

American National Standard Dimensional Tolerances for Aluminum Mill Products

Secretariat
The Aluminum Association
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American National Standard

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American National Standard Dimensional Tolerances for Aluminum Mill Products

Secretariat

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American National Standards Institute

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Foreword

This Standard is a revision of ANSI H35.2(M)-2009, which consists of logical values for long-term metric use rather than a restatement of ANSI H35.2 in metric terms. This latest (2013) revision consists of modification to the column headings and pipe size units for extruded and drawn pipe to harmonize with ANSI/ASME standard; clarification on tolerance calculation for wall thickness (eccentricity) of extruded tube; 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 over 10 mm.

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 0.2 millimeters (Formerly 0.15 mm, changed to 0.2 mm for international harmonization). There is an overlap in the thickness range 0.15-0.2 mm 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 Diameter" and "ANSI Schedule Numbers." (Note: Larger sizes usually greater than 25 millimetres are typically extruded while smaller sizes are typically drawn.)

Plate—A rolled product that is rectangular in cross section and with thickness over 6.3 millimetres and 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, zeos, 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 over 10 mm in diameter that is long in relation to cross section and over 10 millimetres in 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 0.15 millimeters and less than 6.3 millimeters and with slit, sheared or sawed edges. There is an overlap in the thickness range 0.15-0.2 mm 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 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 up through 10 millimetres.

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 0.050 mm	multiple of 0.005 mm
Tolerance over 0.050 mm thru 0.50 mm	multiple of 0.01 mm
Tolerance over 0.50 thru 1.00 mm	multiple of 0.02 mm
Tolerance over 1.00 mm	multiple of 0.05 mm

For measurements commonly made with instruments not permitting such accuracy, standard dimensional tolerances are expressed as follows:

Tolerance up thru 5 mm	multiple of 0.5 mm
Tolerance over 5 mm thru 50 mm	multiple of 1 mm
Tolerance over 50 mm	multiple of 5 mm

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*

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Aluminum Mill Products

7. Sheet and Plate

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7. Sheet and Plate

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, mm		SPECIFIED WIDTH—mm							
		Up thru 1 000	Over 1 000 Thru 1 500	Over 1 500 Thru 2 000	Over 2 000 Thru 2 500	Over 2 500 Thru 3 000	Over 3 000 Thru 3 500	Over 3 500 Thru 4 000	Over 4 000 Thru 4 500
Over	Thru	TOLERANCES—mm plus and minus							
0.15	0.40	0.025	0.040	..	..	..	..	..	..
0.40	0.63	0.040	0.050	0.08	0.09	..	..	..	..
0.63	0.80	0.045	0.06	0.09	0.10	..	..	..	..
0.80	1.00	0.050	0.08	0.09	0.11	0.15	..	..	..
1.00	1.20	0.06	0.09	0.11	0.14	0.18	0.20	..	..
1.20	1.60	0.08	0.09	0.13	0.15	0.18	0.23	..	..
1.60	2.00	0.09	0.10	0.14	0.18	0.20	0.25	..	..
2.00	2.50	0.09	0.11	0.15	0.18	0.23	0.28	..	..
2.50	3.20	0.11	0.14	0.18	0.23	0.28	0.33	..	..
3.20	4.00	0.14	0.18	0.23	0.28	0.33	0.38	..	..
4.00	5.00	0.18	0.23	0.28	0.33	0.38	0.46	..	..
5.00	6.30	0.23	0.28	0.33	0.38	0.46	0.56	0.69	..
6.30	8.00	0.30	0.36	0.38	0.46	0.56	0.69	0.89	1.10
8.00	10.00	0.38	0.43	0.51	0.58	0.69	0.84	1.05	1.30
10.00	16.00	0.58	0.69	0.81	0.89	1.10	1.35	1.65	..
16.00	25.00	0.79	0.94	1.10	1.20	1.45	1.80	2.15	..
25.00	40.00	1.00	1.20	1.40	1.65	1.90	2.30	2.65	..
40.00	60.00	1.40	1.55	1.80	2.45	2.55	2.90	..	..
60.00	80.00	1.90	2.15	2.55	2.65	3.20	..	..	..
80.00	100.00	2.55	2.90	3.20	3.30	4.00	..	..	..
100.00	160.00	3.30	3.70	4.20	..	..	..	..	..

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, mm		SPECIFIED WIDTH—mm											
		Up thru 1 000	Over 1 000 thru 1 200	Over 1 200 thru 1 400	Over 1 400 thru 1 500	Over 1 500 thru 1 800	Over 1 800 thru 2 000	Over 2 000 thru 2 200	Over 2 200 thru 2 500	Over 2 500 thru 3 000	Over 3 000 thru 3 500	Over 3 500 thru 4 000	Over 4 000 thru 4 500
Over	Thru	TOLERANCES—mm plus and minus											
0.15	0.25	0.035	0.06	0.06	0.06	..	..	..	..	..	..	..	..
0.25	0.40	0.040	0.07	0.07	0.07	..	..	..	..	..	..	..	..
0.40	0.63	0.040	0.07	0.07	0.07	..	..	..	..	..	..	..	..
0.63	0.80	0.040	0.040	0.06	0.08	0.08	..	..	..	..	..	..	..
0.80	1.00	0.040	0.040	0.06	0.08	0.08	0.10	0.10	0.20	..	..	..	..
1.00	1.20	0.050	0.050	0.06	0.08	0.08	0.10	0.10	0.22	0.26	0.30	..	..
1.20	1.60	0.050	0.050	0.08	0.08	0.08	0.10	0.10	0.24	0.30	0.34	..	..
1.60	2.00	0.050	0.050	0.08	0.09	0.09	0.10	0.10	0.26	0.34	0.40	..	..
2.00	2.50	0.065	0.065	0.09	0.11	0.11	0.12	0.12	0.30	0.38	0.46	..	..
2.50	3.20	0.09	0.09	0.10	0.12	0.12	0.12	0.12	0.34	0.42	0.52	..	..
3.20	4.00	0.11	0.11	0.12	0.18	0.18	0.25	0.25	0.40	0.48	0.58	..	..
4.00	5.00	0.15	0.18	0.18	0.23	0.23	0.30	0.30	0.46	0.56	0.66	..	..
5.00	6.30	0.24	0.32	0.32	0.32	0.44	0.44	0.54	0.54	0.64	0.76	..	..
6.30	8.00	0.32	0.40	0.40	0.40	0.50	0.50	0.62	0.62	0.74	0.86	1.05	1.30
8.00	10.00	0.44	0.46	0.46	0.46	0.58	0.58	0.72	0.72	0.86	1.00	1.20	1.50
10.00	16.00	0.60	0.60	0.60	0.60	0.72	0.72	0.86	0.86	1.00	1.20	1.50	1.80
16.00	25.00	0.80	0.80	0.80	0.80	0.94	0.94	1.10	1.10	1.30	1.55	1.90	2.20
25.00	40.00	1.00	1.00	1.00	1.00	1.20	1.20	1.40	1.40	1.65	1.95	2.30	2.70
40.00	60.00	1.40	1.40	1.40	1.40	1.60	1.90	1.90	2.30	2.60	3.00	..	..
60.00	80.00	2.00	2.00	2.00	2.00	2.10	2.10	2.80	2.80	3.30	3.30	..	..
80.00	100.00	2.60	2.60	2.60	2.60	2.95	2.95	3.40	3.40	3.90	4.10	..	..
100.00	160.00	3.40	3.40	3.40	3.40	3.80	3.80	4.30	4.30	..	..	..	..

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.

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TABLE 7.8 Width Tolerances—Sheared Flat Sheet and Plate

SPECIFIED THICKNESS mm		SPECIFIED WIDTH—mm						
		Up thru 250	Over 250 thru 500	Over 500 thru 1 000	Over 1 000 thru 2 000	Over 2 000 thru 3 000	Over 3 000 thru 4 000	Over 4 000 thru 5 000
Over	Thru	TOLERANCES ②—mm						
0.15	3.20	±1.5	±2	±2.5	±3	±4	±4.5	..
3.20	6.30	±2	±2.5	±3	±3.5	±4.5	±5	..
6.30	12.50	+6	+7	+8	+9	+11	+12	+14

TABLE 7.9 Length Tolerances—Sheared Flat Sheet and Plate

SPECIFIED THICKNESS mm		SPECIFIED LENGTH—mm										
		Up thru 1 000	Over 1 000 thru 2 000	Over 2 000 thru 3 000	Over 3 000 thru 4 000	Over 4 000 thru 5 000	Over 5 000 thru 7 500	Over 7 500 thru 10 000	Over 10 000 thru 12 500	Over 12 500 thru 15 000	Over 15 000 thru 17 500	Over 17 500 thru 20 000
Over	Thru	TOLERANCES ②—mm										
0.15	3.20	±2	±2.5	±3	±3	±3.5	±4.5	±5	±6	±7	±8	..
3.20	6.30	±2.5	±3	±3	±3.5	±4	±5	±6	±7	±8	±9	..
6.30	12.50	+8	+9	+10	+10	+11	+13	+14	+16	+18	+19	+21

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

SPECIFIED THICKNESS mm		SPECIFIED WIDTH AND LENGTH—mm										
		Up thru 1 000	Over 1 000 thru 2 000	Over 2 000 thru 3 000	Over 3 000 thru 4 000	Over 4 000 thru 5 000	Over 5 000 thru 7 500	Over 7 500 thru 10 000	Over 10 000 thru 12 500	Over 12 500 thru 15 000	Over 15 000 thru 17 500	Over 17 500 thru 20 000
Over	Thru	TOLERANCES ②—mm										
2.00	6.30	±3	±3	±4	±4	±5	±6	±7	±8	±9	±10	±11
6.30	160.00	+6	+7	+8	+9	+10	+12	+14	+16	+18	+20	+22

TABLE 7.11 Width Tolerances ①—Slit Coiled Sheet

SPECIFIED THICKNESS mm		SPECIFIED WIDTH—mm							
		Up thru 150	Over 150 thru 250	Over 250 thru 500	Over 500 thru 750	Over 750 thru 1 000	Over 1 000 thru 1 500	Over 1 500 thru 2 000	Over 2 000 thru 2 500
Over	Thru	TOLERANCES ②—mm plus and minus							
0.15	3.20	0.25	0.5	1	1	1	1.5	2.5	3.5
3.20	5.00	..	1	1	1	1.5	2	3	..
5.00	6.30	..	1	1	1.5	2	3	4	..

TABLE 7.12 Lateral Bow Tolerances ①—Coiled Sheet

SPECIFIED THICKNESS mm		SPECIFIED WIDTH—mm				
		12 thru 25	Over 25 thru 50	Over 50 thru 100	Over 100 thru 250	Over 250
Over	Thru	TOLERANCE—mm in 2 000 mm Allowable Deviation of a Side Edge from a Straight Line				
0.15	1.60	20	15	10	6	5
1.60	3.20	..	..	10	6	5

For all numbered footnotes, see page 12.

TABLE 7.13 Lateral Bow Tolerances—Flat Sheet and Plate

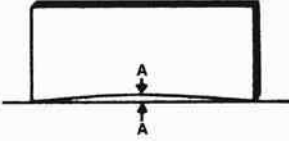
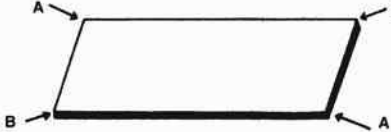
SPECIFIED THICKNESS mm		SPECIFIED WIDTH mm		ALLOWABLE DEVIATION OF A SIDE EDGE FROM A STRAIGHT LINE					
									
				Maximum allowable value of AA					
				SPECIFIED LENGTH—mm					
				Up thru 1000	Over 1000 thru 2000	Over 2000 thru 3000	Over 3000 thru 4000	Over 4000 thru 5000	Over 5000 thru 6000
Over		Thru		TOLERANCE—mm					
0.15	3.20	..	100	3	11	25	45	70	100 ⑤
		100	250	1	3.5	8	13	21	30 ⑤
		250	900	1	2.5	5	9	14	30 ⑤
		900	..	0.5	1.5	3	5	8	12 ⑤
3.20	6.30	100	400	1	3	6	11	17	25 ⑤
		400	..	0.5	1.5	3	5	8	12 ⑤
6.30	150.00	..	250	3	11	25	45	70	100 ⑤
		250	400	1	3	6	11	17	25 ⑤
		400	..	0.5	2	3.5	6	10	14 ⑤

TABLE 7.14 Squareness Tolerances—Flat Sheet and Plate

SPECIFIED LENGTH mm	SPECIFIED WIDTH—mm	
	Up thru 1 000	Over 1 000
	ALLOWABLE DIFFERENCE IN LENGTH OF DIAGONALS ④—mm	
		
	Maximum difference between AA and BB	
Up thru 3 500	0.8 × each 100 mm segment of width ③	0.7 × each 100 mm segment of width ③
Over 3 500	1.2 × each 100 mm segment of width ③	1.0 × each 100 mm segment of width 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 0.24 mm per metre per 10°C must be recognized.

③ If specified width is other than an exact multiple of 100 mm, tolerance is determined by using the next largest exact multiple. For example, if specified width is 750 mm and specified length is 2 800 mm, the tolerance is $0.8 \text{ mm} \times 8 = 6.4 \text{ mm}$. This result, if not a whole mm, is rounded to upward to the nearest mm.

④ Use values for calculating only. Round result upward to nearest mm.

⑤ Also applicable to any 6 000 mm increment of longer sheet or plate.

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

OverThru		SPECIFIED DIAMETER—mm					
		Up thru 500	Over 500 thru 1 000	Over 1 000 thru 2 000	Over 2 000 thru 3 000	Over 3 000 thru 4 000	Over 4 000 thru 5 000
SPECIFIED THICKNESS mm		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER mm plus and minus					
							
		Difference between AA and specified diameter					
0.15	6.30	1	1	1.5	2.5	4	6
6.30	12.50	2.5	3.5	5	7	9	13
12.50	25.00	6	7	9	11	13	

TABLE 7.16 Diameter Tolerances—Sawed Sheet and Plate Circles ^①

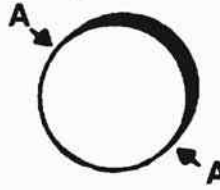
Over		Thru	SPECIFIED DIAMETER—mm						
			Up thru 500	Over 500 thru 1 000	Over 1 000 thru 2 000	Over 2 000 thru 3 000	Over 3 000 thru 4 000	Over 4 000 thru 5 000	
SPECIFIED THICKNESS mm		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER mm plus and minus							
									
		Difference between AA and specified diameter							
2.00	25.00	3.5	4	5	6	8	11		
25.00	50.00	5	6	8	10	13	16		
50.00	100.00	8	10	12	15	18	21		

TABLE 7.17 Flatness Tolerances—Flat Sheet ^②

Alloy (Includes Alclads)	Specified Thickness mm		Longitudinal or Transverse Distance (mm) Center to Center of Buckles or Edge Waves ^③				
			Up thru 500	Over 500 thru 1 000	Over 1 000 thru 1 500	Over 1 500 thru 2 000	Over 2 000
	Over	Thru	TOLERANCES, mm ^④ ^⑤ ^⑥				
1060, 1100, 1350, 3003, 3005, 3105, 5005, 5050, 5X57	0.50	1.60	2	4	6	8	10
	1.60	6.30	3	5	8	10	13
3004, 5052, 5083, 5086, 5252, 5X54, 5456, brazing sheet, and all heat treatable alloys	0.50	1.60	4	6	9	11	14
	1.60	6.30	5	7	10	12	15

^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 1 500 mm 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 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, mm		TOLERANCE ^① mm—Allowable Deviation from Flat	
Over	Thru	TX51 tempers ^②	Other than TX51 tempers ^{② ⑦}
6.30	80.00	5 in any 2 000 mm ^③	7 in any 2 000 mm or less
80.00	100.00	3.5 in any 2 000 mm or less	7 in any 2 000 mm or less

TRANSVERSE FLATNESS

SPECIFIED THICKNESS, mm		TOLERANCE ^① mm—Allowable Deviation from Flat						
		Width—mm						
		Up thru 500	Over 500	Thru 1 000	Over 1 000	Thru 1 500	Over 1 500	Thru 2 000
Over	Thru	All tempers ^⑦	TX51 tempers ^②	Other than TX51 tempers ^{② ⑦}	TX51 tempers ^②	Other than TX51 tempers ^{② ⑦}	TX51 tempers ^②	Other than TX51 tempers ^{② ⑦}
6.30	16.00	Only short-span flatness	6	7	8	10	10	13
16.00	40.00		4	6	6	8	8	10
40.00	80.00	tolerance	3	5	4	6	5	7
80.00	160.00	applies	2.5	4	3	5	3.5	6

SHORT-SPAN FLATNESS ^⑤

SPECIFIED THICKNESS, mm		TOLERANCE ^⑥ mm—Allowable Deviation from Flat	
Over	Thru	TX51 tempers ^②	Other than TX51 tempers ^{② ⑦}
6.30	16.00	2.00	2.50
16.00	160.00	1.50	1.80

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

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

^③ For lengths under 2 000 mm, the tolerance is 3.5 mm.

^④ For widths over 2 000 mm, these tolerances apply for any 2 000 mm of total width.

^⑤ Short-span flatness is the deviation from flat over full span for spans 500 mm 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 mm	NOMINAL WIDTH—mm	
	Up thru 1000	Over 1000 thru 1500
	TOLERANCE—mm plus and minus	
0.60	0.06	0.10
0.80	0.07	0.11
0.90	0.08	0.12
1.0	0.08	0.12
1.2	0.10	0.13

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 ± 3 mm
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: ± 1 mm

TABLE 7.30 Squareness Tolerance—Commercial Roofing and Siding

Allowable difference in length of diagonals: ± 13 mm
--

TABLE 7.28 Length Tolerances^②—Commercial Roofing and Siding

Allowable deviation from specified length: ± 13 mm
--

^① Applicable prior to painting, corrugating or embossing.

^② Applicable to lengths of 1 000 thru 9 000 mm for all products except ribbed siding. For ribbed siding, tolerances are applicable to lengths of 1000 thru 11000 mm.

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TABLE 7.31 Thickness Tolerances—Duct Sheet

STANDARD THICKNESS mm	TOLERANCE—mm plus and minus	
	STANDARD WIDTHS—mm	
	600, 750, 900	1 200
0.40	0.030	0.050
0.45, 0.50, 0.55, 0.60	0.040	0.06
0.80	0.045	0.07
1.0	0.050	0.08
1.2	0.06	0.09
1.6	0.08	0.10

TABLE 7.32 Width Tolerances—Flat Duct Sheet

STANDARD THICKNESS mm	TOLERANCE—mm plus and minus	
	STANDARD WIDTHS—mm	
	600, 750, 900	1 200
All	2.5	3

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

STANDARD THICKNESS mm	TOLERANCE—mm plus and minus	
	STANDARD WIDTHS—mm	
	600, 750, 900	1 200
All	1	1.5

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

STANDARD LENGTH	STANDARD WIDTH	TOLERANCE, mm
All	All	±6

Table 7.35 intentionally blank

TABLE 7.36 Mass per Square Metre—Tread Plate

The following nominal masses per square metre are based on alloy 6061, which has a density of 2.70×10^3 kilograms per cubic metre:

THICKNESS mm	NOMINAL MASS kg/m ²
2.50	7.4
3.20	9.3
4.00	11.5
5.00	14.2
6.00	16.9
8.00	22.3
10.00	27.7
12.00	33.1
16.00	43.9

TABLE 7.37 Thickness Tolerances—Tread Plate

SPECIFIED THICKNESS ①—mm	TOLERANCE—mm	
	Plus ②	Minus
2.50	0.20	0.30
3.20	0.26	0.38
4.00	0.28	0.48
5.00	0.35	0.60
6.00	0.42	0.72
8.00	0.56	0.96
10.00	0.70	1.20
12.00	0.84	1.40
16.00	1.10	1.90

① Specified thickness does not include height of pattern.

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

TABLE 7.38 Width Tolerances—Tread Plate

Allowable deviation from specified width: plus 10 mm

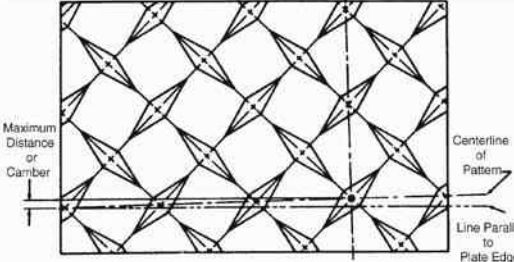
TABLE 7.39 Length Tolerances—Tread Plate

SPECIFIED LENGTH mm		TOLERANCE mm—plus
Over	Thru	
..	4 000	10
4 000	6 000	11
6 000	..	12

TABLE 7.40 Height of Pattern Tolerance—Tread Plate

Minimum height of raised pattern: 1.00 mm.
(Maximum height is controlled by weight tolerance.)

Dimensional Tolerances for

TABLE 7.41 Camber of Pattern Line ④
Tolerances—Tread Plate


SPECIFIED LENGTH mm		TOLERANCE—mm	
		SPECIFIED WIDTH—mm	
Over	Thru	Up thru 1 000	Over 1 000 thru 2 000
..	500	3	3
500	2 000	13	13
2 000	4 000	20	25
4 000	..	25	40

TABLE 7.42 Lateral Bow ③ Tolerances—
Tread Plate

SPECIFIED WIDTH mm		TOLERANCE—mm
		ALLOWABLE DEVIATION OF A SIDE EDGE FROM A STRAIGHT LINE
		SPECIFIED THICKNESS—mm
Over	Thru	2.50–16.00 mm
..	100	25 in any 3 000 mm
100	400	6 in any 3 000 mm
400	2 000	3 in any 3 000 mm

TABLE 7.43 Squareness Tolerances ⑤—
Tread Plate

SPECIFIED LENGTH mm		TOLERANCE—mm
		ALLOWABLE DIFFERENCE IN LENGTH OF DIAGONALS
Over	Thru	
..	4 000	10
4 000	6 000	11
6 000	..	12

③ Applicable only to lengths up through 6 000 mm.

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 required.

8. Fin Stock

Table 8.1 intentionally blank

TABLE 8.2 Thickness Tolerances—Fin Stock

SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus
over	thru	
0.10	0.25	0.013
0.25	0.40	0.025
0.40	0.80	0.038

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 over 0.10 thru 0.15 mm are the same as those specified for thicknesses over 0.15 mm.

9. Foil

Table 9.1 intentionally blank

TABLE 9.2 Covering Area—Unmounted Foil

SPECIFIED THICKNESS mm	COVERING AREA—m ² /kg ①			SPECIFIED THICKNESS mm	COVERING AREA—m ² /kg ①		
	Nominal	Minimum ②	Maximum ②		Nominal	Minimum ②	Maximum ②
0.005	74.1	67.3	82.3	0.030	12.3	11.2	13.7
0.006	61.7	56.1	68.6	0.040	9.26	8.42	10.3
0.007	52.9	48.1	58.8	0.050	7.41	6.73	8.23
0.008	46.3	42.1	51.4	0.060	6.17	5.61	6.66
0.009	41.2	37.4	45.7	0.070	5.29	4.81	5.88
0.010	37.0	33.7	41.2	0.080	4.63	4.21	5.14
0.011	33.7	30.6	37.4	0.090	4.12	3.74	4.57
0.012	30.9	28.1	34.3	0.100	3.70	3.37	4.12
0.014	26.5	24.1	29.4	0.110	3.37	3.06	3.74
0.016	23.1	21.0	25.7	0.120	3.09	2.81	3.43
0.018	20.6	18.7	22.9	0.140	2.65	2.41	2.94
0.020	18.5	16.8	20.6	0.160	2.31	2.10	2.57
0.022	16.8	15.3	18.7	0.180	2.06	1.87	2.29
0.025	14.8	13.5	16.5	0.200	1.85	1.68	2.06
0.028	13.2	12.0	14.57				

① Based on a density of 2700 kg/m³, the density of 1145 and 1235 aluminum. Covering area in m²/kg is calculated using the following formula:

$$\text{Covering Area} = \frac{1000}{\text{thickness in mm} \times \text{density in kg/m}^3}$$

Alloy	Density (kg/m ³)
1100	2710
1145	2700
1235	2705
3003	2730
5052	2680
5056	2640

② Based on the standard thickness tolerance of plus and minus 10% per roll or shipment.

TABLE 9.3 Roll Width—Unmounted Foil

SPECIFIED WIDTH mm		TOLERANCE—mm plus and minus	
Over	Thru	Unmounted Foil	Colored, Embossed and Coated Foil
..	300	0.5	1
300	..	1	1

TABLE 9.5 Length and Width—Flat Sheets of Unmounted Foil

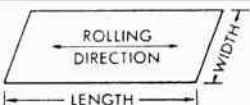
SPECIFIED LENGTH OR WIDTH mm	TOLERANCE—mm plus and minus
	
All	1

TABLE 9.4 Inside Diameter—Core, Unmounted Foil

SPECIFIED INSIDE DIAMETER mm	TOLERANCE—mm plus and minus	
	Fiber Cores	Metal Cores
33	+1, -0.5	+0.5, -0
76	+1, -0.5	+0.5, -0

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

ROLL DIAMETER mm		FOIL THICKNESS—mm			
		0.008 thru 0.025		Over 0.025	
		FOIL WIDTH—mm			
over	thru	Up thru 1300 ②	Over 1300	Up thru 1300 ②	Over 1300
...	250	3	4	1	1
250	350	5	7	2	3
350	450	8	11	4	5
450	550	10	13	6	7
Maximum Average Number Per Roll in Total Shipment					
...	250	2	2	½	½
250	350	3	5	1	1
350	450	5	8	2	2
450	550	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 1300 mm.

TABLE 9.7 Coating Weights—
Unmounted Foil

COATING TYPE	TOLERANCE percent plus and minus
Heat seal, Clear	20 or 0.5 g/m ² ^①
Polyethylene	15
Elvax	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 mm	TOLERANCE—mm plus and minus	
	Laminated Foil	Colored, Embossed and Coated Foil
Up thru 300	0.5	1
Over 300	1	1

TABLE 9.12 Coating Weights—Laminated Foil

COATING TYPE	TOLERANCE percent plus and minus
Heat Seal, Clear	20 or 0.5 g/m ² ^①
Polyethylene	15
Elvax	30

^① Whatever is greater.

TABLE 9.10 Inside Diameter—Core,
Laminated Foil

SPECIFIED INSIDE DIAMETER mm	TOLERANCE—mm plus and minus	
	Fiber Cores	Metal Cores
33	+1, -0.5	+0.5, -0
76	+1, -0.5	+0.5, -0

TABLE 9.13 Covering Area (Yield)—
Laminated Foil

NOMINAL COVERING AREA m ² /kg	TOLERANCE ^① percent plus and minus
All	10

^① Average per roll or shipment.

TABLE 9.11 Length and Width—Flat Sheets of
Unmounted Foil

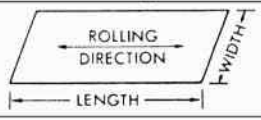
SPECIFIED LENGTH OR WIDTH mm	TOLERANCE—mm plus and minus
	
All	1

TABLE 9.14 Adhesive Weight—Laminated Foil

ADHESIVE TYPE	TOLERANCE percent plus and minus
Solid Glue, Asphalt Thermoplastic	20 or 0.5 g/m ² ^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 As expressed in g/m² or Grammage

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 mm min.
Rectangular Rhomboid or Die	3.5

TABLE 9.21 Minimum Type Size—Rotogravure

TYPE	LINE CYLINDER	TONE OR PROCESS
Relief	1.4 mm	2.1 mm
Reverse	2.1 mm	2.8 mm

TABLE 9.18 Overall Size—Cut Labels

SPECIFIED SIZE mm	TOLERANCE—mm plus and minus	
	Within a Shipment	Within a Pack
All	1	0.5

TABLE 9.22 Quantity Tolerance ①

SPECIFIED QUANTITY mm		TOLERANCE Percent
over	thru	
..	500	+100, -50
500	5 000	±40
5 000	10 000	±35
10 000	15 000	±30
15 000	20 000	±25
20 000	25 000	±20
25 000	30 000	±15
30 000	..	±10

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

TABLE 9.19 Border Variation—Cut Labels

TYPE OF LABEL	TOLERANCE mm plus and minus
Unembossed or Full Embossed	1
Embossed to Register	1.5

TABLE 9.23 Covering Area (Yield) ①

NOMINAL COVERING AREA m ² /kg	TOLERANCE percent plus and minus
All	10

① Average per roll or shipment

TABLE 9.20 Width—Rolls

SPECIFIED WIDTH mm	TOLERANCE mm plus and minus
All	1

**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.

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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 mm		TOLERANCE—mm plus and minus Except as noted			
		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER			
over	thru	Drawn Wire	Cold Finished Rod	Rolled Rod	
				Plus	Minus
..	0.80	0.015	..	..	..
0.80	1.60	0.025	..	..	..
1.60	10.00	0.040	..	..	..
10.00	12.50	..	0.040	0.50	0.50
12.50	25.00	..	0.050	0.63	0.63
25.00	40.00	..	0.06	..	..
40.00	50.00	..	0.10	..	..
50.00	70.00	..	0.15	..	..
70.00	90.00	..	0.20	..	..
90.00	120.00	..	0.30	..	..
120.00	150.00	..	0.50	..	..
150.00	175.00	..	0.63	..	..
175.00	200.00	..	0.80	..	..

TABLE 10.6 Diameter—Centerless Ground Round Wire and Rod

SPECIFIED DIAMETER mm		TOLERANCE mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
over	thru	
3.20	16.00	0.015
16.00	40.00	0.025
40.00	50.00	0.06

TABLE 10.7 Diameter—Rivet and Cold Heading Wire and Rod

SPECIFIED DIAMETER mm		TOLERANCE			
		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER			
		Rivet Wire		Rivet Rod	
over	thru	mm plus	mm minus	mm plus	mm minus
..	1.60	0.015	0.015	..	..
1.60	3.20	0.025	0.015	..	..
3.20	4.00	0.025	0.025	..	..
4.00	10.00	0.050	0.025	..	..
10.00	12.50	..	..	0.050	0.025
12.50	25.00	..	..	0.08	0.025

TABLE 10.8 Diameter—Drawing Stock

SPECIFIED DIAMETER mm		TOLERANCE—mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
Over	Thru	
10.00	12.50	0.50
12.50	25.00	0.63

TABLE 10.9 Thickness and Width—Rectangular Wire and Bar

SPECIFIED THICKNESS OR WIDTH mm		TOLERANCE mm plus and minus			
		ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS AND WIDTH			
		Drawn Wire and Cold Finished Bar		Rolled Bar	
over	thru	Thickness	Width	Thickness	Width
..	0.80	0.025	..	..	..
0.80	1.60	0.040	..	..	..
1.60	12.50	0.050	0.050	0.15	..
12.50	20.00	0.06	0.06	0.20	0.40
20.00	25.00	0.06	0.06	0.30	0.40
25.00	40.00	0.08	0.08	0.40	0.40
40.00	50.00	0.13	0.13	0.40	0.80
50.00	70.00	0.20	0.20	0.50	0.80
70.00	100.00	..	0.25	0.50	0.80
100.00	160.00	..	..	..	1.20
160.00	250.00	..	..	..	1.60

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

SPECIFIED DISTANCE ACROSS FLATS mm		TOLERANCE mm plus and minus		
		ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS		
		Drawn Wire	Cold Finished Bar	Rolled Bar
over	thru			
..	0.80	0.025	..	..
0.80	1.60	0.040	..	..
1.60	10.00	0.050	..	..
10.00	12.50	..	0.050	..
12.50	25.00	..	0.06	..
25.00	40.00	..	0.08	..
40.00	50.00	..	0.13	0.40
50.00	70.00	..	0.20	0.50
70.00	100.00	..	..	0.50

Dimensional Tolerances for

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

SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus	SPECIFIED WIDTH mm		TOLERANCE mm plus and minus	
						
ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS		0.025 0.040 0.050	ALLOWABLE DEVIATION FROM SPECIFIED WIDTH		0.18 0.25 ..	
over	thru		over	thru		
..	0.50		..	25.00		0.18
0.50	1.60		25.00	50.00		0.25
1.60	5.00	..	..	..		

TABLE 10.12 Thickness and Width—Flattened and Slit Wire

SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus	SPECIFIED WIDTH mm		TOLERANCE mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS			ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
over	thru		over	thru	
0.40	0.50	0.025	12.50	16.00	0.06
0.50	1.60	0.040	16.00	40.00	0.10
1.60	2.00	0.050	40.00	120.00	0.15

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

SPECIFIED DIAMETER, WIDTH OR DISTANCE ACROSS FLATS mm		TOLERANCE ⑤—mm plus			
		ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
		SPECIFIED LENGTH—mm			
over	thru	Thru 5 000	over 5 000 thru 10 000	over 10 000 thru 15 000	over 15 000
..	70.00	4	7	10	25
70.00	200.00	6	9	11	25
200.00	..	7	10	13	25

TABLE 10.14 Twist ④—Bar and Straight Lengths

PRODUCT	TEMPER	SPECIFIED WIDTH: (RECTANGLES); SPECIFIED DISTANCE ACROSS FLATS: (SQUARES, HEXAGONS AND OCTAGONS) mm		TOLERANCE ① ③—DEGREES	
				ALLOWABLE DEVIATION FROM STRAIGHT	
		over	thru	Y (max.) in degrees	
Square, Rectangular and Octagonal Bar	All except O and TX51 ②	..	40.00	3°/m but not greater than 7°	
	TX51 ②	40.00	80.00	1.5°/m but not greater than 5°	
Hexagonal Bar	All except O	..	40.00	3°/m but not greater than 7°	
		40.00	80.00	1.5°/m but not greater than 5°	

① For TX51 tempers, tolerance is applicable only to thicknesses of 12.50 mm 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 product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	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 10 mm.

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TABLE 10.15 Straightness—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) mm	TOLERANCE ①—mm ALLOWABLE DEVIATION FROM STRAIGHT, D(MAX)M,  IN TOTAL LENGTH OR IN ANY 300 MM OR LONGER CHORD SEGMENT OF TOTAL LENGTH.
ROLLED			
Rod and Hexagonal, Square, Rectangular and Octagonal Bar	All except O	All	4mm/m
COLD FINISHED			
Rod and Hexagonal Bar	All except O and TX51 ②	All	2mm/m
	TX51 ②	12.50 and over	2mm/m
Square, Rectangular and Octagonal Bar	All except O and TX51 ②	All	2mm/m
	TX51 ②	12.50 and over	4mm/m

TABLE 10.16 Straightness—Screw Machine Stock

SPECIFIED DIAMETER: (ROD); SPECIFIED DISTANCE ACROSS FLATS: (HEXAGONAL BAR) mm	TEMPER	TOLERANCE ① ALLOWABLE DEVIATION FROM STRAIGHT	
		In any 300 mm of length	In any standard length
All	All Except TX51 ②	0.3 mm	2.5 mm
12.50 and over	TX51 ②	0.3 mm	2.5 mm

TABLE 10.18 Angularity


Allowable deviation from nominal angle: ± 1 degree

TABLE 10.17 Flatness—Flat Surfaces

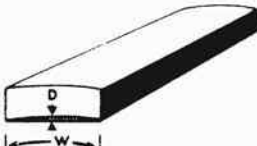
SURFACE WIDTH mm	TOLERANCE—mm 
	Maximum Allowable Deviation D
Up thru 25	0.10
Over 25	$.004 \times W$ (mm)
In any 25 mm of width	0.10

TABLE 10.19 Squareness of Saw Cuts

Allowable deviation from square: 1 degree

TABLE 10.20 Corner Radii Bar

Thickness, mm		Corner Radii
over	thru	mm, max.
1.90	10.00	0.4
10.00	40.00	0.8
40.00	...	1.2

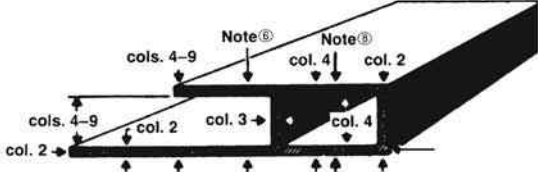
① When mass of piece on flat surface minimizes deviation.

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

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 TEMPER ^⑦

																		
SPECIFIED DIMENSION		TOLERANCE ② ③—mm 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 ⑥										
		mm		At Dimensioned Points over 5 thru 15 mm from Base of Leg		At Dimensioned Points over 15 thru 30 mm from Base of Leg		At Dimensioned Points over 30 thru 60 mm from Base of Leg		At Dimensioned Points over 60 thru 100 mm from Base of Leg		At Dimensioned Points over 100 thru 150 mm from Base of Leg		At Dimensioned Points over 150 thru 200 mm from Base of Leg				
		All Except Those Covered by Column 3		Wall Thickness ④ Completely ⑤ Enclosing Space 70 mm ⑦ and Over (Eccentricity)														
Col. 1		Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7		Col. 8		Col. 9		
over	thru	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	Standard Tolerance, All Except 5XXX Alloys ⑪	Precision Tolerance, All Except 5XXX Alloys	
CIRCUMSCRIBING CIRCLE SIZES THRU 250 mm IN DIAMETER																		
..	3.20	0.15	0.10	±10% of specified dimension; ±1.50 max. ± 25 min.	±10% of specified dimension; ±1.50 max. ± 25 min.	0.25	0.17	0.30	0.20	..	..	..	..	..	..	..	..	
3.20	6.30	0.18	0.12			0.30	0.20	0.36	0.24	0.41	0.27	..	..	..	..	..	..	..
6.30	12.50	0.20	0.13			0.36	0.24	0.41	0.27	0.46	0.30	0.50	0.33	0.56	0.37	..	..	..
12.50	20.00	0.23	0.15			0.41	0.27	0.46	0.30	0.50	0.33	0.56	0.37	..	..	..	..	..
20.00	25.00	0.25	0.17			0.46	0.30	0.50	0.33	0.56	0.37	0.64	0.42	0.76	0.50	..	..	
25.00	40.00	0.30	0.20	±10% of specified dimension; ±1.50 max. ± 25 min.	±10% of specified dimension; ±1.50 max. ± 25 min.	0.54	0.36	0.58	0.38	0.66	0.44	0.76	0.50	0.88	0.58	..	..	
40.00	50.00	0.36	0.24			0.60	0.40	0.66	0.44	0.78	0.51	0.92	0.61	1.05	0.69	1.25	0.83	
50.00	100.00	0.60	0.40			0.86	0.57	0.96	0.63	1.20	0.79	1.45	0.96	1.70	1.12	2.05	1.35	
100.00	150.00	0.86	0.57			1.10	0.73	1.25	0.83	1.65	1.09	2.00	1.32	2.40	1.58	2.80	1.85	
150.00	200.00	1.10	0.73			1.35	0.89	1.55	1.02	2.10	1.39	2.50	1.65	3.05	2.01	3.55	2.34	
200.00	250.00	1.35	0.89			1.65	1.09	1.90	1.25	2.50	1.65	3.05	2.01	3.70	2.44	4.30	2.84	
CIRCUMSCRIBING CIRCLE SIZES OVER 250 mm IN DIAMETER																		
..	3.20	0.36	0.24	±15% of specified dimension; ±2.30 max. ± 38 min.	±15% of specified dimension; ±2.30 max. ± 38 min.	0.46	0.30	0.50	0.33	..	..	..	..	..	..	..	..	
3.20	6.30	0.38	0.25			0.48	0.32	0.56	0.37	0.72	0.48	..	..	..	..	..	..	..
6.30	12.50	0.41	0.27			0.50	0.33	0.60	0.40	0.76	0.50	1.25	0.83	..	..	..	..	..
12.50	20.00	0.43	0.28			0.56	0.37	0.68	0.45	1.00	0.66	1.50	0.99	..	..	..	..	..
20.00	25.00	0.46	0.30			0.58	0.38	0.76	0.50	1.25	0.83	1.80	1.19	2.30	1.52	..	..	
25.00	40.00	0.48	0.32	±15% of specified dimension; ±2.30 max. ± 38 min.	±15% of specified dimension; ±2.30 max. ± 38 min.	0.60	0.40	0.86	0.57	1.50	0.99	2.05	1.35	2.55	1.68	..	..	
40.00	50.00	0.60	0.40			0.86	0.57	1.10	0.73	1.80	1.19	2.30	1.52	2.80	1.85	4.30	2.84	
50.00	100.00	0.86	0.57			1.10	0.73	1.35	0.89	2.05	1.35	2.55	1.68	3.05	2.01	4.55	3.00	
100.00	150.00	1.10	0.73			1.35	0.89	1.65	1.09	2.30	1.52	2.80	1.85	3.30	2.18	4.85	3.20	
150.00	200.00	1.35	0.89			1.65	1.09	1.90	1.25	2.55	1.68	3.05	2.01	3.55	2.34	5.10	3.37	
200.00	250.00	1.65	1.09	±15% of specified dimension; ±2.30 max. ± 38 min.	±15% of specified dimension; ±2.30 max. ± 38 min.	1.90	1.25	2.15	1.42	2.80	1.85	3.30	2.18	3.80	2.51	5.35	3.53	
250.00	300.00	1.90	1.25			2.15	1.42	2.40	1.58	3.05	2.01	3.55	2.34	4.05	2.67	5.60	3.70	
300.00	350.00	2.15	1.42			2.40	1.58	2.65	1.75	3.30	2.18	3.80	2.51	4.30	2.84	5.85	3.86	
350.00	400.00	2.40	1.58			2.65	1.75	2.90	1.91	3.55	2.34	4.05	2.67	4.55	3.00	6.10	4.03	
400.00	450.00	2.65	1.75			2.90	1.91	3.15	2.08	3.80	2.51	4.30	2.84	4.85	3.20	6.35	4.19	
450.00	500.00	2.90	1.91	±15% of specified dimension; ±2.30 max. ± 38 min.	±15% of specified dimension; ±2.30 max. ± 38 min.	3.15	2.08	3.40	2.24	4.05	2.67	4.55	3.00	5.10	3.37	6.60	4.36	
500.00	550.00	3.15	2.08			3.40	2.24	3.65	2.41	4.30	2.84	4.85	3.20	5.35	3.53	6.85	4.52	
550.00	600.00	3.40	2.24			3.65	2.41	3.90	2.57	4.55	3.00	5.10	3.37	5.60	3.70	7.10	4.69	
600.00	650.00	3.65	2.41			3.90	2.57	4.15	2.74	4.80	3.15	5.40	3.54	6.00	3.95	7.40	4.86	

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.

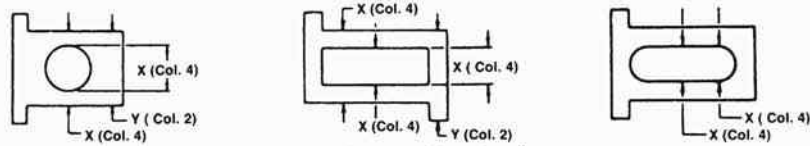
④ Where dimensions specified are outside and inside, rather than wall thickness itself, the allowable deviation (eccentricity) given in Column 3 applies to mean wall thickness. (Mean wall thickness is the average of two wall thickness measurements taken at opposite sides of the void.)

(Continued on bottom of next page)

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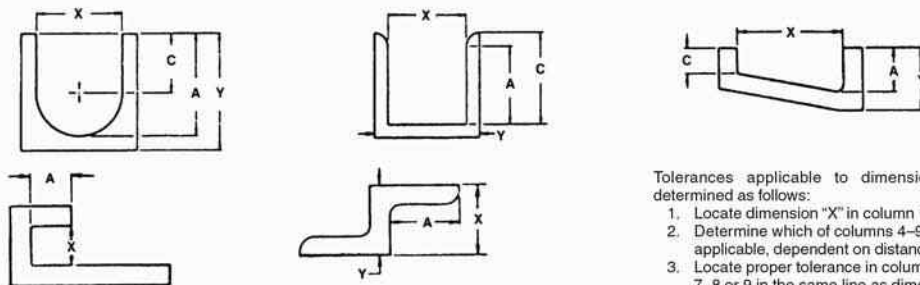
Examples Illustrating Use of Table 11.2, Page 24

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.

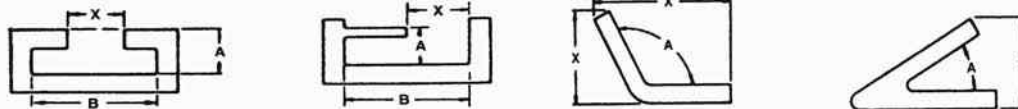
Open-Space Dimensions



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 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."



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."

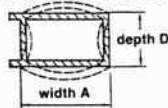
Footnotes for Tables 11.2 through 11.4 (Continued)

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 5 mm and less from base of leg the tolerances in Col. 2 are applicable.

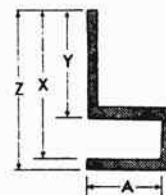
⑦ Tolerances for extruded profiles in T3510, T4510, T6510, T73510, T76510 and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.

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.

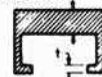


Example—Alloy 6061 hollow profile having 25 × 75 mm rectangular outside dimensions; width tolerance is ±0.46 mm and depth tolerance ±0.86 mm. (Tolerances at corners, Col. 2, metal dimensions, are ±0.60 mm for the width and ±0.25 mm for the depth.) Note that the Col. 4 tolerance of 0.46 mm must be adjusted to 0.60 mm 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."



3t or Greater



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 5xxx alloys tolerances are 150% of all other alloys, standard tolerance.

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

SPECIFIED DIMENSION mm		TOLERANCE ^③ —mm 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
over	thru								
..	3.20	0.15	0.10	0.15	0.10	0.15	0.10	0.15	0.10
3.20	6.30	0.18	0.12	0.18	0.12	0.18	0.12	0.18	0.12
6.30	12.50	0.20	0.13	0.20	0.13	0.20	0.13	0.20	0.13
12.50	19.00	0.23	0.15	0.23	0.15	0.23	0.15	0.23	0.15
19.00	25.00	0.25	0.17	0.25	0.17	0.25	0.17	0.25	0.17
25.00	40.00	0.30	0.20	0.30	0.20	0.30	0.20	0.30	0.20
40.00	50.00	0.36	0.24	0.36	0.24	0.36	0.24	0.36	0.24
50.00	100.00	0.61	0.40	0.61	0.40	0.61	0.40	0.61	0.40
100.00	150.00	0.86	0.57	0.86	0.57	0.86	0.57	0.86	0.57
150.00	180.00	1.10	0.73	1.10	0.73	1.10	0.73	1.10	0.73
180.00	200.00	1.10	0.73	1.35	0.89	1.10	0.73	1.10	0.73
200.00	220.00	1.35	0.89	1.65	1.09	1.35	0.89	1.35	0.89
220.00	235.00	1.35	0.89	1.65	1.09	1.65	1.09	1.35	0.89
235.00	250.00	1.35	0.89	1.65	1.09	1.65	1.09	1.65	1.09
250.00	300.00	1.90	1.25	1.90	1.25	1.90	1.25	1.90	1.25
300.00	350.00	2.15	1.42	2.15	1.42	2.15	1.42	2.15	1.42
350.00	400.00	2.40	1.58	2.40	1.58	2.40	1.58	2.40	1.58

Note: Shaded tolerances denote products with a circumscribing circle size of 250 inches in diameter.

For all numbered footnotes, see two preceding pages.

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

SPECIFIED DIMENSION mm		TOLERANCE—mm 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
over	thru				
..	3.20	0.15	0.10	0.36	0.24
3.20	6.30	0.18	0.12	0.38	0.25
6.30	12.50	0.20	0.13	0.41	0.27
12.50	20.00	0.23	0.15	0.43	0.28
20.00	25.00	0.25	0.17	0.46	0.30
25.00	40.00	0.30	0.20	0.48	0.32
40.00	50.00	0.36	0.24	0.61	0.40
50.00	100.00	0.61	0.40	0.86	0.57
100.00	150.00	0.86	0.57	1.10	0.73
150.00	200.00	1.10	0.73	1.35	0.89
200.00	250.00	1.35	0.89	1.60	1.06
250.00	300.00	..	..	1.90	1.25
300.00	350.00	..	..	2.15	1.42
350.00	400.00	..	..	2.40	1.58
400.00	450.00	..	..	2.65	1.75
450.00	500.00	..	..	2.90	1.91
500.00	550.00	..	..	3.15	2.08
550.00	600.00	..	..	3.40	2.24

Note: Shaded tolerances denote products with a circumscribing circle size over 250 mm in diameter.

For all numbered footnotes, see two preceding pages.

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

SPECIFIED DIAMETER (WIRE AND ROD): SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER ^④ (PROFILES): mm		TOLERANCE—mm plus			
		ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
		SPECIFIED LENGTH—mm			
over	thru	Up thru 5 000	Over 5 000 thru 10 000	Over 10 000 thru 15 000	Over 15 000
..	70.00	4	7	10	25
70.00	200.00	6	9	11	25
200.00	..	7	10	13	25

TABLE 11.6 Straightness ^①—Rod, Bar and Profiles

PRODUCT	TEMPER	SPECIFIED DIAMETER (ROD): SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER ④ (PROFILES):		SPECIFIED THICKNESS (RECTANGLES): MINIMUM THICKNESS (PROFILES):		TOLERANCE ③—mm
						ALLOWABLE DEVIATION (D) FROM STRAIGHT ⑥
						  
						Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of total length
		mm		mm		
		over	thru	over	thru	
Rod and Square, Hexagonal and Octagonal Bar	All except O TX510 ②, TX511 ②	All		...	...	1 mm/m
	O	12.50	...	...	...	4 mm/m
	TX510 ②	12.50	...	...	...	4 mm/m
	TX511 ②	12.50	...	...	...	1 mm/m
Rectangular Bar	All except O, TX510 ②, TX511 ②	...	40.00	...	2.50	4 mm/m
		40.00	...	2.50	...	1 mm/m
	O	12.50	...	...	...	4 mm/m
	TX510 ②	12.50	...	12.50	...	4 mm/m
	TX511 ②	12.50	...	12.50	...	1 mm/m
Profiles	All except O TX510 ② ⑤, TX511 ②	...	40.00	...	2.50 ⑦	4 mm/m
		40.00	...	2.50	...	1 mm/m
	O	12.50	...	...	2.50 ⑦	16 mm/m
				2.50	...	4 mm/m
	TX511 ②	12.50	...	...	2.50 ⑦	4 mm/m
				2.50	...	1 mm/m

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 product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	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 2.50 mm or less. Otherwise use the tolerance shown for 2.50 mm and over.

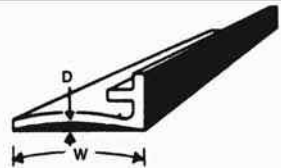
^⑧ Tolerance for "O" temper material is four times the standard tolerances shown.

^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):		SPECIFIED THICKNESS (RECTANGLES):		TOLERANCE ^③ —Degrees
		CIRCUMSCRIBING CIRCLE DIAMETER ^④ (PROFILES):		MINIMUM THICKNESS (PROFILES):		
		over	thru	over	thru	
Bar	All except O TX510 ^② , TX511 ^②	.. 40.00 80.00	40.00 80.00 ..	All All All		3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 3°
	O	12.50 40.00 80.00	40.00 80.00 ..	12.50 12.50 12.50		9°/m but not greater than 21° 4.5°/m but not greater than 15° 3°/m but not greater than 9°
	TX510 ^②	12.50 80.00	80.00 ..	12.50 12.50		4°/m but not greater than 7° 1.5°/m but not greater than 5°
	TX511 ^②	12.50 40.00 80.00	40.00 80.00 ..	12.50 12.50 12.50		3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 3°
						Allowable deviation from straight, y(max), in total length or in any 300 mm chord segment of the total length
Profiles	All except O TX510 ^{② ⑤} , TX511 ^②	.. 40.00 80.00	40.00 80.00 ..	All All All		3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 3°
	O	12.50 12.50 40.00 80.00	.. 40.00 80.00 ..	2.50 2.50 2.50 2.50	2.50	9°/m but not greater than 21° 9°/m but not greater than 21° 4.5°/m but not greater than 15° 3°/m but not greater than 9°
	TX511 ^②	12.50 12.50 40.00 80.00	.. 40.00 80.00 ..	2.50 2.50 2.50 2.50	2.50 2.50 2.50 ..	3°/m but not greater than 7° 3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 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 25 mm OR ANY 25 mm INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE FACTOR x 25 (mm)										
		WIDTHS OVER 25 mm Maximum Allowable Deviation D = TOLERANCE FACTOR x W (mm)										
MINIMUM THICKNESS OF METAL FORMING THE SURFACE mm		SURFACE WIDTH—mm										
		UP THRU 150.00	OVER 150.00 THRU 200.00	OVER 200.00 THRU 250.00	OVER 250.00 THRU 300.00	OVER 300.00 THRU 350.00	OVER 350.00 THRU 400.00	OVER 400.00 THRU 450.00	OVER 450.00 THRU 500.00	OVER 500.00 THRU 550.00	OVER 550.00 THRU 600.00	OVER 600
OVER	THRU	TOLERANCE FACTOR										
Up thru	3.20	0.004	0.006	0.10	0.14	..	..	..	..	..	..	..
3.20	4.00	0.004	0.006	0.008	0.013	0.014	0.014	0.014	..	..	..	..
4.00	5.00	0.004	0.006	0.007	0.012	0.013	0.013	0.013	..	..	..	..
5.00	6.30	0.004	0.006	0.006	0.010	0.012	0.012	0.012	0.014	0.014	..	..
6.30	8.00	0.004	0.006	0.006	0.008	0.010	0.010	0.012	0.012	0.012	0.014	..
8.00	12.50	0.004	0.004	0.006	0.008	0.008	0.008	0.010	0.010	0.010	0.012	0.012
12.50	20.00	0.004	0.004	0.006	0.006	0.008	0.008	0.008	0.008	0.008	0.010	0.012
20.00	25.00	0.004	0.004	0.006	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.010
25.00	40.00	0.004	0.004	0.004	0.006	0.006	0.008	0.008	0.008	0.008	0.008	0.008
40.00	50.00	0.004	0.004	0.004	0.004	0.006	0.006	0.006	0.008	0.008	0.008	0.008
50.00	..	0.004	0.004	0.004	0.004	0.004	0.006	0.006	0.006	0.008	0.008	0.008

For all numbered footnotes, see page 27.

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TABLE 11.9 Flatness (Flat Surfaces)^①—Hollow Profiles (EXCEPT FOR PROFILES IN O^⑧, T3510, T4510, T6510, T73510, T76510 and T8510 TEMPER^④)

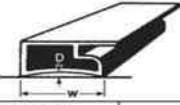
		SURFACES WIDTHS UP THRU 25 mm OR ANY 25 mm INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE FACTOR x 25 (mm)											
		WIDTHS OVER 25 mm Maximum Allowable Deviation D = TOLERANCE x W (mm)											
		SURFACE WIDTH—mm											
MINIMUM THICKNESS OF METAL FORMING THE SURFACE mm		UP THRU 150.00	OVER 150.00 THRU 200.00	OVER 200.00 THRU 250.00	OVER 250.00 THRU 300.00	OVER 300.00 THRU 350.00	OVER 350.00 THRU 400.00	OVER 400.00 THRU 450.00	OVER 450.00 THRU 500.00	OVER 500.00 THRU 550.00	OVER 550.00 THRU 600.00	OVER 600.00	
OVER	THRU	TOLERANCE FACTOR											
Up thru	3.20	0.006	0.008	0.012	0.016	..	..	..	..	..	..	..	..
3.20	4.00	0.006	0.008	0.010	0.014	0.016	..	..	..	..	..	..	..
4.00	5.00	0.005	0.007	0.010	0.013	0.015	0.015	..	..	..	..	..	..
5.00	6.30	0.004	0.006	0.010	0.012	0.014	0.014	0.014	0.016	..	..	..	..
6.30	8.50	0.004	0.006	0.008	0.010	0.012	0.012	0.014	0.014	0.014	0.016	..	..
8.00	12.50	0.004	0.006	0.008	0.010	0.010	0.010	0.012	0.012	0.012	0.014	0.016	..
12.50	20.00	0.004	0.004	0.006	0.008	0.008	0.008	0.010	0.010	0.012	0.012	0.014	..
20.00	25.00	0.004	0.004	0.006	0.006	0.008	0.008	0.008	0.008	0.010	0.010	0.012	..
25.00	40.00	0.004	0.004	0.004	0.006	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.008

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

SPECIFIED SECTION THICKNESS mm		ALLOWABLE DEPTH OF CONDITIONS ^② mm max.
over	thru	
..	1.60	0.040
1.60	3.20	0.050
3.20	5.00	0.06
5.00	6.30	0.08
6.30	12.50	0.10
12.50	..	0.20

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

Temper	
All except O, TX510 ^④	Allowable deviation from specified contour: 0.005 mm per mm of chord length (C); 0.13 mm minimum. Not applicable to contours with chord length over 150 mm.
O	Allowable deviation from specified contour: 0.015 mm per mm of chord length (C); 0.40 mm minimum. Not applicable to contours with chord length over 150 mm.

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

Allowable deviation from square: 1 degree

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

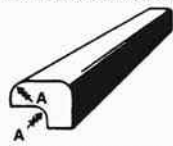
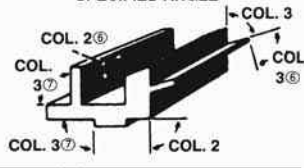
SPECIFIED RADIUS ^⑧ mm		TOLERANCE—mm ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
		Difference between radius A and specified radius
		±0.5 (1 mm if unspecified)
over	thru	±0.5
..	5.00	±10%
5.00	..	..

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

TEMPER	SPECIFIED THICKNESS OF THINNER LEG mm	TOLERANCE Degrees plus and minus ALLOWABLE DEVIATION FROM SPECIFIED ANGLE	
			
		RATIO: ⑥ ⑦ LEG OR SURFACE LENGTH TO LEG OR METAL THICKNESS	
		over	thru
		Col. 1	Col. 2
		1 and less	Over 1 thru 40
		Col. 1	Col. 2
		Col. 3	Col. 4
		Col. 5	Col. 6
		Col. 7	Col. 8
		Col. 9	Col. 10
		Col. 11	Col. 12
		Col. 13	Col. 14
		Col. 15	Col. 16
		Col. 17	Col. 18
		Col. 19	Col. 20
		Col. 21	Col. 22
		Col. 23	Col. 24
		Col. 25	Col. 26
		Col. 27	Col. 28
		Col. 29	Col. 30
		Col. 31	Col. 32
		Col. 33	Col. 34
		Col. 35	Col. 36
		Col. 37	Col. 38
		Col. 39	Col. 40
		Col. 41	Col. 42
		Col. 43	Col. 44
		Col. 45	Col. 46
		Col. 47	Col. 48
		Col. 49	Col. 50
		Col. 51	Col. 52
		Col. 53	Col. 54
		Col. 55	Col. 56
		Col. 57	Col. 58
		Col. 59	Col. 60
		Col. 61	Col. 62
		Col. 63	Col. 64
		Col. 65	Col. 66
		Col. 67	Col. 68
		Col. 69	Col. 70
		Col. 71	Col. 72
		Col. 73	Col. 74
		Col. 75	Col. 76
		Col. 77	Col. 78
		Col. 79	Col. 80
		Col. 81	Col. 82
		Col. 83	Col. 84
		Col. 85	Col. 86
		Col. 87	Col. 88
		Col. 89	Col. 90
		Col. 91	Col. 92
		Col. 93	Col. 94
		Col. 95	Col. 96
		Col. 97	Col. 98
		Col. 99	Col. 100
		Col. 101	Col. 102
		Col. 103	Col. 104
		Col. 105	Col. 106
		Col. 107	Col. 108
		Col. 109	Col. 110
		Col. 111	Col. 112
		Col. 113	Col. 114
		Col. 115	Col. 116
		Col. 117	Col. 118
		Col. 119	Col. 120
		Col. 121	Col. 122
		Col. 123	Col. 124
		Col. 125	Col. 126
		Col. 127	Col. 128
		Col. 129	Col. 130
		Col. 131	Col. 132
		Col. 133	Col. 134
		Col. 135	Col. 136
		Col. 137	Col. 138
		Col. 139	Col. 140
		Col. 141	Col. 142
		Col. 143	Col. 144
		Col. 145	Col. 146
		Col. 147	Col. 148
		Col. 149	Col. 150
		Col. 151	Col. 152
		Col. 153	Col. 154
		Col. 155	Col. 156
		Col. 157	Col. 158
		Col. 159	Col. 160
		Col. 161	Col. 162
		Col. 163	Col. 164
		Col. 165	Col. 166
		Col. 167	Col. 168
		Col. 169	Col. 170
		Col. 171	Col. 172
		Col. 173	Col. 174
		Col. 175	Col. 176
		Col. 177	Col. 178
		Col. 179	Col. 180
		Col. 181	Col. 182
		Col. 183	Col. 184
		Col. 185	Col. 186
		Col. 187	Col. 188
		Col. 189	Col. 190
		Col. 191	Col. 192
		Col. 193	Col. 194
		Col. 195	Col. 196
		Col. 197	Col. 198
		Col. 199	Col. 200
		Col. 201	Col. 202
		Col. 203	Col. 204
		Col. 205	Col. 206
		Col. 207	Col. 208
		Col. 209	Col. 210
		Col. 211	Col. 212
		Col. 213	Col. 214
		Col. 215	Col. 216
		Col. 217	Col. 218
		Col. 219	Col. 220
		Col. 221	Col. 222
		Col. 223	Col. 224
		Col. 225	Col. 226
		Col. 227	Col. 228
		Col. 229	Col. 230
		Col. 231	Col. 232
		Col. 233	Col. 234
		Col. 235	Col. 236
		Col. 237	Col. 238
		Col. 239	Col. 240
		Col. 241	Col. 242
		Col. 243	Col. 244
		Col. 245	Col. 246
		Col. 247	Col. 248
		Col. 249	Col. 250
		Col. 251	Col. 252
		Col. 253	Col. 254
		Col. 255	Col. 256
		Col. 257	Col. 258
		Col. 259	Col. 260
		Col. 261	Col. 262
		Col. 263	Col. 264
		Col. 265	Col. 266
		Col. 267	Col. 268
		Col. 269	Col. 270
		Col. 271	Col. 272
		Col. 273	Col. 274
		Col. 275	Col. 276
		Col. 277	Col. 278
		Col. 279	Col. 280
		Col. 281	Col. 282
		Col. 283	Col. 284
		Col. 285	Col. 286
		Col. 287	Col. 288
		Col. 289	Col. 290
		Col. 291	Col. 292
		Col. 293	Col. 294
		Col. 295	Col. 296
		Col. 297	Col. 298
		Col. 299	Col. 300
		Col. 301	Col. 302
		Col. 303	Col. 304
		Col. 305	Col. 306
		Col. 307	Col. 308
		Col. 309	Col. 310
		Col. 311	Col. 312
		Col. 313	Col. 314
		Col. 315	Col. 316
		Col. 317	Col. 318
		Col. 319	Col. 320
		Col. 321	Col. 322
		Col. 323	Col. 324
		Col. 325	Col. 326
		Col. 327	Col. 328
		Col. 329	Col. 330
		Col. 331	Col. 332
		Col. 333	Col. 334
		Col. 335	Col. 336
		Col. 337	Col. 338
		Col. 339	Col. 340
		Col. 341	Col. 342
		Col. 343	Col. 344
		Col. 345	Col. 346
		Col. 347	Col. 348
		Col. 349	Col. 350
		Col. 351	Col. 352
		Col. 353	Col. 354
		Col. 355	Col. 356
		Col. 357	Col. 358
		Col. 359	Col. 360
		Col. 361	Col. 362
		Col. 363	Col. 364
		Col. 365	Col. 366
		Col. 367	Col. 368
		Col. 369	Col. 370
		Col. 371	Col. 372
		Col. 373	Col. 374
		Col. 375	Col. 376
		Col. 377	Col. 378
		Col. 379	Col. 380
		Col. 381	Col. 382
		Col. 383	Col. 384
		Col. 385	Col. 386
		Col. 387	Col. 388
		Col. 389	Col. 390
		Col. 391	Col. 392
		Col. 393	Col. 394
		Col. 395	Col. 396
		Col. 397	Col. 398
		Col. 399	Col. 400
		Col. 401	Col. 402
		Col. 403	Col. 404
		Col. 405	Col. 406
		Col. 407	Col. 408
		Col. 409	Col. 410
		Col. 411	Col. 412
		Col. 413	Col. 414
		Col. 415	Col. 416
		Col. 417	Col. 418
		Col. 419	Col. 420
		Col. 421	Col. 422
		Col. 423	Col. 424
		Col. 425	Col. 426
		Col. 427	Col. 428
		Col. 429	Col. 430
		Col. 431	Col. 432
		Col. 433	Col. 434
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		Col. 437	Col. 438
		Col. 439	Col. 440
		Col. 441	Col. 442
		Col. 443	Col. 444
		Col. 445	Col. 446
		Col. 447	Col. 448
		Col. 449	Col. 450
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		Col. 461	Col. 462
		Col. 463	Col. 464
		Col. 465	Col. 466
		Col. 467	Col. 468
		Col. 469	Col. 470
		Col. 471	Col. 472
		Col. 473	Col. 474
		Col. 475	Col. 476
		Col. 477	Col. 478
		Col. 479	Col. 480
		Col. 481	Col. 482
		Col. 483	Col. 484
		Col. 485	Col. 486
		Col. 487	Col. 488
		Col. 489	Col. 490
		Col. 491	Col. 492
		Col. 493	Col. 494
		Col. 495	Col. 496
		Col. 497	Col. 498
		Col. 499	Col. 500
		Col. 501	Col. 502
		Col. 503	Col. 504
		Col. 505	Col. 506
		Col. 507	Col. 508
		Col. 509	Col. 510
		Col. 511	Col. 512
		Col. 513	Col. 514
		Col. 515	Col. 516
		Col. 517	Col. 518
		Col. 519	Col. 520
		Col. 521	Col. 522
		Col. 523	Col. 524
		Col. 525	Col. 526
		Col. 527	Col. 528
		Col. 529	Col. 530
		Col. 531	Col. 532
		Col. 533	Col. 534
		Col. 535	Col. 536
		Col. 537	Col. 538
		Col. 539	Col. 540
		Col. 541	Col. 542
		Col. 543	Col. 544
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		Col. 549	Col. 550
		Col. 551	Col. 552
		Col. 553	Col. 554
		Col. 555	Col. 556
		Col. 557	Col. 558
		Col. 559	Col. 560
		Col. 561	Col. 562
		Col. 563	Col. 564
		Col. 565	Col. 566
		Col. 567	Col. 568
		Col. 569	Col. 570
		Col. 571	Col. 572
		Col. 573	Col. 574
		Col. 575	Col. 576
		Col. 577	Col. 578
		Col. 579	Col. 580
		Col. 581	Col. 582
		Col. 583	Col. 584
		Col. 585	Col. 586
		Col. 587	Col. 588
		Col. 589	Col. 590
		Col. 591	Col. 592
		Col. 593	Col. 594
		Col. 595	Col. 596
		Col. 597	Col. 598
		Col. 599	Col. 600
		Col. 601	Col. 602
		Col. 603	Col. 604
		Col. 605	Col. 606
		Col. 607	Col. 608
		Col. 609	Col. 610
		Col. 611	Col. 612
		Col. 613	Col. 614
		Col. 615	Col. 616
		Col. 617	Col. 618
		Col. 619	Col. 620
		Col. 621	Col. 622
		Col. 623	Col. 624
		Col. 625	Col. 626
		Col. 627	Col. 628
		Col. 629	Col. 630
		Col. 631	Col. 632
		Col. 633	Col. 634
		Col. 635	Col. 636
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		Col. 639	Col. 640
		Col. 641	Col. 642
		Col. 643	Col. 644
		Col. 645	Col. 646
		Col. 647	Col. 648
		Col. 649	Col. 650
		Col. 651	Col. 652
		Col. 653	Col. 654
		Col. 655	Col. 656
		Col. 657	Col. 658
		Col. 659	Col. 660
		Col. 661	Col. 662
		Col. 663	Col. 664
		Col. 665	Col. 666
		Col. 667	Col. 668
		Col. 669	Col. 670
		Col. 671	Col. 672
		Col. 673	Col. 674
		Col. 675	Col. 676
		Col. 677	Col. 678
		Col. 679	Col. 680
		Col. 681	Col. 682
		Col. 683	Col. 684
		Col. 685	Col. 686
		Col. 687	Col. 688
		Col. 689	Col. 690
		Col. 691	Col. 692
		Col. 693	Col. 694
		Col. 695	Col. 696
		Col. 697	Col. 698
		Col. 699	Col. 700
		Col. 701	Col. 702
		Col. 703	Col. 704
		Col. 705	Col. 706
		Col. 707	Col. 708
		Col. 709	Col. 710
		Col. 711	Col. 712
		Col. 713	Col. 714
		Col. 715	Col. 716
		Col. 717	Col. 718
		Col. 719	Col.

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 gage 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 gage 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 gage 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 gages. 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 1 mm maximum including tolerances.
- ⑩ Tolerance for "O" temper material is four times the standard tolerances shown.

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12. Tube and Pipe

Table 12.1 intentionally blank

TABLE 12.2 Diameter—Round Extruded Tube

EXCEPT FOR T3510, T4510, T6510, T73510 AND T8510 TEMPER^⑦

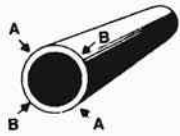
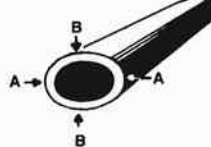
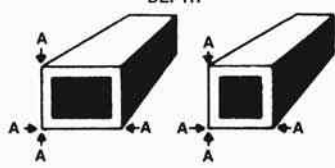
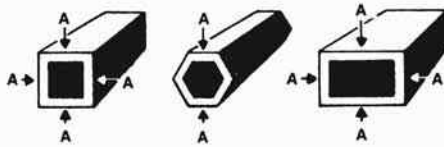
SPECIFIED DIAMETER ^① mm	TOLERANCE ^② —mm plus and minus				
	ALLOWABLE DEVIATION OF MEAN DIAMETER ^③ FROM SPECIFIED DIAMETER (Size)		ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER ^④		
	 Difference between $\frac{1}{2}(AA+BB)$ and specified diameter		 Difference between AA or BB and specified diameter		
Col. 1	Col. 2		Col. 3		
over	thru	5xxx≥4.0 nominal Mg ^⑥	Other Alloys	5xxx≥4.0 nominal Mg ^⑥	Other Alloys
12.50	25.00	0.38	0.25	0.76	0.50
25.00	50.00	0.46	0.30	0.96	0.64
50.00	100.00	0.58	0.38	1.15	0.76
100.00	150.00	0.96	0.64	1.90	1.25
150.00	200.00	1.35	0.88	2.85	1.90
200.00	250.00	1.75	1.15	3.80	2.55
250.00	300.00	2.10	1.40	4.80	3.20
300.00	350.00	2.50	1.65	5.70	3.80
350.00	400.00	2.85	1.90	6.70	4.45
400.00	450.00	3.25	2.15	7.60	5.10

TABLE 12.3 Width and Depth—Square, Rectangular, Hexagonal and Octagonal Tube

EXCEPT FOR T3510, T4510, T6510, T73510 AND T8510 TEMPER^⑦

SPECIFIED WIDTH OR DEPTH mm	TOLERANCE ^② —mm 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			
Col. 1	Col. 2			Col. 3		Col. 4	
over	thru	5xxx≥4.0 nominal Mg ^⑥	Other Alloys	5xxx≥4.0 nominal Mg ^⑥	Other Alloys	All Alloys	
12.50	20.00	0.46	0.30	0.76	0.50	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.	
20.00	25.00	0.54	0.36	0.76	0.50		
25.00	50.00	0.68	0.46	0.96	0.64		
50.00	100.00	0.96	0.64	1.35	0.88		
100.00	130.00	1.35	0.88	1.75	1.15		
130.00	150.00	1.75	1.15	2.10	1.40	Example: The width tolerance of a 25 × 75 mm alloy 6061 rectangular tube is ±0.50 mm and the depth tolerance ±0.88 mm.	
150.00	180.00	2.10	1.40	2.50	1.65		
180.00	200.00	2.50	1.65	2.75	1.90		
200.00	230.00	2.85	1.90	3.10	2.15		
230.00	250.00	3.25	2.15	3.65	2.40		
250.00	280.00	3.65	2.40	4.00	2.65		
280.00	330.00	4.00	2.65	4.40	2.90		

For all numbered footnotes, see page 35.

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TABLE 12.4 Wall Thickness—Round Extruded Tube

SPECIFIED WALL THICKNESS ⑤ mm		TOLERANCE ① ②—mm 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										
		thru 30	over 30 thru 80		over 80 thru 130		over 130					
Col. 1	Col. 2		Col. 3		Col. 4		Col. 5		Col. 6			
over	thru	5xxx ≥4.0 nominal Mg ⑥	Other Alloys	5xxx ≥4.0 nominal Mg ⑥	Other Alloys	5xxx ≥4.0 nominal Mg ⑥	Other Alloys	5xxx ≥4.0 nominal Mg ⑥	Other Alloys	All Alloys		
..	1.20	0.23	0.15	..	..	..	..	..	..	10% of mean wall thickness with a minimum of 0.25 and a maximum of 1.50		
1.20	1.60	0.28	0.18	0.30	0.20	0.30	0.20	0.38	0.25			
1.60	2.00	0.30	0.20	0.30	0.20	0.36	0.23	0.46	0.35			
2.00	3.20	0.36	0.23	0.36	0.23	0.38	0.25	0.58	0.38			
3.20	6.30	0.36	0.23	0.36	0.23	0.50	0.33	0.76	0.50			
6.30	10.00	0.43	0.28	0.43	0.28	0.60	0.41	0.96	0.64			
10.00	12.50	..	..	0.58	0.38	0.80	0.54	1.35	0.88	3.00		
12.50	20.00	..	..	0.76	0.50	1.05	0.72	1.75	1.15			
20.00	25.00	..	..	..	..	1.35	0.88	2.10	1.40			
25.00	35.00	..	..	..	..	1.75	1.15	2.50	1.65			
35.00	50.00	..	..	..	..	..	..	2.85	1.90			
50.00	60.00	..	..	..	..	..	..	3.25	2.15	3.00		
60.00	80.00	..	..	..	..	..	..	3.65	2.40			
80.00	90.00	..	..	..	..	..	..	4.00	2.65			
90.00	100.00	..	..	..	..	..	..	4.40	2.90			

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

SPECIFIED WALL THICKNESS ⑥ mm		TOLERANCE ① ②—mm 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 ½ (AA + BB) and specified wall thickness					Difference between AA and mean wall thickness					
		CIRCUMSCRIBING CIRCLE DIAMETER ⑩—mm										
		thru 130		over 130		thru 130		over 130				
Col. 1		Col. 2		Col. 3		Col. 4		Col. 5				
over	thru	5xxx≥4.0 nominal Mg ⑥	Other Alloys	5xxx≥4.0 nominal Mg ⑥	Other Alloys	All Alloys	All Alloys	All Alloys	All Alloys			
..	1.20	0.20	0.13	0.30	0.20	0.13	0.13	10% of mean wall thickness with a minimum of 0.25 and a maximum of 1.50				
1.20	1.60	0.23	0.15	0.36	0.23	0.18	0.18					
1.60	3.20	0.28	0.18	0.38	0.25	0.25	0.25					
3.20	6.30	0.30	0.20	0.58	0.38	0.38	0.38					
6.30	10.00	0.43	0.28	0.76	0.50	0.64	0.64					
10.00	12.50	0.52	0.36	1.15	0.76	0.76	0.76					
12.50	20.00	0.96	0.64	1.50	1.00	1.00	1.00					
20.00	25.00	1.35	0.90	1.90	1.25	1.25	1.25					
25.00	35.00	1.75	1.15	2.30	1.50	1.50	1.50					
35.00	50.00	..	..	2.65	1.80	..	..					

For all numbered footnotes, see page 35.

TABLE 12.6 Length—Extruded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH		TOLERANCE—mm plus excepted as noted							
		ALLOWABLE DEVIATION FROM SPECIFIED LENGTH							
		STRAIGHT				COILED			
		SPECIFIED LENGTH—mm							
		Up thru 5 000	Over 5 000 thru 10 000	Over 10 000 thru 15 000	Over 15 000	Up thru 30 000	Over 30 000 thru 75 000	Over 75 000 thru 150 000	Over 150 000
over	thru								
12.50	35.00	4	7	10	25	+5%, −0%	±10%	±15%	±20%
35.00	70.00	4	7	10	25	..	..	..	..
70.00	200.00	6	9	11	25	..	..	..	..
200.00	..	7	10	13	25	..	..	..	..

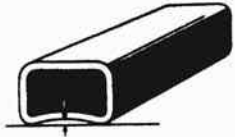
TABLE 12.7 Twist ^①—Other-than-Round Extruded Tube

TEMPER	SPECIFIED WIDTH mm		SPECIFIED THICKNESS mm		TOLERANCE ^⑧ —Degrees
					 Y (max.) in degrees
	over	thru	over	thru	Allowable deviation from straight, y(max), in total length or in any 300 mm or longer chord segment of the total length
All except O, TX510, TX511 ^⑥	12.50 40.00 80.00	40.00 80.00 ..	All All All		3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 3°
O, TX510 ^⑥	12.50	..	2.5	..	^⑦
TX511 ^⑥	12.50 40.00 80.00	40.00 80.00 ..	2.5 2.5 2.5		3°/m but not greater than 7° 1.5°/m but not greater than 5° 1°/m but not greater than 3°

TABLE 12.8 Straightness—Extruded Tube in
Straight Lengths

TEMPER	SPECIFIED mm		TOLERANCE ^⑨ ^⑩ —mm
			 Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of the total length
	over	thru	
All except O, TX510 ^⑦ ^⑥	12.50 150.00	150.00 ..	1 mm/m 2 mm/m
O, TX510 ^⑥	12.50	..	^⑦

TABLE 12.9 Flatness (Flat Surfaces)—Extruded
TubeEXCEPT FOR O, T3510, T4510, T6510, T73510, T76510 AND T8510
TEMPERS ^⑦

MINIMUM THICKNESS OF METAL FORMING THE SURFACE mm		TOLERANCE—mm	
		 Maximum Allowable Deviation Y	
		WIDTH (W) UP THRU 25 mm OR ANY 25 mm INCREMENT OF WIDER SURFACES	WIDTH (W) OVER 25 THRU 120 mm
over	thru		
..	5.00	0.15	0.006 × W (mm)
5.00	..	0.10	0.004 × W (mm)

For all numbered footnotes, see page 35.

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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 ^⑮ mm		TOLERANCE—mm
		ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
		Difference between radius A and specified radius
over	thru	
Sharp corners		+0.5
0.50	5.00	±0.5
5.00	..	±10%

TABLE 12.12 Angularity—Extruded Tube

Allowable deviation from square: ±2 degrees.
--

TABLE 12.13 Surface Roughness ^⑮ ^⑰—Extruded Tube

Specified Outside Diameter mm		Specified Wall Thickness mm		Allowable Depth of Conditions ^⑮ mm, max.
over	thru	over	thru	
..	325.00	..	1.60	0.07
		1.60	3.20	0.08
		3.20	5.00	0.09
		5.00	6.30	0.10
		6.30	12.50	0.13
		12.50	..	0.20
325.00	400.00	..	12.50	0.25
400.00	500.00	12.50	..	0.30
		..	12.50	0.40
500.00	..	..	12.50	0.40
		12.50	..	0.50

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 2.5% exclusive—2.5 × tolerance (max.)
 1.5% to 2% exclusive—3.0 × tolerance (max.)
 1% to 1.5% 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 2.5 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 mass 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 product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	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 2.5 mm.

⑬ Conditions include die lines, mandrel lines and handling marks.

⑭ For tube over 325 mm 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 1 mm maximum including tolerances.

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

SPECIFIED OUTSIDE DIAMETER mm	TOLERANCE—mm plus and minus	
	ALLOWABLE DEVIATION OF MEAN DIAMETER FROM SPECIFIED DIAMETER	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER
6.00 thru 16.00	0.10	0.15

TABLE 12.17 Wall Thickness—Extruded Coiled Tube

SPECIFIED WALL THICKNESS mm	TOLERANCE—mm 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
0.80 thru 1.30	0.08	0.10

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.

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TABLE 12.20 Diameter—Drawn Round Tube

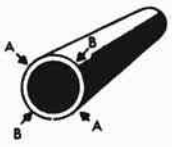
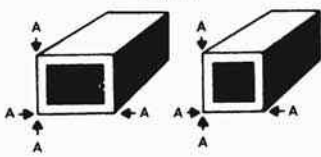
SPECIFIED DIAMETER mm		TOLERANCE ②—mm plus and minus			
		ALLOWABLE DEVIATION OF MEAN DIAMETER ③ FROM SPECIFIED DIAMETER (Size)	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER ④		
		 Difference between $\frac{1}{2}(AA + BB)$ and specified diameter	Difference between AA or BB and specified diameter		
over	thru		NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ⑤	ANNEALED TUBE
Col. 1		Col. 2	Col. 3	Col. 4	Col. 5
..	12.50	0.08	0.08	0.16	0.48
12.50	25.00	0.10	0.10	0.20	0.60
25.00	50.00	0.13	0.13	0.25	0.75
50.00	80.00	0.15	0.15	0.30	0.90
80.00	130.00	0.20	0.20	0.41	1.20
130.00	150.00	0.25	0.25	0.50	1.50
150.00	200.00	0.38	0.38	0.76	2.25
200.00	250.00	0.50	0.50	1.00	3.00
250.00	300.00	0.64	0.64	1.25	3.75

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

SPECIFIED WIDTH OR DEPTH ① mm		TOLERANCE ②—mm 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
..	12.50	0.08	0.16	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
12.50	25.00	0.10	0.20	
25.00	50.00	0.13	0.25	
50.00	80.00	0.15	0.30	
80.00	130.00	0.20	0.41	
130.00	150.00	0.25	0.50	
150.00	200.00	0.38	0.76	
200.00	250.00	0.50	1.00	
250.00	300.00	0.64	1.25	

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 2.5 percent of the specified outside diameter. The tolerance for tube with wall thickness less than 2.5 percent of the specified outside diameter is determined by multiplying the applicable tolerance in columns 3 thru 5 as follows:

2% to 2.5% exclusive— $1.5 \times$ tolerance

1.5% to 2% exclusive— $2.0 \times$ tolerance

1% to 1.5% exclusive— $3.0 \times$ tolerance

0.5% to 1% exclusive— $4.0 \times$ tolerance

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

⑥ Example: The width tolerance of 25×75 mm rectangular tube is plus and minus 0.20 mm, and the depth tolerance is plus and minus 0.30 mm.

⑦ Not applicable to annealed (O temper) tube.

Dimensional Tolerances for

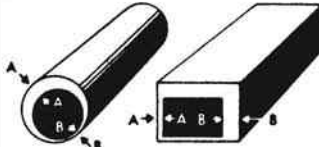
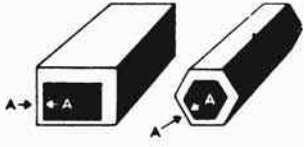
TABLE 12.22 Diameter—Drawn Oval, Elliptical and Streamline Tube

EQUIVALENT ROUND DIAMETER ^③ mm		TOLERANCE ^{① ②} —mm			
		LENGTH OF MAJOR AXIS, mm		LENGTH OF MAJOR AXIS, mm	
					
		Difference between AA and specified length		Difference between AA and specified length	
over	thru	Col. 1		Col. 2	
..	70.00	+1.00	–0.64	+0.64	–0.38
70.00	110.00	+1.25	–0.90	+0.90	–0.64
110.00	150.00	+1.80	–1.25	+1.40	–1.00
150.00	200.00	+2.55	–2.15	+2.05	–1.60
200.00	250.00	+4.05	–3.55	+2.90	–2.15

TABLE 12.23 Corner Radii—Drawn Tube

SPECIFIED ^⑦ RADIUS mm		TOLERANCE—mm
		ALLOWABLE DEVIATION FROM SPECIFIED RADIUS
		
		Difference between radius A and specified radius
over	thru	
Sharp Corners		+0.5
0.50	5.00	±0.5
5.00	..	±10%

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

SPECIFIED THICKNESS ^④ mm		TOLERANCE ^{① ②} —mm 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)	
				ROUND, NON-HEAT-TREAT- ABLE ALLOYS ^⑤	ROUND, HEAT-TREATABLE ALLOYS AND OTHER THAN ROUND, ALL ALLOYS
		Difference between $\frac{1}{2}(AA+BB)$ and specified wall thickness			
over	thru	Col. 1		Col. 3	Col. 4
0.23	0.80	0.05		0.05	Plus and minus 10% of specified wall thickness, min ±0.08
0.80	1.20	0.08		0.08	
1.20	2.00	0.10		0.10	
2.00	3.20	0.13		0.15	
3.20	5.00	0.15		0.20	
5.00	8.00	0.20		0.30	
8.00	10.00	0.38		0.50	
10.00	12.50	0.50		0.76	

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 ±0.08 mm.

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 1 mm maximum including tolerances.

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TABLE 12.25 Straightness—Drawn Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH mm		TOLERANCE ① ②—mm
		 D(max) Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of total length
over	thru	
..	9.50	42 mm/m
9.50	150.00	1 mm/m
150.00	..	2 mm/m

TABLE 12.26 Twist ④—Drawn Tube

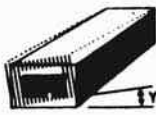
SPECIFIED WIDTH mm		TOLERANCE ① ②—Degree
		 Y (max) in degrees Allowable deviation from straight, y(max), in total length or in any 300 mm or longer chord segment of total length.
over	thru	
..	40.00	3°/m but not greater than 7°
40.00	80.00	1.5°/m but not greater than 5°
80.00	..	1°/m but not greater than 3°

TABLE 12.27 Length—Drawn Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH mm		TOLERANCE—mm plus excepted as noted							
		ALLOWABLE DEVIATION FROM SPECIFIED LENGTH							
		STRAIGHT				COILED			
		SPECIFIED LENGTH—mm							
		Up thru 5 000	Over 5 000 thru 10 000	Over 10 000 thru 15 000	Over 15 000	Up thru 30 000	Over 30 000 thru 75 000	Over 75 000 thru 150 000	Over 150 000
over	thru								
..	6.30	7	10	13	..	+5%, -0%	±10%	±15%	±20%
6.30	35.00	4	7	10	25	+5%, -0%	±10%	±15%	±20%
35.00	70.00	4	7	10	25	..	..	..	..
70.00	200.00	6	9	11	25	..	..	..	..
200.00	..	7	10	13	25	..	..	..	..

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

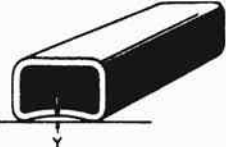
SPECIFIED WIDTH OR DEPTH mm		TOLERANCE ③—mm
		ALLOWABLE DEVIATION FROM FLAT  Maximum allowable distance Y
over	thru	
..	12.50	0.08
12.50	25.00	0.10
25.00	50.00	0.13
50.00	80.00	0.15
80.00	130.00	0.20
130.00	150.00	0.25
150.00	200.00	0.38
200.00	250.00	0.50
250.00	300.00	0.64

TABLE 12.29 Squareness of Cut Ends—Drawn Tube

Allowable deviation from square: 1 degree

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 mass 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 0.50 mm 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 product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

TABLE 12.31 Surface Roughness—Drawn Tube^②

Depth of surface conditions shall not exceed 10% of the smaller (or nominal) wall thickness or 0.13 mm, whichever is smaller.

② Not applicable to annealed (O temper) tube.

TABLE 12.32 Dents—Drawn Tube

SPECIFIED DIAMETER		TOLERANCES—mm		
		NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ^⑤	ANNEALED TUBE
over	thru	Col. 2	Col. 3	Col. 4
...	12.50	0.08	0.16	0.48
12.50	25.00	0.10	0.20	0.60
25.00	50.00	0.13	0.25	0.75
50.00	80.00	0.15	0.30	0.90
80.00	130.00	0.20	0.41	1.20
130.00	150.00	0.25	0.50	1.50
150.00	200.00	0.38	0.76	2.25
200.00	250.00	0.50	1.00	3.00
250.00	300.00	0.64	1.25	3.75

Depth of dents shall not exceed twice the tolerances specified in table 12.32 at any point from specified diameter with the following exception.

For tube having a wall thickness less than 2.5 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.)

⑤ 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, mm		TOLERANCE ^① mm plus and minus
over	thru	
...	12.50	0.08
12.50	25.00	0.10
25.00	40.00	0.13
40.00	50.00	0.15

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

SPECIFIED OUTSIDE DIAMETER, mm		TOLERANCE ^① mm plus and minus
over	thru	
...	12.50	0.05
12.50	20.00	0.06
20.00	25.00	0.08
25.00	30.00	0.09
30.00	50.00	0.10

TABLE 12.36 Wall Thickness Tolerances—Heat Exchanger Tube

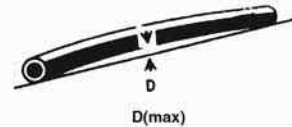
SPECIFIED WALL THICKNESS, mm		TOLERANCE—mm plus	
		ALLOWABLE DEVIATION OF MEAN ^② WALL THICKNESS FROM SPECIFIED WALL THICKNESS	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS (Eccentricity)
over	thru		
...	0.80	0.10	0.15
0.80	1.20	0.15	0.22
1.20	1.60	0.20	0.30
1.60	2.00	0.25	0.38
2.00	2.50	0.30	0.46
2.50	3.20	0.36	0.56
3.20	4.00	0.45	0.70
4.00	5.00	0.60	0.90

TABLE 12.37 Length Tolerances—Heat Exchanger Tube

SPECIFIED LENGTH		TOLERANCE—mm plus
over	thru	
...	5 000	2.5
5 000	10 000	5
10 000	20 000	7

TABLE 12.38 Straightness Tolerances—Heat Exchanger Tube

SPECIFIED OUTSIDE DIAMETER, mm		TOLERANCE ^③ —mm
over	thru	
9.00	50.00	1 mm/m



Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of total length

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

Welded Tube

TABLE 12.41 Diameter Tolerances—Welded Round Tube

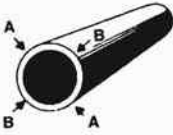
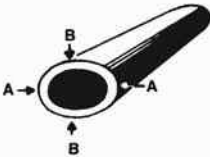
SPECIFIED DIAMETER ① mm		TOLERANCE ①—mm plus and minus	
		ALLOWABLE DEVIATION OF MEAN DIAMETER ② FROM SPECIFIED DIAMETER (Size)	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER
		 Difference between $\frac{1}{2}(AA+BB)$ and specified diameter	 Difference between AA or BB and specified diameter
over	thru	Col. 2	Col. 3
12.50	25.00	0.10	0.20
25.00	50.00	0.13	0.25

TABLE 12.42 Width and Depth Tolerances—Welded Square Tube

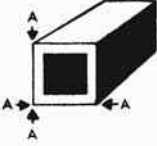
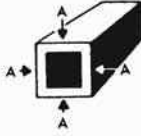
SPECIFIED WIDTH OR DEPTH mm		TOLERANCE ①—mm plus and minus	
		ALLOWABLE DEVIATION OF WIDTH OR DEPTH AT CORNERS FROM SPECIFIED WIDTH OR DEPTH	ALLOWABLE DEVIATION OF WIDTH OR DEPTH NOT AT CORNERS FROM SPECIFIED WIDTH OR DEPTH
		 Difference between AA and specified width or depth	 Difference between AA and specified width or depth
over	thru	Col. 2	Col. 3
12.50	25.00	0.13	0.20
25.00	50.00	0.15	0.25

TABLE 12.43 Wall Thickness Tolerances—Welded Round and Square Tube

SPECIFIED THICKNESS mm		TOLERANCE ③—mm plus
		ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS
		
over	thru	
0.63	1.00	0.10
1.00	2.00	0.13

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.

Dimensional Tolerances for

TABLE 12.44 Length Tolerances—Welded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH mm	TOLERANCE—mm					
	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH					
	SPECIFIED LENGTH—mm					
	Up thru 3 000		Over 3 000 thru 6 000		Over 6 000 thru 12 000	
	Plus	Minus	Plus	Minus	Plus	Minus
Up thru 50.00	4	0	6	0	10	0

TABLE 12.45 Straightness Tolerances—Welded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH mm	TOLERANCE ①—mm	
	 D(max)	
	over	thru
12.50	25.00	2.5 mm/m
25.00	50.00	3.5 mm/m

TABLE 12.46 Twist ② Tolerances—Welded Tube

SPECIFIED WIDTH mm	TOLERANCE ①—Degrees	
	 Y (max) in degrees	
	over	thru
..	40.00	3°/m but not greater than 7°
40.00	50.00	1.5°/m but not greater than 5°

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 product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	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

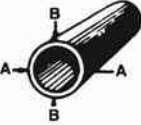
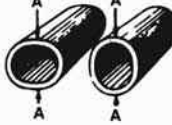
Nominal Diameter ④ ⑤	TOLERANCE—mm	
	Allowable deviation of mean ② diameter from nominal diameter ①	Allowable deviation of diameter at any point from nominal diameter ① ⑦
		
	Difference between ½(AA+BB) and nominal diameter	Difference between AA and nominal diameter
SCHEDULES 5 AND 10		
Under 50	+0.40, -0.80	+ .40, - .80
50–100	+0.80, -0.80	+1%, -1%
125–150	+1.60, -0.80	+1%, -1%
200–300	+2.40, -0.80	+1%, -1%
SCHEDULE 20 AND GREATER		
Under 50	+0.40, -0.80	+ .40, - .80
50–100	+0.80, -0.80	+1%, -1%
125–150	+1.60, -0.80	+1%, -1%
200–300	+2.40, -0.80	+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	±12.5%, ±0.30 mm 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 mm		TOLERANCE mm plus
over	thru	ALLOWABLE DEVIATION FROM SPECIFIED LENGTH
...	6 000	6
6 000	12 000	13

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

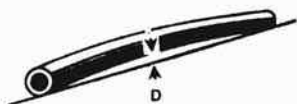
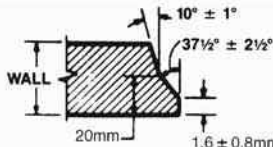
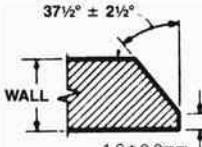
Nominal Diameter ④ ⑤	TOLERANCE ④—mm
	
	Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of total length.
Under 150	1 mm/m
150–300	2 mm/m

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

DOUBLE LEVEL For Wall Thickness Over 20.00 mm	STRAIGHT BEVEL For Wall Thickness up thru 20.00 mm
	

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 mass tolerance.
 ④ When mass 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 The 1 percent tolerances are rounded to the nearest 0.1 mm before applying the tolerance.
 ⑧ In accordance with ANSI/ASME Standards B36.10M and B36.19M.
 ⑨ Nominal Diameter (DN) is a dimensionless designator used in the SI (metric) system to describe pipe size.

TABLE 12.55 Diameters, Wall Thicknesses, Weights—Pipe

Nominal Diameter ① ⑤	SCHEDULE NUMBER	OUTSIDE DIAMETER mm			INSIDE DIAMETER mm	WALL THICKNESS mm			MASS PER METRE g	
		Nom. ①	Min. ② ④	Max. ② ④		Nom. ①	Min. ②	Max. ②	Nom. ③	Max. ② ③
6	40	10.30	9.50	10.70	6.84	1.73	1.51	..	0.13	0.14
	80	10.30	9.50	10.70	5.48	2.41	2.11	..	0.16	0.17
8	40	13.70	12.90	14.10	9.22	2.24	1.96	..	0.22	0.24
	80	13.70	12.90	14.10	7.66	3.02	2.64	..	0.27	0.29
10	40	17.10	16.30	17.50	12.48	2.31	2.02	..	0.29	0.31
	80	17.10	16.30	17.50	10.70	3.20	2.80	..	0.38	0.41
15	40	21.30	20.50	21.70	15.76	2.77	2.42	..	0.44	0.48
	80	21.30	20.50	21.70	13.84	3.73	3.26	..	0.56	0.60
	160	21.30	20.50	21.70	11.74	4.78	4.18	..	0.67	0.72
20	40	26.70	25.90	27.10	20.96	2.87	2.51	..	0.58	0.63
	80	26.70	25.90	27.10	18.88	3.91	3.42	..	0.76	0.82
	160	26.70	25.90	27.10	15.58	5.56	4.86	..	1.00	1.08
25	40	33.40	32.60	33.80	26.64	3.38	2.96	..	0.86	0.93
	80	33.40	32.60	33.80	24.30	4.55	3.98	..	1.11	1.20
	160	33.40	32.60	33.80	20.70	6.35	5.56	..	1.46	1.58
32	40	42.20	41.40	42.60	35.08	3.56	3.12	..	1.17	1.26
	80	42.20	41.40	42.60	32.50	4.85	4.24	..	1.54	1.66
	160	42.20	41.40	42.60	29.50	6.35	5.56	..	1.93	2.08
40	40	48.30	47.50	48.70	40.94	3.68	3.22	..	1.39	1.50
	80	48.30	47.50	48.70	38.14	5.08	4.44	..	1.86	2.01
	160	48.30	47.50	48.70	34.02	7.14	6.25	..	2.49	2.69
50	40	60.30	59.70	60.90	52.48	3.91	3.42	..	1.87	2.02
	80	60.30	59.70	60.90	49.22	5.54	4.85	..	2.57	2.78
	160	60.30	59.70	60.90	42.82	8.74	7.65	..	3.82	4.13
65	40	73.00	72.30	73.70	62.68	5.16	4.52	..	2.97	3.21
	80	73.00	72.30	73.70	58.98	7.01	6.13	..	3.92	4.23
	160	73.00	72.30	73.70	53.94	9.53	8.34	..	5.13	5.54
80	40	88.90	88.00	89.80	77.92	5.49	4.80	..	3.88	4.19
	80	88.90	88.00	89.80	73.66	7.62	6.67	..	5.25	5.67
	160	88.90	88.00	89.80	66.64	11.13	9.74	..	7.34	7.93
90	40	101.60	100.60	102.60	90.12	5.74	5.02	..	4.67	5.04
	80	101.60	100.60	102.60	85.44	8.08	7.07	..	6.41	6.92

For all numbered footnotes, see page 45.

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

Nominal Diameter ① ③	SCHEDULE NUMBER	OUTSIDE DIAMETER mm			INSIDE DIAMETER mm	WALL THICKNESS mm			MASS PER METRE g	
		Nom. ①	Min. ② ④	Max. ② ④		Nom. ①	Min. ②	Max. ②	Nom. ③	Max. ② ③
100	40	114.30	113.20	115.40	102.26	6.02	5.27	..	5.53	5.97
	80	114.30	113.20	115.40	97.18	8.56	7.49	..	7.68	8.29
	120	114.30	113.20	115.40	92.04	11.13	9.74	..	9.74	10.53
	160	114.30	113.20	115.40	87.32	13.49	11.80	..	11.54	12.45
125	40	141.30	139.90	142.70	128.20	6.55	5.73	..	7.49	8.09
	80	141.30	139.90	142.70	122.24	9.53	8.34	..	10.65	11.50
	120	141.30	139.90	142.70	115.90	12.70	11.11	..	13.85	14.96
	160	141.30	139.90	142.70	109.54	15.88	13.90	..	16.89	18.24
150	40	168.30	166.60	170.00	154.08	7.11	6.22	..	9.72	10.50
	80	168.30	166.60	170.00	146.36	10.97	9.60	..	14.64	15.81
	120	168.30	166.60	170.00	139.76	14.27	12.49	..	18.64	20.13
	160	168.30	166.60	170.00	131.78	18.26	15.98	..	23.24	25.10
200	20	219.10	216.90	221.30	206.40	6.35	5.56	..	11.46	12.38
	30	219.10	216.90	221.30	205.02	7.04	6.16	..	12.66	13.67
	40	219.10	216.90	221.30	202.74	8.18	7.16	..	14.63	15.80
	60	219.10	216.90	221.30	198.48	10.31	9.02	..	18.26	19.72
	80	219.10	216.90	221.30	193.70	12.70	11.11	..	22.23	24.01
	100	219.10	216.90	221.30	188.92	15.09	13.20	..	26.11	28.21
	120	219.10	216.90	221.30	182.58	18.26	15.98	..	31.11	33.60
	140	219.10	216.90	221.30	177.86	20.62	18.04	..	34.72	37.50
	160	219.10	216.90	221.30	173.08	23.01	20.13	..	38.27	41.33
250	20	273.10	270.40	275.80	260.40	6.35	5.56	..	14.37	15.52
	30	273.10	270.40	275.80	257.50	7.60	6.82	..	17.55	18.95
	40	273.10	270.40	275.80	254.56	9.27	8.11	..	20.75	22.41
	60	273.10	270.40	275.80	247.70	12.70	11.11	..	28.05	30.29
	80	273.10	270.40	275.80	242.92	15.09	13.20	..	33.02	35.66
	100	273.10	270.40	275.80	236.58	18.26	15.98	..	39.47	42.63
300	20	323.90	320.70	327.10	311.20	6.35	5.56	..	17.10	18.47
	30	323.90	320.70	327.10	307.14	8.38	7.33	..	22.43	24.22
	40	323.90	320.70	327.10	303.28	10.31	9.02	..	27.42	28.61
	60	323.90	320.70	327.10	295.36	14.27	12.49	..	37.48	40.48
	80	323.90	320.70	327.10	288.94	17.48	15.30	..	45.43	49.06

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 2700 kg/m³ for alloy 6061. For alloy 6063 multiply by 0.99 and for alloy 3003 multiply by 1.01.

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

⑤ Nominal Diameter (DN) is a dimensionless designator used in the SI (metric) system 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

CLASS 1. FORGING STOCK				CLASS 2. FORGING STOCK			
SPECIFIED DIAMETER mm		TOLERANCE mm plus and minus		SPECIFIED DIAMETER mm		TOLERANCE mm plus and minus	
over	thru	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER	CONDITIONING ALLOWANCE ②	over	thru	ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER	
10.00	12.50	0.38	–1	10.00	12.50	0.040	
12.50	25.00	0.38	–1	12.50	25.00	0.050	
25.00	40.00	0.38	–1	25.00	40.00	0.06	
40.00	80.00	0.38	–1	40.00	80.00	0.20	
80.00	130.00	0.78	–2	..	..	..	
100.00	200.00	1.60	–2	..	..	..	

TABLE 14.2 Distance Across Flats ①—Square Forging Stock

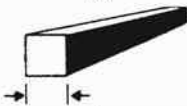
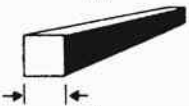
CLASS 1. FORGING STOCK				CLASS 2. FORGING STOCK			
SPECIFIED DISTANCE ACROSS FLATS mm		TOLERANCE mm plus and minus		SPECIFIED DISTANCE ACROSS FLATS mm		TOLERANCE mm plus and minus	
		ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS	CONDITIONING ALLOWANCE ②			ALLOWABLE DEVIATION FROM SPECIFIED DISTANCE ACROSS FLATS	
over	thru			over	thru		
10.00	12.50	0.25	–1 on face	10.00	12.50	0.050	
12.50	25.00	0.38	–1 on face	12.50	25.00	0.06	
25.00	50.00	0.46	–1 on face	25.00	40.00	0.08	
50.00	80.00	0.50	–1 on face	40.00	100.00	0.13	
80.00	100.00	0.80	–1 on face	..	..	..	

TABLE 14.3 Thickness and Width ①—Rectangular Forging Stock

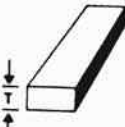
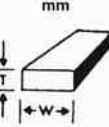
CLASS 1. FORGING STOCK								CLASS 2. FORGING STOCK			
SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus		SPECIFIED WIDTH mm		TOLERANCE mm plus and minus		SPECIFIED THICKNESS OR WIDTH mm		TOLERANCE mm plus and minus	
		ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS	CONDITIONING ALLOWANCE ②			ALLOWABLE DEVIATION FROM SPECIFIED WIDTH	CONDITIONING ALLOWANCE ②			ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS OR WIDTH	
over	thru			over	thru			over	thru		
10.00	12.50	0.25	–1 on face	..	40.00	0.46	–2 on face	10.00	12.50	0.050	
12.50	25.00	0.38	–1 on face	40.00	100.00	0.76	–2 on face	12.50	25.00	0.06	
25.00	50.00	0.46	–1 on face	100.00	150.00	1.20	–2 on face	25.00	40.00	0.08	
50.00	80.00	0.50	–1 on face	150.00	250.00	1.60	–2 on face	40.00	100.00	0.13	

TABLE 14.4 Length ①—Specific and Multiple—Forging Stock

SPECIFIED DIAMETER, WIDTH OR DISTANCE ACROSS FLATS mm		TOLERANCE—mm plus			
		ALLOWABLE DEVIATION FROM SPECIFIED LENGTH			
		SPECIFIED LENGTH—mm			
		Thru 5 000	Over 5 000 thru 10 000	Over 10 000 thru 15 000	Over 15 000
over	thru				
..	70.00	4	7	10	25
70.00	200.00	6	9	11	25
200.00	..	7	10	13	25

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 mm		STRAIGHTNESS ^② mm	DIMENSIONAL TOLERANCES		
over	thru		THICKNESS mm, plus	WIDTH ^③ mm, plus	LENGTH mm, plus
...	2000	6.50	6.50	10.00	25.00
2000	4000	10.00	6.50	12.00	25.00
4000	...	12.00	10.00	20.00	25.00

^① Corner radii may vary from 0 to 12 mm.^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.

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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 WIDTH mm		TOLERANCE mm plus and minus or percent
		ALLOWABLE DEVIATION OF MEAN ^① DIAMETER FROM SPECIFIED DIAMETER
Over	thru	
0.25	1.00	.015
1.00	2.50	.025
2.50	6.50	1%

TABLE 16.8 Diameter—Tolerances—Drawing Stock—Electric Conductors

SPECIFIED WIDTH mm		TOLERANCE—mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED DIAMETER
Over	thru	
9.50	12.50	0.50
12.50	25.00	0.65

TABLE 16.9 Diameter—Tolerances—Magnet Wire—Electric Conductors

SPECIFIED DIAMETER		TOLERANCE—mm plus and minus
		ALLOWABLE DEVIATION OF MEAN ^① DIAMETER FROM SPECIFIED DIAMETER
over	thru	
..	0.25	0.003
0.25	0.50	0.005
0.50	0.75	0.008
0.75	1.00	0.010
1.00	1.25	0.013
1.25	1.50	0.015
1.50	2.00	0.020
2.00	3.75	0.025
3.75	6.50	0.038

TABLE 16.10 Thickness—Tolerances—Rolled Bar—Electric Conductors

SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS
Over	thru	
3.20	12.50	0.15
12.50	20.00	0.20
20.00	25.00	0.30
25.00	50.00	0.50

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 When mass of piece on flat surface minimizes deviation.

③ 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 0.8 mm using a steel scale and a straightedge.

TABLE 16.11 Width—Tolerances—Rolled Bar—Electric Conductors

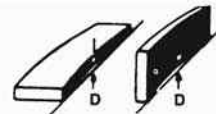
SPECIFIED WIDTH mm		TOLERANCE mm plus and minus
		ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
Over	thru	
12.50	40.00	0.40
40.00	100.00	0.80
100.00	150.00	1.20
150.00	300.00	1.60

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

SPECIFIED WIDTH		TOLERANCE—mm plus	
Over	thru	Up thru 5 000	Over 5 000
..	90.00	3	6
90.00	..	6	6

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

TOLERANCE ^② ^③ —mm
Maximum Curvature (Depth of Arc)



D (max.) = 4 mm in any 1 m of chord length

TABLE 16.14 Flatness (Flat Surfaces)—Tolerances—Rolled Bar and Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH mm		TOLERANCE—mm
		Maximum Allowable Deviation D
over	thru	
..	25	0.10
25	..	.004 × W(mm)
in any 25 mm of width		0.10

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 mm		NOMINAL RADIUS	RADIUS TOLERANCE
		over	thru		
Square Corners		3.20 25.00	25.00 ...	...	+1 mm +2 mm
Round Corners	Radius	3.20 5.00 25.00	5.00 25.00 ...	1 mm 2 mm 4 mm	± 0.5 mm ± 0.5 mm ± 0.5 mm
Rounded Edge	Radius	3.20	...	$1.25 \times$ Bar thickness	$\pm 0.25 \times$ Bar thickness
Full Rounded Edge	Radius	All		$0.5 \times$ Bar thickness	+25%

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

SPECIFIED THICKNESS mm		TOLERANCE mm plus and minus
over	thru	ALLOWABLE DEVIATION FROM SPECIFIED THICKNESS
6.30	8.00	0.32
8.00	10.00	0.44
10.00	16.00	0.60
16.00	25.00	0.80
25.00	40.00	1.00
40.00	60.00	1.30
60.00	80.00	1.80

Footnotes for Tables 16.14 Through 16.19

① Twist is normally measured by placing the product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

② When mass of bar on flat surface minimizes deviation.

TABLE 16.19 Twist ②—Tolerances—Rolled Bar and Sawed-Plate Bar—Electric Conductors

SPECIFIED WIDTH mm		TOLERANCE ②-DEGREES Allowable Deviation from Straight
		Allowable deviation from straight, Y(max), in total length or in any 300 mm or longer chord segment of total length.
over	thru	
...	40.00	3°/m but not greater than 7°
40.00	80.00	1.5°/m but not greater than 5°
80.00	...	1°/m but not greater than 3°

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

SPECIFIED WIDTH mm		TOLERANCE mm plus and minus
Over	thru	ALLOWABLE DEVIATION FROM SPECIFIED WIDTH
50.00	150.00	2.40
150.00	350.00	3.20

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

SPECIFIED THICKNESS WIDTH, OR DIAMETER mm		TOLERANCE ①—mm plus and minus
Over	thru	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION
3.20	6.30	0.18
6.30	12.50	0.20
12.50	20.00	0.23
20.00	25.00	0.25
25.00	40.00	0.30
40.00	50.00	0.36
50.00	100.00	0.60
100.00	150.00	0.86
150.00	200.00	1.10
200.00	250.00	1.65
250.00	300.00	1.90

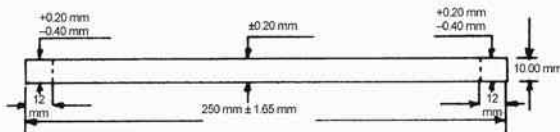
Footnotes for Tables 16.20 Through 16.23

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

- a. Specified bar thickness less than 12 mm; corner radii 1 mm or less; width to thickness ratio 24 to 1 and greater.

Tolerance per Table 16.22 except for distance 12 mm from each edge where plus tolerance of Table 16.22 applies and minus tolerance of $2 \times$ Table 16.22 tolerance applies.

Example:



- b. Specified bar thickness 12 mm and greater; corner radii 5 mm or less; width to thickness ratio 10 to 1 and greater. Thickness tolerance per Table 16.22 except for distance 12 mm from edge where plus tolerance of Table 16.22 applies and minus tolerance $2 \times$ Table 16.22 applies.

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 DIAMETER OR WIDTH mm		TOLERANCE—mm plus ALLOWABLE DEVIATION FROM SPECIFIED LENGTH	
		SPECIFIED LENGTH—mm	
Over	thru	Up thru 5 000	Over 5 000 thru 10 000
...	70.00	4	7
70.00	200.00	6	9
200.00	...	7	10

Dimensional Tolerances for

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

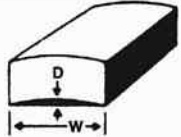
SPECIFIED WIDTH mm		TOLERANCE—mm
		
Over	thru	Maximum Allowable Deviation D
..	25	0.10
25	150	.004 × w(mm)
In any 25 mm of length		0.10

TABLE 16.25 Twist^③—Tolerances—Extruded Bar—Electric Conductors

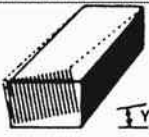
SPECIFIED WIDTH mm		TOLERANCE ^② —DEGREES
		ALLOWABLE DEVIATION FROM STRAIGHT
		
		Y (max.) in degrees
		Allowable deviation from straight, Y(max), in total length or in any 300 mm or longer chord segment of total length.
over	thru	
..	40.00	3°/m but not greater than 7°
40.00	80.00	1.5°/m but not greater than 5°
80.00		1°/m but not greater than 3°

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

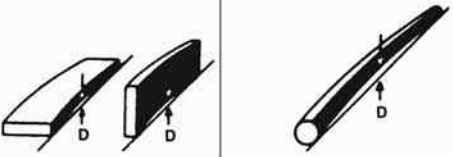
BAR TOLERANCE—mm		ROD TOLERANCE—mm	
			
		Allowable deviation from straight, D(max), in total length or in any 300 mm or longer chord segment of total length.	
D(max) in any 3 m length		Diameter mm	
		over	thru
Flatwise	Edgewise	10	150
6 mm	3 mm	150	..
		D(max) mm	
		1	
		2	

TABLE 16.27 Angularity—Extruded Bar—Electric Conductors

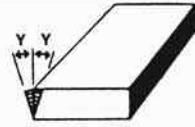
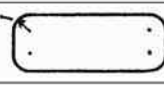
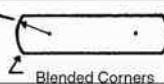
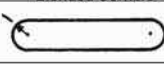

Allowable deviation from nominal angle: ±1 degree.

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

Allowable deviation from square: 1 degree.
--

TABLE 16.29 Corner and Edge Radii—Tolerances—Extruded Bar—Electric Conductors

	SPECIFIED EDGE CONTOUR	SPECIFIED BAR THICKNESS mm		NOMINAL RADIUS	RADIUS TOLERANCE
		over	thru		
Square Corners		3.20 25.00	25.00 ..		+1 mm +2 mm
Round Corners	Radius 	3.20 5.00 25.00	5.00 25.00 ..	1 mm 2 mm 4 mm	±0.5 mm ±0.5 mm ±0.5 mm
Rounded Edge	Radius  Blended Corners	.. 4.00	4.00 ..	1.25 × Bar thickness 1.25 × Bar thickness	±0.5 mm ±10%
Full Rounded Edge	Radius 	.. 10.00	10.00 ..	0.5 × Bar thickness 0.5 × Bar thickness	±0.5 mm ±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 0.8 mm using a steel scale and a 3-metre long straightedge.

② When mass of bar on flat surface minimizes deviation.

③ Twist is normally measured by placing the product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness of the 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 tolerance to linear deviation:

Tolerance Degrees	Max. Allowable Linear Deviation mm/mm of Width
0.25	0.004
0.5	0.009
1	0.017
1.5	0.026
3	0.052
5	0.087
7	0.122
9	0.156
15	0.259
21	0.358

Table 16.30 intentionally blank**Pipe****TABLE 16.31 Outside Diameter—Tolerances—Pipe—Electric Conductors**

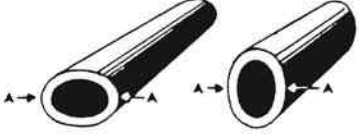
PIPE SIZE DESIGNATION	TOLERANCE—mm	
	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM NOMINAL DIAMETER ① ② ④	
		
	SCHEDULE 40 or 80	
Under 2	+0.40	−0.80
2–4	+1%	−1%
5–7	+1%	−1%
8–12	+1%	−1%

TABLE 16.32 Wall Thickness—Pipe—Electric Conductors

Allowable deviation of wall thickness at any point from nominal wall thickness ①: minus 12.5 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 mass of piece on flat surface minimizes deviation.
 ④ The one percent tolerances are rounded to the nearest 0.1 mm before applying the tolerance.

TABLE 16.33 Straightness—Tolerances—Pipe—Electric Conductors

PIPE SIZE DESIGNATION	TOLERANCE ③—mm
	ALLOWABLE DEVIATION FROM STRAIGHT
	
Under 6	1 mm/m
6–12	2 mm/m

TABLE 16.34 Length—Tolerances—Pipe—Electric Conductors

Allowable deviation from specified length: plus 6 mm. Applies only in lengths up through 6 000 mm.

TABLE 16.35 Weight—Pipe—Electric Conductors

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