AIRCRAFT ALUMINUM TUBE TOLERANCE

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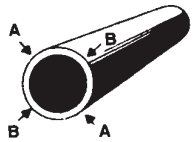
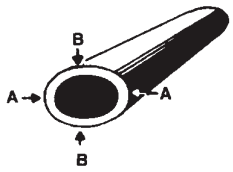
TABLE 12.2 Diameter—Round Tube

EXCEPT FOR T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPERS ⑦

SPECIFIED DIAMETER ① in.	TOLERANCE ②—in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN DIAMETER ③ FROM SPECIFIED DIAMETER (Size)		ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER ④	
	 Difference between ½ (AA+BB) and specified diameter		 Difference between AA or BB and specified diameter	
Col. 1	Col. 2		Col. 3	
	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	5xxx ≥4.0 nominal Mg ⑯	Other Alloys
0.500–0.999		.010		.020
1.000–1.999		.012		.025
2.000–3.999		.015		.030
4.000–5.999		.025		.050
6.000–7.999		.035		.075
8.000–9.999		.045		.100
10.000–11.999		.055		.125
12.000–13.999		.065		.150
14.000–15.999		.075		.175
16.000–17.999		.085		.200
18.000–19.999		.095		.225
20.000–21.999		.105		.250
22.000–23.999		.115		.275

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 of if wall thickness is less than 2½ percent of outside diameter of a circle having a circumference equal to the perimeter of the tube.

⑤ The mean wall thickness of round tube is the average of two measurements taken opposite each other. The mean wall thickness of other-than-round tube is the average of two measurements taken opposite each other at approximate center line of tube and perpendicular to the longitudinal axis of the cross section.

⑥ When dimensions specified are outside and inside, rather than wall thickness itself, allowable deviation at any point (eccentricity) applies to mean wall thickness.

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

⑧ TX510 and TX511 are general designations for the following stress-relieved tempers: T3510, T4510, T6510, T8510, T73510, T76510; and T3511, T4511, T6511, T8511, T73511, T76511, respectively.

⑨ When weight of piece on flat surface minimizes deviation.

⑩ The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the cross section of the extruded product.

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

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

⑫ Tolerances not applicable to TX510, or TX511 temper tube having a wall thickness less than 0.095 in.

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

⑭ For tube over 12.750 in. O.D. the 2000 and 7000 series alloys and 5000 series alloys with nominal magnesium content of 3 percent or more are excluded.

⑮ Not applicable to O temper tube.

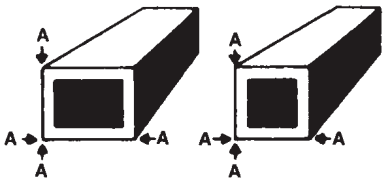
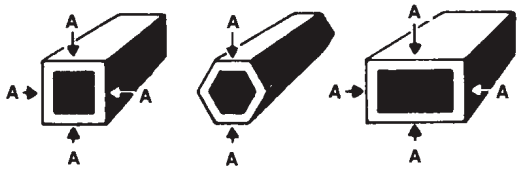
⑯ Tolerances apply to 5xxx alloys with ≥4.0% Mg.

⑰ Not applicable to 2219 alloy tube. Most tubes in 2219 alloy will have die lines about twice the depth shown in the table; however, for each tube size the supplier should be contacted for the roughness value to apply.

⑱ If unspecified, the radius shall be 1/32 in. maximum including tolerances.

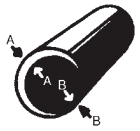
TABLE 12.3 Width and Depth—Square, Rectangular, Hexagonal and Octagonal Tube

EXCEPT FOR T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPERS ⑦

SPECIFIED WIDTH OR DEPTH in.	TOLERANCE ②—in. plus and minus				
	ALLOWABLE DEVIATION OF WIDTH OR DEPTH AT CORNERS FROM SPECIFIED WIDTH OR DEPTH  Difference between AA and 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, depth, or distance across flats		
	SQUARE, RECTANGULAR		SQUARE HEXAGONAL, OCTAGONAL		RECTANGULAR
Col. 1	Col. 2		Col. 3		Col. 4
	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	All Alloys
0.500–0.749		.012		.020	The tolerance for the width is the value in the previous column for a dimension equal to the depth, and conversely, but in no case is the tolerance less than at the corners. Example: The width tolerance of a 1 × 3 inch alloy 6061 rectangular tube is ±0.025 inch and the depth tolerance ±0.035 inch.
0.750–0.999		.014		.020	
1.000–1.999		.018		.025	
2.000–3.999		.025		.035	
4.000–4.999		.035		.045	
5.000–5.999		.045		.055	
6.000–6.999		.055		.065	
7.000–7.999		.065		.075	
8.000–8.999		.075		.085	
9.000–9.999		.085		.095	
10.000–10.999		.095		.105	
11.000–12.999		.105		.115	

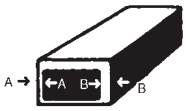
For all numbered footnotes, see preceding page 13.

TABLE 12.4 Wall Thickness—Round Extruded Tube

SPECIFIED WALL THICKNESS ⑥ in.	TOLERANCE ① ②—in. plus and minus								
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ⑤ FROM SPECIFIED WALL THICKNESS  Difference between ½ (AA + BB) and specified wall thickness								ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM MEAN WALL THICKNESS ⑤ (Eccentricity)  Difference between AA and mean wall thickness
	OUTSIDE DIAMETER—IN.								
	Under 1.250		1.250–2.999		3.000–4.999		5.000 and over		
Col. 1	Col. 2		Col. 3		Col. 4		Col. 5		Col. 6
	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	5xxx ≥4.0 nominal Mg ⑯	Other Alloys	All Alloys
Under 0.047		.006		. .		. .		. .	Plus and minus 10% of mean wall thickness max ±0.060 min ±0.010
0.047–0.061		.007		.008		.008		.010	
0.062–0.077		.008		.008		.009		.012	
0.078–0.124		.009		.009		.010		.015	
0.125–0.249		.009		.009		.013		.020	
0.250–0.374		.011		.011		.016		.025	
0.375–0.499		. .		.015		.021		.035	
0.500–0.749		. .		.020		.028		.045	
0.750–0.999		. .		. .		.035		.055	
1.000–1.499		. .		. .		.045		.065	
1.500–2.000		. .		. .		. .		.075	
2.001–2.499		. .		. .		. .		.085	±0.120
2.500–2.999		. .		. .		. .		.095	
3.000–3.499		. .		. .		. .		.105	
3.500–4.000		. .		. .		. .		.115	

For all numbered footnotes, see page 13.

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

SPECIFIED WALL THICKNESS ⑥ in.	TOLERANCE ① ②—in. plus and minus					
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ⑤ FROM SPECIFIED WALL THICKNESS  Difference between ½ (AA + BB) and specified wall thickness				ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM MEAN WALL THICKNESS ⑤ (Eccentricity)  Difference between AA and mean wall thickness	
	CIRCUMSCRIBING CIRCLE DIAMETER ⑩—in.					
	Under 5.000		5.000 and over		Under 5.000	5.000 and over
Col. 1	Col. 2		Col. 3		Col. 4	Col. 5
	5xxx≥4.0 nominal Mg ⑯	Other Alloys	5xxx≥4.0 nominal Mg ⑯	Other Alloys	All Alloys	All Alloys
Under 0.047		.005		.008	.005	Plus and minus 10% of mean wall thickness max ±0.060 min ±0.010
0.047–0.061		.006		.009	.007	
0.062–0.124		.007		.010	.010	
0.125–0.249		.008		.015	.015	
0.250–0.374		.011		.020	.025	
0.375–0.499		.014		.030	.030	
0.500–0.749		.025		.040	.040	
0.750–0.999		.035		.050	.050	
1.000–1.499		.045		.060	.060	
1.500–2.000		. .		.070	. .	

For all numbered footnotes, see page 13.

TABLE 12.6 Length—Extruded Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE—in. plus excepted as noted ALLOWABLE DEVIATION FROM SPECIFIED LENGTH STRAIGHT SPECIFIED LENGTH—ft.			
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50
0.500–1.249	1/8	1/4	3/8	1
1.250–2.999	1/8	1/4	3/8	1
3.000–7.999	3/16	5/16	7/16	1
8.000 and over	1/4	3/8	1/2	1

TABLE 12.7 Twist ⑪—Other-than-Round Extruded Tube

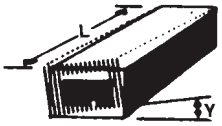
TEMPER	SPECIFIED WIDTH in.	SPECIFIED THICKNESS in.	TOLERANCE ⑨—Degrees ALLOWABLE DEVIATION FROM STRAIGHT  Y (max.) in degrees	
			IN TOTAL LENGTH OR IN ANY SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
All except O, TX510, TX511 ⑧	0.500 thru 1.499 1.500–2.999 3.000 and over	All All All	1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 5 3
O, TX510 ⑧	0.500 and over	0.095 and over	⑦	⑦
TX511 ⑧	0.500–1.499 1.500–2.999 3.000 and over	0.095 and over 0.095 and over 0.095 and over	1 × Measured length, ft. ½ × Measured length, ft. ¼ × Measured length, ft.	7 5 3

TABLE 12.8 Straightness—Extruded Tube in Straight Lengths

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

For all numbered footnotes, see page 13.

TABLE 12.9 Flatness (Flat Surfaces)—Extruded Tube

EXCEPT FOR O, T3510, T4510, T6510, T73510, T76510 AND T8510 TEMPERS ⑦

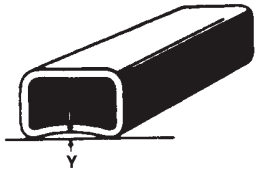
MINIMUM THICKNESS OF METAL FORMING THE SURFACE in.	TOLERANCE—in.	
	 Maximum Allowable Deviation Y	
	WIDTHS UP THRU 1 IN. OR ANY 1 IN. INCREMENT OF WIDER SURFACES	WIDTHS OVER 1 IN. THRU 5.999 IN.
Up thru 0.187	0.006	0.006 × W (inches)
0.188 and over	0.004	0.004 × W (inches)

TABLE 12.10 Squareness of Cut Ends—Extruded Tube

Allowable deviation from square: 1 degree.

TABLE 12.11 Corner and Fillet Radii—Extruded Tube

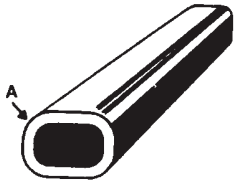
SPECIFIED RADIUS ⑱ in.	TOLERANCE—in.
	ALLOWABLE DEVIATION FROM SPECIFIED RADIUS  Difference between radius A and specified radius
Sharp corners	+1/64
0.016–0.187	±1/64
0.188 and over	±10%

TABLE 12.12 Angularity—Extruded Tube

Allowable deviation from square: ±2 degrees.

For all numbered footnotes, see page 13.

TABLE 12.13 Surface Roughness ⑭ ⑰—Extruded Tube

Specified Outside Diameter in.	Specified Wall Thickness in.	Allowable Depth of Conditions ⑬ in., max.
Up thru 12.750	Up thru 0.063	0.0025
	0.064–0.125	0.003
	0.126–0.188	0.0035
	0.189–0.250	0.004
	0.251–0.500	0.005
	0.501 and over	0.008
12.751–15.000	Up thru 0.500	0.010
	0.501 and over	0.012
15.001–20.000	Up thru 0.500	0.012
	0.501 and over	0.015
20.001 and over	Up thru 0.500	0.015
	0.501 and over	0.020

TABLE 12.14 Dents ⑮—Extruded Tube

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

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

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

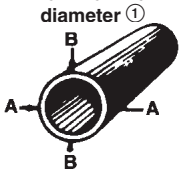
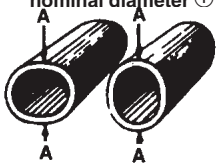
PIPE SIZE in.	TOLERANCE—in.	
	Allowable deviation of mean ② diameter from nominal diameter ①  Difference between ½(AA+BB) and nominal diameter	Allowable deviation of diameter at any point from nominal diameter ①  Difference between AA and nominal diameter
	SCHEDULES 5 AND 10	SCHEDULE 20 AND GREATER
Under 2	+.015–.031	+.015–.031
2–4	+.031–.031	+1%–1%
5–7	+.062–.031	+1%–1%
8–12	+.093–.031	+1%–1%

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

SCHEDULE NUMBER	TOLERANCE
	ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM NOMINAL ① WALL THICKNESS
5 and 10	±12.5%, ±.012 in. min.
20 and greater	–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	⑤
20 and greater	+8% ⑥

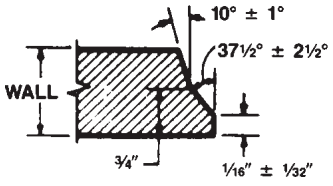
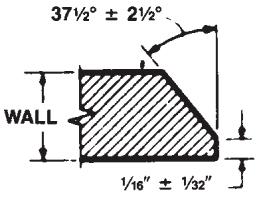
TABLE 12.52 Length Tolerances—Extruded Pipe or Extruded and Drawn Pipe

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

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

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

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

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

Footnotes for Tables 12.49 Through 12.54

① Nominal diameter and wall thickness are those listed in Table 12.55.
② Mean diameter is the average of any two diameter measurements taken at right angles to each other at any point along the length.
③ Maximum wall thickness is controlled by weight tolerance.
④ When weight of pipe on flat surface minimizes deviation.
⑤ For schedule 5 and 10, only diameter, wall thickness and length tolerances apply.
⑥ Minimum weight is controlled by tolerances for outside diameter and wall thickness.

TABLE 12.20 Diameter—Drawn Round Tube

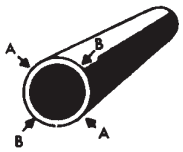
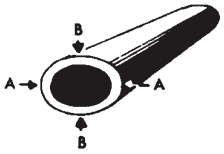
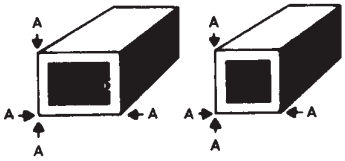
SPECIFIED DIAMETER in.	TOLERANCE ②—in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN DIAMETER ③ FROM SPECIFIED DIAMETER (Size)	ALLOWABLE DEVIATION OF DIAMETER AT ANY POINT FROM SPECIFIED DIAMETER④		
				
	Difference between ½ (AA + BB) and specified diameter	Difference between AA or BB and specified diameter		
		NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ⑤	ANNEALED TUBE
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5
Up thru 0.500	.003	.003	.006	.018
0.501–1.000	.004	.004	.008	.024
1.001–2.000	.005	.005	.010	.030
2.001–3.000	.006	.006	.012	.036
3.001–5.000	.008	.008	.016	.048
5.001–6.000	.010	.010	.020	.060
6.001–8.000	.015	.015	.030	.090
8.001–10.000	.020	.020	.040	.120
10.001–12.000	.025	.025	.050	.150

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

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

Footnotes for Tables 12.20 and 12.21

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

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

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

④ Not applicable to coiled tube or tube having a wall thickness less than 2½ percent of the specified outside diameter. The tolerance for tube with wall thickness less than 2½ percent of the specified outside diameter is determined by multiplying the applicable tolerance in columns 3 thru 5 as follows:
2% to 2½% exclusive—1.5 × tolerance
1½% to 2% exclusive—2.0 × tolerance
1% to 1½% exclusive—3.0 × tolerance
½% to 1% exclusive—4.0 × tolerance

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

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

⑦ Not applicable to annealed (O temper) tube.

TABLE 12.22 Diameter—Drawn Oval, Eliptical and Streamline Tube

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

TABLE 12.23 Corner Radii—Drawn Tube

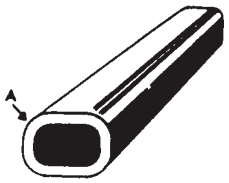
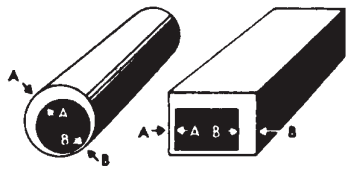
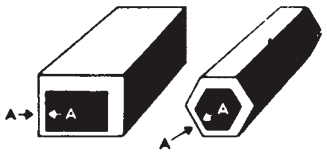
SPECIFIED ⑦ RADIUS in.	TOLERANCE ②—in. ALLOWABLE DEVIATION FROM SPECIFIED RADIUS  Difference between radius A and specified radius
Sharp Corners	+1/64
0.016–0.187	±1/64
0.188 and over	±10%

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

SPECIFIED THICKNESS ④ in	TOLERANCE ① ②—in. plus and minus			
	ALLOWABLE DEVIATION OF MEAN WALL THICKNESS ③ FROM SPECIFIED WALL THICKNESS  Difference between ½(AA+BB) and specified wall thickness		ALLOWABLE DEVIATION OF WALL THICKNESS AT ANY POINT FROM SPECIFIED WALL THICKNESS (Eccentricity)	
			ROUND, NON-HEAT-TREATABLE ALLOYS ⑥ 	ROUND, HEAT-TREATABLE ALLOYS AND OTHER THAN ROUND, ALL ALLOYS 
Col. 1	Col. 2		Col. 3	Col. 4
0.010–0.035	.002		.002	Plus and minus 10% of specified wall thickness, min ±0.003
0.036–0.049	.003		.003	
0.050–0.083	.004		.004	
0.084–0.120	.005		.006	
0.121–0.203	.006		.008	
0.204–0.300	.008		.012	
0.301–0.375	.015		.020	
0.376–0.500	.020		.030	

Footnotes for Tables 12.22 Through 12.24

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

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

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

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

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

⑥ For coiled tube, values in Column 4 apply.

⑦ If unspecified, the radius shall be 1/32 in. maximum including tolerances.

Footnotes for Tables 12.25 Through 12.30

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

② Not applicable to annealed (O temper) tube.

③ Not applicable to annealed (O temper) tube, coiled tube, or tube having a wall thickness less than 0.020 inch or less than 2½% of the equivalent round diameter. Equivalent round diameter is the diameter of a circle having a circumferance equal to the perimeter of the tube.

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

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

Drawn Tube

TABLE 12.25 Straightness—Drawn Tube

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

TABLE 12.26 Twist ④—Drawn Tube

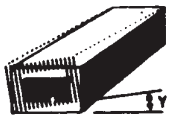
SPECIFIED WIDTH in.	TOLERANCE ① ②—Degree ALLOWABLE DEVIATION FROM STRAIGHT  Y (max) in degrees	
	IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH	MAXIMUM FOR TOTAL LENGTH
Up thru 1.499	1 × Measured length, ft.	7
1.500–2.999	½ × Measured length, ft.	5
3.000 and over	¼ × Measured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

TABLE 12.27 Length—Drawn Tube

SPECIFIED OUTSIDE DIAMETER OR WIDTH in.	TOLERANCE—in. plus except as noted ALLOWABLE DEVIATION FROM SPECIFIED LENGTH							
	STRAIGHT				COILED			
	SPECIFIED LENGTH—ft.							
	Up thru 12	Over 12 thru 30	Over 30 thru 50	Over 50	Up thru 100	Over 100 to 250	250 to 500	500 and over
Up thru 0.249	¼	⅜	½	. .	+5%, –0%	±10%	±15%	±20%
0.250–1.249	⅛	¼	⅜	1	+5%, –0%	±10%	±15%	±20%
1.250–2.999	⅛	¼	⅜	1	. .	. .	. .	. .
3.000–7.999	3⁄16	5⁄16	7⁄16	1	. .	. .	. .	. .
8.000 and over	¼	⅜	½	1	. .	. .	. .	. .

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

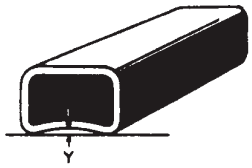
SPECIFIED WIDTH OR DEPTH in.	TOLERANCE ③—in. ALLOWABLE DEVIATION FROM FLAT  Maximum allowable distance Y
Up thru 0.500	.003
0.501–1.000	.004
1.001–2.000	.005
2.001–3.000	.006
3.001–5.000	.008
5.001–6.000	.010
6.001–8.000	.015
8.001–10.000	.020
10.001–12.000	.025

TABLE 12.29 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

For numbered footnotes, Tables 12.25 through 12.30 see previous page.

TABLE 12.31 Surface Roughness—Drawn Tube ②

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

② not applicable to annealed (O Tempers) tube

TABLE 12.32 Dents—Drawn Tube

SPECIFIED DIAMETER in.	TOLERANCES—in.		
	NON-ANNEALED AND NON-HEAT-TREATED TUBE	HEAT-TREATED TUBE ⑤	ANNEALED TUBE
Col. 1	Col. 2	Col. 3	Col. 4
Up thru 0.500	.006	.012	.036
0.501–1.000	.008	.016	.048
1.001–2.000	.010	.020	.060
2.001–3.000	.012	.024	.072
3.001–5.000	.016	.032	.096
5.001–6.000	.020	.040	.120
6.001–8.000	.030	.060	.180
8.001–10.000	.040	.080	.240
10.001–12.000	.050	.100	.300

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

Percent of Wall Thickness

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

⑤ For the T8 tempers of 6063 the tolerances of column 2 apply.