511, T4511, T6511, T8511, T73511, T76511, respectively.
- ⑨ When weight of piece on flat surface minimizes deviation.
- ⑩ The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the cross section of the extruded product.

- ⑪ Twist is normally measured by placing the extruded tube on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the extruded tube and the flat surface. From this measurement, the actual deviation from straightness of the extruded tube at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
¼	0.004
½	0.009
1	0.017
1½	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

- ⑫ Tolerances not applicable to TX510, or TX511 temper tube having a wall thickness less than 0.095 in.
- ⑬ Conditions include die lines, mandrel lines and handling marks.
- ⑭ For tube over 12.750 in. O.D. the 2000 and 7000 series alloys and 5000 series alloys with nominal magnesium content of 3 percent or more are excluded.
- ⑮ Not applicable to O temper tube.
- ⑯ Tolerances apply to 5xxx alloys with ≥4.0% Mg.
- ⑰ Not applicable to 2219 alloy tube. Most tubes in 2219 alloy will have die lines about twice the depth shown in the table; however, for each tube size the supplier should be contacted for the roughness value to apply.
- ⑱ If unspecified, the radius shall be ½ in. maximum including tolerances.

*Table 12.15 intentionally blank***TABLE 12.16 Outside Diameter—Extruded Coiled Tube**

SPECIFIED OUTSIDE DIAMETER in.	TOLERANCE—in. plus and minus	
	ALLOWABLE DEVIATION OF MEAN DIAMETER FROM SPECIFIED DIAMETER	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER
0.250–0.625	0.004	0.006

TABLE 12.17 Wall Thickness—Extruded Coiled Tube

SPECIFIED WALL THICKNESS, in.	TOLERANCE—in. plus and minus	
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS FROM SPECIFIED WALL THICKNESS	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS
0.032–0.050	0.003	0.004

TABLE 12.18 Coil Length ^①—Extruded Coiled Tube

PERCENT OF COILS IN SHIPMENT	RANGE OF LENGTH
70 min. 30 max.	80 to 120 percent of nominal 60 to 80 percent of nominal

^① Coil size shall be as agreed upon between supplier and purchaser.

Table 12.19 intentionally blank

Aluminum Mill Products

TABLE 12.20 Diameter—Drawn Round Tube

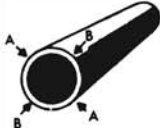
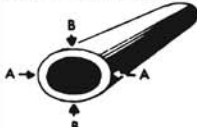
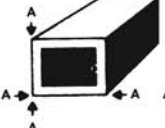
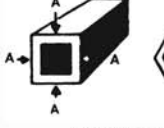
SPECIFIED DIAMETER in.	TOLERANCE ②—in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN DIAMETER ③ FROM SPECIFIED DIAMETER (Size)	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER ④		
				
	Difference between $\frac{1}{2}(AA + BB)$ and specified diameter	Difference between AA or BB and specified diameter		
Col. 1	Col. 2	NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ⑤	ANNEALED TUBE
Up thru 0.500	.003	.003	.006	.018
0.501–1.000	.004	.004	.008	.024
1.001–2.000	.005	.005	.010	.030
2.001–3.000	.006	.006	.012	.036
3.001–5.000	.008	.008	.016	.048
5.001–6.000	.010	.010	.020	.060
6.001–8.000	.015	.015	.030	.090
8.001–10.000	.020	.020	.040	.120
10.001–12.000	.025	.025	.050	.150

TABLE 12.21 Width and Depth—Drawn Square, Rectangular, Hexagonal and Octagonal Tube

SPECIFIED WIDTH OR DEPTH ① in.	TOLERANCE ②—in. plus and minus		
	ALLOWABLE DEVIATION OF WIDTH OR DEPTH AT CORNERS FROM SPECIFIED WIDTH OR DEPTH	ALLOWABLE DEVIATION OF WIDTH OR DEPTH NOT AT CORNERS FROM SPECIFIED WIDTH OR DEPTH ④ ⑦	
			
	Difference between AA and specified width or depth	Difference between AA and specified width, depth, or distance across flats	
	SQUARE, RECTANGULAR	SQUARE, HEXAGONAL, OCTAGONAL	RECTANGULAR
Col. 1	Col. 2	Col. 3	Col. 4
Up thru 0.500	.003	.006	The tolerance for the width is the value in Col. 3 for the dimension equal to the depth, and conversely, but in no case is the tolerance less than at the corners. ⑥
0.501–1.000	.004	.008	
1.001–2.000	.005	.010	
2.001–3.000	.006	.012	
3.001–5.000	.008	.016	
5.001–6.000	.010	.020	
6.001–8.000	.015	.030	
8.001–10.000	.020	.040	
10.001–12.000	.025	.050	

Footnotes for Tables 12.20 and 12.21

① When outside diameter, inside diameter, and wall thickness (or their equivalent dimensions in other than round tube) are all specified, standard tolerances are applicable to any two of these dimensions, but not to all three. When both outside and inside diameters or inside diameter and wall thickness are specified, the tolerance applicable to the specified or calculated O.D. dimension shall also apply to the I.D. dimension.

② When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance of the dimension under consideration.

③ Mean diameter is the average of two diameter measurements taken at right angles to each other at the same longitudinal location on the tube.

④ Not applicable to coiled tube or tube having a wall thickness less than 2½ percent of the specified outside diameter. The tolerance for tube with wall thickness less than 2½ percent of the specified outside diameter is determined by multiplying the applicable tolerance in columns 3 thru 5 as follows:

2% to 2½% exclusive—1.5 × tolerance

1½% to 2% exclusive—2.0 × tolerance

1% to 1½% exclusive—3.0 × tolerance

½% to 1% exclusive—4.0 × tolerance

⑤ For the T8 tempers of 6063 the tolerance in Column 3 apply.

⑥ Example: The width tolerance of 1 × 3 inch rectangular tube is plus and minus 0.008 inch, and the depth tolerance is plus and minus 0.012 in.

⑦ Not applicable to annealed (O temper) tube.

Dimensional Tolerances for

TABLE 12.22 Diameter—Drawn Oval, Elliptical and Streamline Tube

EQUIVALENT ROUND DIAMETER ^⑤ in.	TOLERANCE ^① ^② —in.			
	LENGTH OF MAJOR AXIS, in.		LENGTH OF MAJOR AXIS, in.	
	Difference between AA and specified length		Difference between AA and specified length	
Col. 1	Col. 2		Col. 3	
Up thru 2.500	+ .040	− .025	+ .025	− .015
2.501–4.250	+ .050	− .035	+ .035	− .025
4.251–6.000	+ .070	− .050	+ .055	− .040
6.001–8.000	+ .100	− .085	+ .080	− .060
8.001–10.000	+ .160	− .140	+ .115	− .085

TABLE 12.23 Corner Radii—Drawn Tube

SPECIFIED ^⑦ RADIUS in.	TOLERANCE ^② —in.
	ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
	Difference between radius A and specified radius
Sharp Corners	+ $\frac{1}{32}$
0.016–0.187	± $\frac{1}{64}$
0.188 and over	± 10%

TABLE 12.24 Wall Thickness—Drawn Round and Other-Than-Round Tube

SPECIFIED THICKNESS ^④ in.	TOLERANCE ^① ^② —in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ^③ FROM SPECIFIED WALL THICKNESS		ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS (Eccentricity)	
	Difference between $\frac{1}{2}(AA+BB)$ and specified wall thickness		ROUND, NON-HEAT- TREATABLE ALLOYS ^⑥	ROUND, HEAT-TREATABLE ALLOYS AND OTHER THAN ROUND, ALL ALLOYS
	Col. 2		Col. 3	Col. 4
0.010–0.035	.002		.002	Plus and minus 10% of specified wall thickness, min ±0.003
0.036–0.049	.003		.003	
0.050–0.083	.004		.004	
0.084–0.120	.005		.006	
0.121–0.203	.006		.008	
0.204–0.300	.008		.012	
0.301–0.375	.015		.020	
0.376–0.500	.020		.030	

Footnotes for Tables 12.22 Through 12.24

① When outside diameter, inside diameter, and wall thickness (or their equivalent dimensions in other-than-round tube) are all specified, standard tolerances are applicable to any two of these dimensions, but not to all three. When both outside and inside diameters or inside diameter and wall thickness are specified, the tolerance applicable to the specified or calculated O.D. dimension shall also apply to the I.D. dimension.

② When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

③ The mean wall thickness of round tube is the average of two measurements taken opposite each other. The mean wall thickness of other-than-round tube is the average of two measurements taken opposite each other at approximate center line of tube and perpendicular to the longitudinal axis of the cross section.

④ When dimensions specified are outside and inside, rather than wall thickness itself, allowable deviation at any point (eccentricity) is plus and minus 10 percent of the mean wall thickness but not less than ±0.003 inch.

⑤ Equivalent round diameter is the diameter of the circle having a circumference equal to the perimeter of the tube.

⑥ For coiled tube, values in Column 4 apply.

⑦ If unspecified, the radius shall be $\frac{1}{32}$ in. maximum including tolerances.

Aluminum Mill Products

TABLE 12.25 Straightness—Drawn Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE ① ②—in.
	ALLOWABLE DEVIATION FROM STRAIGHT
	 D(max) IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
Up thru 0.374	.500 × Measured length, ft.
0.375–5.999	.010 × Measured length, ft.
6.000 and over	.020 × Measured length, ft.

TABLE 12.26 Twist ④—Drawn Tube

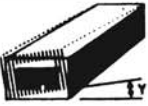
SPECIFIED WIDTH in.	TOLERANCE ① ②—Degree	MAXIMUM FOR TOTAL LENGTH
	ALLOWABLE DEVIATION FROM STRAIGHT	
	 Y (max) in degrees IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	
Up thru 1.499	1 × Measured length, ft.	7
1.500–2.999	½ × Measured length, ft.	5
3.000 and over	¼ × Measured length, ft.	3

TABLE 12.27 Length—Drawn Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE—in. plus except as noted							
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH							
	STRAIGHT				COILED			
	SPECIFIED LENGTH—ft.							
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50	Up thru 100	Over 100 to 250	250 to 500	500 and over
Up thru 0.249	¼	⅜	½	..	+5%, -0%	±10%	±15%	±20%
0.250-1.249	⅛	¼	⅜	1	+5%, -0%	±10%	±15%	±20%
1.250-2.999	⅛	¼	⅜	1	..	..	..	..
3.000-7.999	⅜	⅜	⅜	1	..	..	..	..
8.000 and over	¼	⅜	½	1	..	..	..	..

TABLE 12.28 Flatness (Flat Surfaces)—
Other-Than-Round Drawn Tube

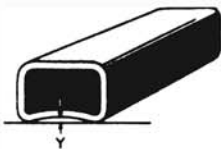
SPECIFIED WIDTH OR DEPTH in.	TOLERANCE ③—in.
	ALLOWABLE DEVIATION FROM FLAT
	 Maximum allowable distance Y
Up thru 0.500	.003
0.501–1.000	.004
1.001–2.000	.005
2.001–3.000	.006
3.001–5.000	.008
5.001–6.000	.010
6.001–8.000	.015
8.001–10.000	.020
10.001–12.000	.025

TABLE 12.30 Angularity—Drawn Tube

Allowable deviation from specified angle: ±2 degrees
--

Footnotes for Tables 12.25 Through 12.30

- ① Tolerance is applicable when weight of tube on flat surface minimizes deviation.
- ② Not applicable to annealed (O temper) tube.
- ③ Not applicable to annealed (O temper) tube, coiled tube, or tube having a wall thickness less than 0.020 inch or less than 2½% of the equivalent round diameter. Equivalent round diameter is the diameter of a circle having a circumference equal to the perimeter of the tube.
- ④ Twist is normally measured by placing the drawn tube on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the drawn tube and the flat surface. From this measurement, the actual deviation from straightness of the drawn tube at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
¼	0.004
½	0.009
1	0.017
1½	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

TABLE 12.29 Squareness of Cut Ends—
Drawn Tube

Allowable deviation from square: 1 degree

**TABLE 12.31 Surface Roughness—
Drawn Tube ②**

Depth of surface conditions shall not exceed 10% of the smaller (or nominal) wall thickness or 0.005 inch, whichever is smaller.

② Not applicable to annealed (O temper) tube.

TABLE 12.32 Dents—Drawn Tube

SPECIFIED DIAMETER in.	TOLERANCES—in.		
	NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ③	ANNEALED TUBE
Col. 1	Col. 2	Col. 3	Col. 4
Up thru 0.500	.006	.012	.036
0.501–1.000	.008	.016	.048
1.001–2.000	.010	.020	.060
2.001–3.000	.012	.024	.072
3.001–5.000	.016	.032	.096
5.001–6.000	.020	.040	.120
6.001–8.000	.030	.060	.180
8.001–10.000	.040	.080	.240
10.001–12.000	.050	.100	.300

For tube having a wall thickness less than 2½ percent of the outside diameter, the following multipliers of the above tolerances apply.

Percent of Wall Thickness

- 2% to 2.5% exclusive—1.25 × tolerance (max.)
- 1.5% to 2% exclusive—1.50 × tolerance (max.)
- 1% to 1.5% exclusive—2.0 × tolerance (max.)
- 0.5% to 1% exclusive—2.5 × tolerance (max.)

③ For the T8 tempers of 6063 the tolerances of Column 2 apply.

Table 12.33 intentionally blank

**TABLE 12.34 Outside Diameter Tolerances—
Heat-Treatable Heat Exchanger
Tube**

SPECIFIED OUTSIDE DIAMETER, in.	TOLERANCE ① in. plus and minus
Up thru 0.500	.003
0.501–1.000	.004
1.001–1.500	.005
1.501–2.000	.006

**TABLE 12.35 Outside Diameter Tolerances—
Non-Heat-Treatable Heat
Exchanger Tube**

SPECIFIED OUTSIDE DIAMETER, in.	TOLERANCE ① in. plus and minus
Up thru 0.500	.002
0.501–0.749	.0025
0.750–1.000	.003
1.001–1.250	.0035
1.251–2.000	.004

**TABLE 12.36 Wall Thickness Tolerances—
Heat Exchanger Tube**

SPECIFIED WALL THICKNESS, in.	TOLERANCE—in. plus	
	ALLOWABLE DEVIATION OF MEAN ② WALL THICKNESS FROM SPECIFIED WALL THICKNESS	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS (Eccentricity)
Up thru 0.035	.004	.006
0.036–0.049	.006	.009
0.050–0.058	.007	.010
0.059–0.065	.008	.012
0.066–0.072	.009	.013
0.073–0.083	.010	.015
0.084–0.095	.011	.017
0.096–0.109	.013	.020
0.110–0.120	.014	.022
0.121–0.134	.016	.024
0.135–0.145	.017	.026
0.146–0.154	.018	.028
0.155–0.179	.021	.032
0.180–0.200	.024	.036

**TABLE 12.37 Length Tolerances—Heat
Exchanger Tube**

SPECIFIED LENGTH	TOLERANCE—in. plus
Up thru 15	⅜
Over 15–20	⅜
Over 20–30	⅜
Over 30–60	⅜

**TABLE 12.38 Straightness Tolerances—Heat
Exchanger Tube**

SPECIFIED OUTSIDE DIAMETER in.	TOLERANCE ③—in.
	ALLOWABLE DEVIATION FROM STRAIGHT
	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
0.375–2.000	.010 × Measured length, ft.

**TABLE 12.39 Squareness of Cut Ends—Heat
Exchanger Tube**

Allowable deviation from square: 1 degree

Footnotes for Tables 12.34 Through 12.39

① As measured by use of "go" or "no go" ring gages.

② Mean wall thickness is the average of two measurements taken opposite each other.

③ Tolerance is applicable when weight of tube on flat surface minimizes deviation.

Table 12.40 intentionally blank

Aluminum Mill Products
Welded Tube

ANSI H35.2-2013

TABLE 12.41 Diameter Tolerances—Welded Round Tube

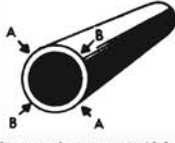
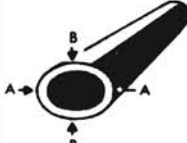
SPECIFIED DIAMETER ① in.	TOLERANCE ①—in. plus and minus	
	ALLOWABLE DEVIATION OF MEAN DIAMETER ② FROM SPECIFIED DIAMETER (Size)	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER
	 Difference between $\frac{1}{2}(AA+BB)$ and specified diameter	 Difference between AA or BB and specified diameter
Col. 1	Col. 2	Col. 3
0.500–1.000	.004	.008
1.001–2.000	.005	.010

TABLE 12.42 Width and Depth Tolerances—
Welded Square Tube

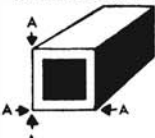
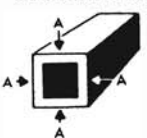
SPECIFIED WIDTH OR DEPTH in.	TOLERANCE ①—in. plus and minus	
	ALLOWABLE DEVIATION OF WIDTH OR DEPTH AT CORNERS FROM SPECIFIED WIDTH OR DEPTH	ALLOWABLE DEVIATION OF WIDTH OR DEPTH NOT AT CORNERS FROM SPECIFIED WIDTH OR DEPTH
	 Difference between AA and specified width or depth	 Difference between AA and specified width or depth
Col. 1	Col. 2	Col. 3
0.501–1.000	.005	.008
1.001–2.000	.006	.010

TABLE 12.43 Wall Thickness Tolerances—
Welded Round and Square Tube

SPECIFIED THICKNESS in.	TOLERANCE ③—in. plus
	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS
	
0.025–0.041	.004
0.042–0.071	.005

Footnotes for Tables 12.41 Through 12.43

① When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimension permissible under the tolerance for the dimension under consideration.

② Mean diameter is the average of two diameter measurements taken at right angle to each other at any point along the length.

③ Not applicable to the weld area or to embossed tube.

TABLE 12.44 Length Tolerances—Welded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE—in.					
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH					
	SPECIFIED LENGTH—ft.					
	Up thru 12		Over 12 thru 20		Over 20 thru 40	
	Plus	Minus	Plus	Minus	Plus	Minus
Up thru 2.000	1/8	0	1/4	0	3/8	0

TABLE 12.45 Straightness Tolerances—Welded Tube

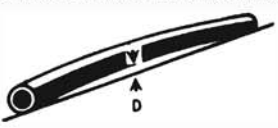
SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE ①—in.	
	ALLOWABLE DEVIATION FROM STRAIGHT	
		
	D(max)	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	
0.501–1.000	.030 × Measured length, ft.	
1.001–2.000	.040 × Measured length, ft.	

TABLE 12.46 Twist ② Tolerances—Welded Tube

SPECIFIED WIDTH in.	TOLERANCE ①—Degrees	
	ALLOWABLE DEVIATION FROM STRAIGHT	
		
	Y (max) in degrees	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	
Up thru 1.500	1 × Measured length, ft.	
1.501–2.000	1/2 × Measured length, ft.	

TABLE 12.47 Squareness of Cut Ends—Welded Tube

Allowable deviation from square: 1 degree

Footnotes for Tables 12.44 Through 12.47

① Tolerance is applicable when weight of tube on flat surface minimizes deviation.

② Twist is normally measured by placing the welded tube on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the welded tube and the flat surface. From this measurement, the actual deviation from straightness of the welded tube at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
1/4	0.004
1/2	0.009
1	0.017
1 1/2	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

Table 12.48 intentionally blank

Aluminum Mill Products

Extruded Pipe or Extruded and Drawn Pipe

TABLE 12.49 Outside Diameter Tolerances—Extruded Pipe or Extruded and Drawn Pipe

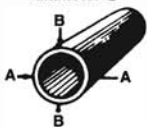
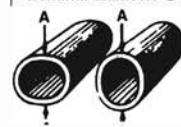
NOMINAL PIPE SIZE ⑦ ⑧	TOLERANCE—in.	
	Allowable deviation of mean ② diameter from nominal diameter ①	Allowable deviation of diameter at any point from nominal diameter ①
	 Difference between $\frac{1}{2}(AA+BB)$ and nominal diameter SCHEDULES 5 AND 10	 Difference between AA and nominal diameter SCHEDULE 20 AND GREATER
Under 2	+ .015–.031	+ .015–.031
2–4	+ .031–.031	+ 1%–1%
5–6	+ .062–.031	+ 1%–1%
8–12	+ .093–.031	+ 1%–1%

TABLE 12.50 Wall Thickness Tolerances—Extruded Pipe or Extruded and Drawn Pipe

SCHEDULE NUMBER	TOLERANCE
	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM NOMINAL ① WALL THICKNESS
5 and 10 20 and greater	$\pm 12.5\%$, ± 0.12 in. min. –12.5% ③

TABLE 12.51 Weight Tolerances—Extruded Pipe or Extruded and Drawn Pipe

SCHEDULE NUMBER	TOLERANCE
	ALLOWABLE DEVIATION FROM THEORETICAL WEIGHT
5 and 10 20 and greater	⑤ +8% ⑥

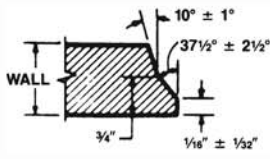
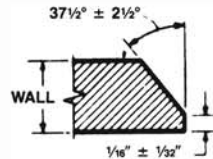
TABLE 12.52 Length Tolerances—Extruded Pipe or Extruded and Drawn Pipe

SPECIFIED LENGTH	TOLERANCE in. plus
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH
ft.	
Up thru 20	0.25
Over 20 thru 40	0.50

TABLE 12.53 Straightness Tolerances—Extruded Pipe or Extruded and Drawn Pipe

NOMINAL PIPE SIZE ⑦ ⑧	TOLERANCE ④—in.
	ALLOWABLE DEVIATION FROM STRAIGHT
	 D(max) IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
Under 6	.010 × Measured length, ft.
6–12	.020 × Measured length, ft.

TABLE 12.54 Standard Welding Bevels—Extruded Pipe or Extruded and Drawn Pipe

DOUBLE LEVEL For Wall Thickness Over 0.750 in.	STRAIGHT BEVEL For Wall Thickness 0.750 in. and Less
	

Footnotes for Tables 12.49 Through 12.54

- ① Nominal diameter and wall thickness are those listed in Table 12.55.
 ② Mean diameter is the average of any two diameter measurements taken at right angles to each other at any point along the length.
 ③ Maximum wall thickness is controlled by weight tolerance.

- ④ When weight of pipe on flat surface minimizes deviation.
 ⑤ For schedule 5 and 10, only diameter, wall thickness and length tolerances apply.
 ⑥ Minimum weight is controlled by tolerances for outside diameter and wall thickness.
 ⑦ In accordance with ANSI/ASME Standards B36.10 M and B36.19M.
 ⑧ Nominal Pipe Size (NPS) is a dimensionless designator and is the customary unit used to describe pipe size.

TABLE 12.55 Diameters, Wall Thicknesses, Weights—Pipe

NOMINAL PIPE SIZE ① ③	SCHEDULE NUMBER	OUTSIDE DIAMETER in.			INSIDE DIAMETER in.	WALL THICKNESS in.			WEIGHT PER FOOT lb.	
		Nom. ①	Min ② ④	Max. ② ④	Nom.	Nom. ①	Min ②	Max. ②	Nom. ③	Max. ② ③
⅝	40	0.405	0.374	0.420	0.269	0.068	0.060	..	0.085	0.091
	80	0.405	0.374	0.420	0.215	0.095	0.083	..	0.109	0.118
¾	40	0.540	0.509	0.555	0.364	0.088	0.077	..	0.147	0.159
	80	0.540	0.509	0.555	0.302	0.119	0.104	..	0.185	0.200
⅞	40	0.675	0.644	0.690	0.493	0.091	0.080	..	0.196	0.212
	80	0.675	0.644	0.690	0.423	0.126	0.110	..	0.256	0.276
1	5	0.840	0.809	0.855	0.710	0.065	0.053	0.077	0.186	..
	10	0.840	0.809	0.855	0.674	0.083	0.071	0.095	0.232	..
	40	0.840	0.809	0.855	0.622	0.109	0.095	..	0.294	0.318
	80	0.840	0.809	0.855	0.546	0.147	0.129	..	0.376	0.406
	160	0.840	0.809	0.855	0.464	0.188	0.164	..	0.453	0.489
1½	5	1.050	1.019	1.065	0.920	0.065	0.053	0.077	0.237	..
	10	1.050	1.019	1.065	0.884	0.083	0.071	0.095	0.297	..
	40	1.050	1.019	1.065	0.824	0.113	0.099	..	0.391	0.422
	80	1.050	1.019	1.065	0.742	0.154	0.135	..	0.510	0.551
	160	1.050	1.019	1.065	0.612	0.219	0.192	..	0.672	0.726
2	5	1.315	1.284	1.330	1.185	0.065	0.053	0.077	0.300	..
	10	1.315	1.284	1.330	1.097	0.109	0.095	0.123	0.486	..
	40	1.315	1.284	1.330	1.049	0.133	0.116	..	0.581	0.627
	80	1.315	1.284	1.330	0.957	0.179	0.157	..	0.751	0.811
	160	1.315	1.284	1.330	0.815	0.250	0.219	..	0.984	1.062
2½	5	1.660	1.629	1.675	1.530	0.065	0.053	0.077	0.383	..
	10	1.660	1.629	1.675	1.442	0.109	0.095	0.123	0.625	..
	40	1.660	1.629	1.675	1.380	0.140	0.122	..	0.786	0.849
	80	1.660	1.629	1.675	1.278	0.191	0.167	..	1.037	1.120
	160	1.660	1.629	1.675	1.160	0.250	0.219	..	1.302	1.407
3	5	1.900	1.869	1.915	1.770	0.065	0.053	0.077	0.441	..
	10	1.900	1.869	1.915	1.682	0.109	0.095	0.123	0.721	..
	40	1.900	1.869	1.915	1.610	0.145	0.127	..	0.940	1.015
	80	1.900	1.869	1.915	1.500	0.200	0.175	..	1.256	1.357
	160	1.900	1.869	1.915	1.338	0.281	0.246	..	1.681	1.815
3½	5	2.375	2.344	2.406	2.245	0.065	0.053	0.077	0.555	..
	10	2.375	2.344	2.406	2.157	0.109	0.095	0.123	0.913	..
	40	2.375	2.351	2.399	2.067	0.154	0.135	..	1.264	1.365
	80	2.375	2.351	2.399	1.939	0.218	0.191	..	1.737	1.876
	160	2.375	2.351	2.399	1.687	0.344	0.301	..	2.581	2.788
4	5	2.875	2.844	2.906	2.709	0.083	0.071	0.095	0.856	..
	10	2.875	2.844	2.906	2.635	0.120	0.105	0.135	1.221	..
	40	2.875	2.846	2.904	2.469	0.203	0.178	..	2.004	2.164
	80	2.875	2.846	2.904	2.323	0.276	0.242	..	2.650	2.862
	160	2.875	2.846	2.904	2.125	0.375	0.328	..	3.464	3.741
5	5	3.500	3.469	3.531	3.334	0.083	0.071	0.095	1.048	..
	10	3.500	3.469	3.531	3.260	0.120	0.105	0.135	1.498	..
	40	3.500	3.465	3.535	3.068	0.216	0.189	..	2.621	2.830
	80	3.500	3.465	3.535	2.900	0.300	0.262	..	3.547	3.830
	160	3.500	3.465	3.535	2.624	0.438	0.383	..	4.955	5.351
6	5	4.000	3.969	4.031	3.834	0.083	0.071	0.095	1.201	..
	10	4.000	3.969	4.031	3.760	0.120	0.105	0.135	1.720	..
	40	4.000	3.960	4.040	3.548	0.226	0.198	..	3.151	3.403
	80	4.000	3.960	4.040	3.364	0.318	0.278	..	4.326	4.672

For all numbered footnotes, see page 45.

Aluminum Mill Products

TABLE 12.55 Diameters, Wall Thicknesses, Weights—Pipe (concluded)

NOMINAL PIPE SIZE ① ⑤	SCHEDULE NUMBER	OUTSIDE DIAMETER in.			INSIDE DIAMETER in.	WALL THICKNESS in.			WEIGHT PER FOOT lb.	
		Nom. ①	Min ② ④	Max. ② ④		Nom. ①	Min ②	Max. ②	Nom. ③	Max. ② ③
4	5	4.500	4.469	4.531	4.334	0.083	0.071	0.095	1.354	..
	10	4.500	4.469	4.531	4.260	0.120	0.105	0.135	1.942	..
	40	4.500	4.455	4.545	4.026	0.237	0.207	..	3.733	4.031
	80	4.500	4.455	4.545	3.826	0.337	0.295	..	5.183	5.598
	120	4.500	4.455	4.545	3.624	0.438	0.383	..	6.573	7.099
	160	4.500	4.455	4.545	3.438	0.531	0.465	..	7.786	8.409
5	5	5.563	5.532	5.625	5.345	0.109	0.095	0.123	2.196	..
	10	5.563	5.532	5.625	5.295	0.134	0.117	0.151	2.688	..
	40	5.563	5.507	5.619	5.047	0.258	0.226	..	5.057	5.461
	80	5.563	5.507	5.619	4.813	0.375	0.328	..	7.188	7.763
	120	5.563	5.507	5.619	4.563	0.500	0.438	..	9.353	10.10
	160	5.563	5.507	5.619	4.313	0.625	0.547	..	11.40	12.31
6	5	6.625	6.594	6.687	6.407	0.109	0.095	0.123	2.624	..
	10	6.625	6.594	6.687	6.357	0.134	0.117	0.151	3.213	..
	40	6.625	6.559	6.691	6.065	0.280	0.245	..	6.564	7.089
	80	6.625	6.559	6.691	5.761	0.432	0.378	..	9.884	10.67
	120	6.625	6.559	6.691	5.501	0.562	0.492	..	12.59	13.60
	160	6.625	6.559	6.691	5.187	0.719	0.629	..	15.69	16.94
8	5	8.625	8.594	8.718	8.407	0.109	0.095	0.123	3.429	..
	10	8.625	8.594	8.718	8.329	0.148	0.130	0.166	4.635	..
	20	8.625	8.539	8.711	8.125	0.250	0.219	..	7.735	8.354
	30	8.625	8.539	8.711	8.071	0.277	0.242	..	8.543	9.227
	40	8.625	8.539	8.711	7.981	0.322	0.282	..	9.878	10.67
	60	8.625	8.539	8.711	7.813	0.406	0.355	..	12.33	13.31
	80	8.625	8.539	8.711	7.625	0.500	0.438	..	15.01	16.21
	100	8.625	8.539	8.711	7.437	0.594	0.520	..	17.62	19.03
	120	8.625	8.539	8.711	7.187	0.719	0.629	..	21.00	22.68
	140	8.625	8.539	8.711	7.001	0.812	0.710	..	23.44	25.31
	160	8.625	8.539	8.711	6.813	0.906	0.793	..	25.84	27.90
10	5	10.750	10.719	10.843	10.482	0.134	0.117	0.151	5.256	..
	10	10.750	10.719	10.843	10.420	0.165	0.144	0.186	6.453	..
	20	10.750	10.642	10.858	10.250	0.250	0.219	..	9.698	10.47
	30	10.750	10.642	10.858	10.136	0.307	0.269	..	11.84	12.79
	40	10.750	10.642	10.858	10.020	0.365	0.319	..	14.00	15.12
	60	10.750	10.642	10.858	9.750	0.500	0.438	..	18.93	20.45
	80	10.750	10.642	10.858	9.562	0.594	0.520	..	22.29	24.07
	100	10.750	10.642	10.858	9.312	0.719	0.629	..	26.65	28.78
12	5	12.750	12.719	12.843	12.438	0.156	0.136	0.176	7.258	..
	10	12.750	12.719	12.843	12.390	0.180	0.158	0.202	8.359	..
	20	12.750	12.622	12.878	12.250	0.250	0.219	..	11.55	12.47
	30	12.750	12.622	12.878	12.090	0.330	0.289	..	15.14	16.35
	40	12.750	12.622	12.878	11.938	0.406	0.355	..	18.52	20.00
	60	12.750	12.622	12.878	11.626	0.562	0.492	..	25.31	27.33
	80	12.750	12.622	12.878	11.374	0.688	0.602	..	30.66	33.11

Footnotes for Table 12.55

① In accordance with ANSI/ASME Standards B36.10M and B36.19M

② Based on standard tolerances for outside diameter, wall thickness and weight shown earlier in this section.

③ Based on nominal dimensions, plain ends, and a density of 0.098 lb per cu in., the density of 6061 alloy. For alloy 6063 multiply by 0.99 and for alloy 3003 multiply by 1.011.

④ For schedules 5 and 10 these values apply to mean outside diameters.

⑤ Nominal Pipe Size (NPS) is a dimensionless designator and is the customary unit used to describe pipe size.

13. Structural Profiles

Tolerance limits for aluminum alloy structural profiles are identical with those for other extruded profiles as shown in Section 11.

Aluminum Mill Products

14. Forging Stock

TABLE 14.1 Diameter ^①—Round Forging Stock

SPECIFIED DIAMETER in.	CLASS 1. FORGING STOCK		CLASS 2. FORGING STOCK	
	TOLERANCE in. plus and minus		SPECIFIED DIAMETER in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER	CONDITIONING ALLOWANCE ^②		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
0.375–0.500	.015	$-\frac{1}{32}$	0.375–0.500	.0015
0.501–1.000	.015	$-\frac{1}{32}$	0.501–1.000	.002
1.001–1.500	.015	$-\frac{1}{32}$	1.001–1.500	.0025
1.501–3.000	.015	$-\frac{1}{32}$	1.501–3.000	.008
3.001–5.000	.031	$-\frac{1}{16}$	..	..
5.001–8.000	.063	$-\frac{1}{16}$	..	..

TABLE 14.2 Distance Across Flats ^①—Square Forging Stock

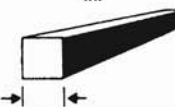
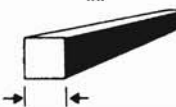
CLASS 1. FORGING STOCK			CLASS 2. FORGING STOCK		
SPECIFIED DISTANCE ACROSS FLATS in. 	TOLERANCE in. plus and minus		SPECIFIED DISTANCE ACROSS FLATS in. 	TOLERANCE in. plus and minus	
	ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS	CONDITIONING ALLOWANCE ②		ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS	
0.375–0.500	.010	– $\frac{1}{32}$ on face	0.375–0.500	.002	
0.501–1.000	.015	– $\frac{1}{32}$ on face	0.501–1.000	.0025	
1.001–2.000	.018	– $\frac{1}{32}$ on face	1.001–1.500	.003	
2.001–3.000	.020	– $\frac{1}{32}$ on face	1.501–4.000	.005	
3.001–4.000	.032	– $\frac{1}{32}$ on face	..	..	

TABLE 14.3 Thickness and Width ^①—Rectangular Forging Stock

CLASS 1. FORGING STOCK						CLASS 2. FORGING STOCK	
SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus		SPECIFIED WIDTH in.	TOLERANCE in. plus and minus		SPECIFIED THICKNESS OR WIDTH in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS	CONDITIONING ALLOWANCE ②		ALLOWABLE DEVIATION FROM SPECIFIED WIDTH	CONDITIONING ALLOWANCE ②		
							
0.375–0.500	.010	– $\frac{1}{32}$ on face	Up thru 1.500	.018	– $\frac{1}{16}$ on face	0.375–0.500	.002
0.501–1.000	.015	– $\frac{1}{32}$ on face	1.501–4.000	.030	– $\frac{1}{16}$ on face	0.501–1.000	.0025
1.001–2.000	.018	– $\frac{1}{32}$ on face	4.001–6.000	.047	– $\frac{1}{16}$ on face	1.001–1.500	.003
2.001–3.000	.020	– $\frac{1}{32}$ on face	6.001–10.000	.063	– $\frac{1}{16}$ on face	1.501–4.000	.005

TABLE 14.4 Length ^①—Specific and Multiple—Forging Stock

SPECIFIED DIAMETER, WIDTH OR DISTANCE ACROSS FLATS in.	TOLERANCE—in. plus			
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
	SPECIFIED LENGTH—ft.			
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50
Up thru 2.999	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	1
3.000–7.999	$\frac{3}{16}$	$\frac{5}{16}$	$\frac{7}{16}$	1
8.000 and over	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	1

Footnotes for Tables 14.1 and 14.4

^① These tolerances are applicable for forging stock in rod and bar form. Standard tolerances for forging stock in sheet and plate form are as indicated in the section on Sheet and Plate.

^② Conditioning allowance is an additional tolerance at localized areas to permit removal of possible surface defects.

15. Hand Forgings

Tables 15.1 and 15.2 intentionally blank

TABLE 15.3 Standard Tolerances ^① For Hand Forgings

ORDERED LENGTH in.	STRAIGHTNESS ^② in.	DIMENSIONAL TOLERANCES		
		THICKNESS in., plus	WIDTH ^③ in., plus	LENGTH in., plus
up thru 71.99	0.250	0.250	0.375	1.000
72.00–149.99	0.375	0.250	0.500	1.000
150.00 and over	0.500	0.375	0.750	1.000

^① Corner radii may vary from 0 to 0.500 inches.

^② As measured with the hand forging resting on a flat surface.

^③ Measured exclusive of edge bulges typically present on compression cold work forgings.

Aluminum Mill Products

16. Electrical Conductors

Wire, Rod, and Bar—Rolled or Cold-finished

Tables 16.1– 16.6 intentionally blank

TABLE 16.7 Diameter—Tolerances—Cold-Finished Wire—Electric Conductors

SPECIFIED DIAMETER in.	TOLERANCE in. plus and minus or percent
	ALLOWABLE DEVIATION OF MEAN ① DIAMETER FROM SPECIFIED DIAMETER
0.0100–0.0359	.0005
0.0360–0.0999	.0010
0.1000–0.2600	1%

TABLE 16.8 Diameter—Tolerances—Drawing Stock—Electric Conductors

SPECIFIED DIAMETER in.	TOLERANCE—in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
0.375–0.500	.020
0.501–1.000	.025

TABLE 16.9 Diameter—Tolerances—Magnet Wire—Electric Conductors

SPECIFIED DIAMETER in.	TOLERANCE—in. plus and minus
	ALLOWABLE DEVIATION OF MEAN ① DIAMETER FROM SPECIFIED DIAMETER
0.010	.0001
0.011–0.020	.0002
0.021–0.030	.0003
0.031–0.040	.0004
0.041–0.050	.0005
0.051–0.060	.0006
0.061–0.080	.0008
0.081–0.150	.0010
0.151–0.260	.0015

TABLE 16.10 Thickness—Tolerances—Rolled Bar—Electric Conductors

SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS
0.125–0.500	.006
0.501–0.750	.008
0.751–1.000	.012
1.001–2.000	.020

Footnotes for Tables 16.7 Through 16.14

- ① Mean diameter is the average of two measurements taken at right angles to each other at any point along the length. At least three such measurements are made, one near each end and one near the middle of the coil.
- ② Straightness shall be measured by placing the bar on a level table so that the arc or departure from straightness is horizontal. Measure the maximum depth of arc to the nearest 1/32 inch using a steel scale and a straightedge.
- ③ When weight of piece on flat surface minimizes deviation.

TABLE 16.11 Width—Tolerances—Rolled Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
0.500–1.500	.016
1.501–4.000	.032
4.001–6.000	.047
6.001–12.000	.063

TABLE 16.12 Length—Tolerances—Rolled Bar and Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE—in. plus	
	Up thru 18 ft.	Over 18 ft.
Up thru 3.499	1/4	1/4
3.500 and over	1/4	1/4

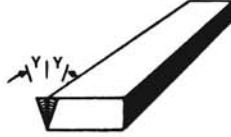
TABLE 16.13 Straightness—Tolerances—Rolled Bar and Sawed-Plate Bar—Electric Conductors

TOLERANCE ② ③—in.

D (max.) = 1/4 inch in any 5 feet of bar length

TABLE 16.14 Flatness—Tolerances—Rolled Bar and Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE—in.
	Maximum Allowable Deviation D
Up thru 1	.004
Over 1	.004 × W (inches)
In any 1 in. of width	.004

TABLE 16.15 Angularity—Rolled Bar—Electric ConductorsAllowable deviation from nominal angle: ± 1 degree.**TABLE 16.16 Squareness of Saw Cuts—Rolled Bar—Electric Conductors**

Allowable deviation from square: 1 degree.

TABLE 16.17 Corner and Edge Radii —Tolerances—Rolled Bar—Electric Conductors

	SPECIFIED EDGE CONTOUR	SPECIFIED BAR THICKNESS in.	NOMINAL RADIUS	RADIUS TOLERANCE
Square Corners		0.125–1.000 1.001 and over		$+\frac{1}{32}$ $+\frac{1}{16}$
Round Corners	Radius	0.125–0.188 0.189–1.000 1.001 and over	$\frac{1}{32}$ $\frac{1}{16}$ $\frac{1}{8}$	$\pm\frac{1}{64}$ $\pm\frac{1}{64}$ $\pm\frac{1}{64}$
Rounded Edge	Radius Blended Corners	0.125 and over	$1\frac{1}{4} \times$ Bar thickness	$\pm\frac{1}{4} \times$ Bar thickness
Full Rounded Edge	Radius	All	$\frac{1}{2} \times$ Bar thickness	$+25\%$

TABLE 16.18 Thickness —Tolerances—Sawed-Plate Bar—Electric Conductors

SPECIFIED THICKNESS in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS
0.250–0.320	.013
0.321–0.438	.019
0.439–0.625	.025
0.626–0.875	.030
0.876–1.125	.035
1.126–1.375	.040
1.376–1.625	.045
1.626–1.875	.052
1.876–2.250	.060
2.251–2.750	.075
2.751–3.000	.090

TABLE 16.19 Twist ①—Tolerances—Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE ②—DEGREES Allowable Deviation from Straight	
	 Y (max.) in degrees	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
Up thru 1.499	$1 \times$ Measured length, ft.	7
1.500–2.999	$\frac{1}{2} \times$ Measured length, ft.	5
3.000 and over	$\frac{1}{4} \times$ Measured length, ft.	3

Footnotes for Tables 16.15 Through 16.19

① Twist is normally measured by placing the bar on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the bar and the flat surface. From this measurement, the actual deviation from straightness of the bar at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
$\frac{1}{4}$	0.004
$\frac{1}{2}$	0.009
1	0.017
$1\frac{1}{2}$	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

② When weight of bar on flat surface minimizes deviation.

Aluminum Mill Products

TABLE 16.20 Width—Tolerances—Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
2.000–6.000	.094
6.001–14.000	.125

Extruded Rod and Bar

TABLE 16.22 Thickness, Width, Diameter—Tolerances—Extruded Rod and Bar—Electric Conductors

SPECIFIED THICKNESS WIDTH, OR DIAMETER in.	TOLERANCE ①—in. plus and minus
	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION
0.125–0.249	.007
0.250–0.499	.008
0.500–0.749	.009
0.750–0.999	.010
1.000–1.499	.012
1.500–1.999	.014
2.000–3.999	.024
4.000–5.999	.034
6.000–7.999	.044
8.000–9.999	.064
10.000–12.000	.074

TABLE 16.21 Corners and Edges—Sawed-Plate Bar—Electric Conductors

Edge surfaces and rough, showing saw marks, and corners are substantially square, with a slight burr.

TABLE 16.23 Length—Tolerances—Extruded Rod and Bar—Electric Conductors

SPECIFIED WIDTH in.	TOLERANCE—in. plus	
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH	
	SPECIFIED LENGTH—ft.	
	Up thru 12	Over 12 thru 30
Up thru 2.999	1/8	1/4
3.000–7.999	3/16	5/16
8.000 and over	1/4	3/8

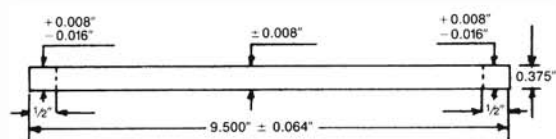
Footnotes for Tables 16.20 Through 16.23

① For some items of relatively thin wide bar greater thickness tolerances are required as follows:

- a. Specified bar thickness less than 0.500 in.; corner radii 1/16 in. or less; width to thickness ratio 24 to 1 and greater.

Tolerance per Table 16.22 except for distance 1/2 in. from each edge where plus tolerance of Table 16.22 applies and minus tolerance of 2 × Table 16.22 tolerance applies.

Example:



- b. Specified bar thickness 0.500 in. and greater; corner radii 3/16 in. or less; width to thickness ratio 10 to 1 and greater. Thickness tolerance per Table 16.22 except for distance 1/2 in. from edge where plus tolerance of Table 16.22 applies and minus tolerance 2 × Table 16.22 applies.

Dimensional Tolerances for

TABLE 16.24 Flatness (Flat Surfaces)—Tolerances—Extruded Bar—Electric Conductors

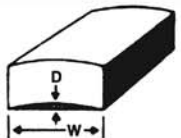
SPECIFIED WIDTH in.	TOLERANCE—in.
	 Maximum Allowable Deviation D
Up thru 1	0.004
Over 1 thru 5.999	.004 × W (inches)
In any 1 in. of width	0.004

TABLE 16.25 Twist ①—Tolerances—Extruded Bar—Electric Conductors

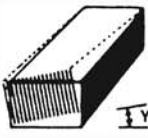
SPECIFIED WIDTH in.	TOLERANCE ②—DEGREES ALLOWABLE DEVIATION FROM STRAIGHT	
	 Y (max.) in degrees	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
Up thru 1.499	1 × Measured length, ft.	7
1.500–2.999	½ × Measured length, ft.	5
3.000 and over	¼ × Measured length, ft.	3

TABLE 16.26 Straightness ① ②—Tolerances—Extruded Rod and Bar—Electric Conductors

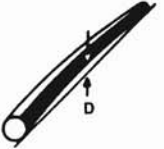
BAR	ROD	
TOLERANCE in. in any 10 ft.	SPECIFIED DIAMETER in.	TOLERANCE in.
		
Flatwise	Edgewise	D (max.)
D (max.) = ¼	D (max.) = ⅓	0.375–5.999 6.000 and over
		.010 × Measured length, ft. .020 × Measured length, ft.

TABLE 16.27 Angularity—Extruded Bar—Electric Conductors

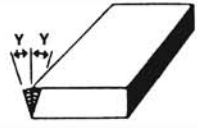
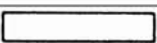
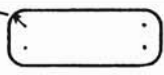
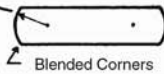
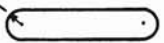

Allowable deviation from nominal angle: ±1 degree.

TABLE 16.28 Squareness of Cut Ends—Extruded Rod and Bar—Electric Conductors

Allowable deviation from square: 1 degree.
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TABLE 16.29 Corner and Edge Radii—Tolerances—Extruded Bar—Electric Conductors

	SPECIFIED EDGE CONTOUR	SPECIFIED BAR THICKNESS in.	NOMINAL RADIUS	RADIUS TOLERANCE
Square Corners		0.125–1.000 1.001 and over	..	+½ in. +⅓ in.
Round Corners	Radius 	0.125–0.188 0.189–1.000 1.001 and over	½ ⅓ ⅛	±⅓ in. ±⅓ in. ±⅓ in.
Rounded Edge	Radius  Blended Corners	Up thru 0.149 0.150 and over	1¼ × Bar thickness 1¼ × Bar thickness	±⅓ in. ±10%
Full Rounded Edge	Radius 	Up thru 0.374 0.375 and over	½ × Bar thickness ½ × Bar thickness	±1⅓ in. +10%

Footnotes for Tables 16.24 Through 16.29

① Deviation from straightness shall be checked as follows: Place the bar or rod on a level surface so that the departure from straightness is horizontal. Measure the maximum depth of arc to the nearest ½ inch using a steel scale and a 120-inch-long straightedge.

② When weight of piece on flat surface minimizes deviation.

③ Twist is normally measured by placing the bar on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the bar and the flat surface. From this measurement, the actual deviation from straightness of the bar at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerances to linear deviation:

Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
¼	0.004
½	0.009
1	0.017
1½	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

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Pipe

TABLE 16.31 Outside Diameter—Tolerances—Pipe—Electric Conductors

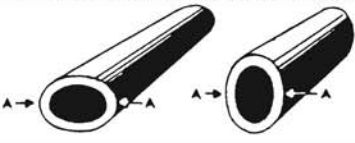
PIPE SIZE in.	TOLERANCE—in. or percent	
	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM NOMINAL DIAMETER ① ②	
	 Difference between AA and nominal diameter	
	SCHEDULE 40 or 80	
Under 2	+ .015	— .031
2–4	+ 1%	— 1%
5–7	+ 1%	— 1%
8–12	+ 1%	— 1%

TABLE 16.32 Wall Thickness—Pipe—Electric Conductors

Allowable deviation of wall thickness at any point from nominal wall thickness ①: minus 12½ percent. (Maximum wall thickness is controlled by weight tolerance.)

Footnotes for Tables 16.31 Through 16.35

- ① Nominal diameter and wall thickness are those listed in Table 12.55.
 ② Not applicable to annealed (O temper) pipe.
 ③ When weight of piece on flat surface minimizes deviation.

TABLE 16.33 Straightness—Tolerances—Pipe—Electric Conductors

PIPE SIZE in.	TOLERANCE ③—in.
	ALLOWABLE DEVIATION FROM STRAIGHT
	 D (max.)
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
Under 6	0.010 × Measured length, ft.
6–12	0.020 × Measured length, ft.

TABLE 16.34 Length—Tolerances—Pipe—Electric Conductors

Allowable deviation from specified length: plus ¼ in. Applies only in lengths 20 ft. and under.

TABLE 16.35 Weight—Pipe—Electric Conductors

Allowable deviation from theoretical weight: plus 8 percent. (Minimum weight is controlled by tolerances for outside diameter and wall thickness.)