

Chronological Summary of Changes to the 2013 Edition of Aluminum Standards and Data		
DATE	PAGE (TABLE/PARAGRAPH)	DESCRIPTION OF CHANGE
16-05-24	5-16	Added Profile Class 2 Hollow Extruded definition
16-05-24	5-16	Added Profile Class 3 Hollow Extruded definition
16-05-24	5-17	Added definition for Rib
16-05-24	5-18	Added definition for Rod Cold-Finished
16-05-24	5-18	Added definition for Rod Cold-Finished Extruded
16-05-24	5-18	Added definition for Rod Cold-Finished Rolled
16-05-24	5-18	Added definition for Rolled-over Edge
16-05-24	5-18	Added definition for Roping
16-05-24	5-19	Added definition for Seam Defect
16-05-24	5-19	Added definition Coiled Cut to Length
16-05-24	5-20	Added definition Standard One Side Bright Finish (S1SBF)
16-05-24	5-20	Added definition Standard Two Sides Bright Finish (S2SBF)
16-05-24	5-20	Added definition for Splice
16-05-24	5-22	Added definition for Streak (Stripe) Roll
16-05-24	5-22	Added definition for Minimum Residual Stress (MRS)
16-05-24	5-22	Added definition for Surface Tear
16-05-24	5-24	Added definition for Arc-Welded
16-05-24	5-16	Modified definition of Profile
16-05-24	5-25	Added Flattened and Slit definition
16-05-24	5-25	Added Wire International definition
16-04-07	11-6	Deleted footnote 3
16-05-18	1-6 (3.2.1)	Modify text to include "grain refining elements"
16-05-18	11-4 (11.11)	Added Mechanical Property Limits for 6560-T5 and 6560-T6
15-11-25	5-10	Replaced definition for "Hardener" with definition for "Hardener, Aluminum"
15-11-25	5-10	Added definition for Grain Refiner
15-11-25	5-14	Modified definition for Master Alloy
15-11-25	5-14	Added definition for Modifier
15-11-03	5-2	Modified definition for Bar
15-11-03	5-2	Modified definition for Artificial Aging
15-11-03	5-3	Modified definition for Bright Sheet
15-11-03	5-3	Modified definition for Bristle Mark
15-11-03	5-5	Modified definition for Coloring
15-11-03	5-5	Modified definition for Condenser Tube
15-11-03	5-6	Changed "Stress Cracking" to "Stress Corrosion Cracking"
15-11-03	5-6	Modified definition for Creep Rupture Strength
15-11-03	5-7	Changed "Dye Penetrant" to "Dye Penetrant Test/Liquid Penetrant Inspection"
15-11-03	5-7	Modified definition for Edge (of a Rolling Ingot)

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DATE	PAGE (TABLE/PARAGRAPH)	DESCRIPTION OF CHANGE
14-08-05	12-7 (12.4)	Added leading zeros
14-08-05	12-7 (12.5)	Added leading zeros
14-08-05	12-8 (12.8)	Added leading zeros
14-08-05	14-2 (14.1)	Added leading zeros
14-08-05	14-2 (14.2)	Added leading zeros
14-08-05	14-2 (14.3)	Added leading zeros
14-08-05	16-6 (16.7)	Added leading zeros
14-08-05	16-6 (16.8)	Added leading zeros
14-08-05	16-6 (16.9)	Added leading zeros
14-08-05	16-6 (16.10)	Added leading zeros
14-08-05	16-6 (16.11)	Added leading zeros
14-08-05	16-7 (16.18)	Added leading zeros
14-08-05	16-8 (16.20)	Added leading zeros
14-08-05	16-8 (16.22)	Added leading zeros
14-08-05	16-9 (16.24)	Added leading zeros
14-08-05	16-9 (16.26)	Added leading zeros
14-07-03	6-1 (Section 3, paragraph 7)	Updated description for mechanical properties
14-03-03	Introduction iii	Revised introduction
14-02-18	4-13	Added color code for Alloy 7095 and 7255
14-02-18	4-13	Added color codes Cyan and Lime
13-11-14	12-8 (12.8)	Changed "Specified Width in." to "Specified Outside Diameter"
13-11-14	12-8 (12.8)	Added footnote reference 19 to "Allowable deviation (D) from straight"
13-11-14	12-9	Footnote 2 is inactive
13-11-14	12-9	Footnote 19 is added

Table 3.4 Typical Heat Treatments for Aluminum Alloy Mill Products ① (continued)

Alloy	Product	Solution Heat Treatment②		Precipitation Heat Treatment		
		Metal Temperature③ °F	Temper Designation	Metal Temperature③ °F	Approx. Time at Temp④ Hours	Temper Designation
6162	Extruded Rod, Bar, Profiles & Tube	⑩	T1 ②⑨	350	8	T5
			T1510⑥ ③⑨	350	8	T5510⑥
			T1511⑥ ③⑨	350	8	T5511⑥
		980 ⑮	T4 ②⑨	350	8	T6
			T4510⑥ ③⑨	350	8	T6510⑥
			T4511⑥ ③⑨	350	8	T6511⑥
6201	Wire	950	T3 ⑤ ②⑨	320	4	T81 ⑤
6262	Rolled or Cold Finished Wire, Rod and Bar	1000	T4 ②⑨	340	8	T6
			T4 ②⑨	340	12	T9 ⑭
			T451⑥ ③⑨	340	8	T651⑥
			T42 ②⑨	340	8	T62
	Extruded Rod, Bar, Profiles and Tube	1000 ⑮	T4 ②⑨	350	12	T6
			T4510⑥ ③⑨	350	12	T6510⑥
			T4511⑥ ③⑨	350	12	T6511⑥
	Drawn Tube	1000	T42 ②⑨	350	12	T62
			T4 ②⑨	340	8	T6
			T4 ②⑨	340	8	T9 ⑭
6351	Extruded Rod, Bar and Profiles	⑩	T1	250	10	T54
		⑩	T1	350	8	T5
		985	T4	350	8	T6
6360	Extruded Rod, Bar, Profiles & Tube	⑩	T1 ②⑨	365	3	T5
		950	T4 ②⑨	365 ⑬	6	T6
	Pipe	970	T4 ②⑨	365 ⑬	6	T6
6463	Extruded Rod, Bar and Profiles	⑩	T1	400	1	T5
		970 ⑮	T4 ②⑨	350 ⑰	8	T6
		970	T42 ②⑨	350 ⑰	8	T62
6560	Extruded Rod, Bar and Profiles and Tube	⑩ 970	T1 ②⑨ T4 ②⑨	365 ⑬ 365 ⑬	5 5	T5 T6
6951⑳	Sheet	985	T42	320	18	T62
7005	Extruded Rod, Bar and Profiles	⑩	T1 ②⑨	⑳	⑳	T53
7049	Die Forgings	875 ㉑	W	⑳	⑳	T73
	Hand Forgings	875 ㉑	W	⑳	⑳	T73
W52 ⑩			⑳	⑳	T7352⑩	
7050	Plate	890	W51 ⑥	㉑	㉑	T7451⑥
			W51 ⑥	㉒	㉒	T7651⑥
	Rolled or Cold Finished Wire and Rod	890	W	㉓	㉓	T7
	Extruded Rod, Bar, and Profiles	890	W510 ⑥	㉔	㉔	T73510⑥
			W510 ⑥	㉕	㉕	T74510⑥
			W510 ⑥	㉖	㉖	T76510⑥
			W511 ⑥	㉔	㉔	T73511⑥
W511 ⑥			㉕	㉕	T74511⑥	
W511 ⑥	㉖	㉖	T76511⑥			

For all numbered footnotes, see pages 3–19 and 3–20.

terminology

Strain—Surface patterns on formed products of some alloys after straining. Stochastic flamboyant strain marks which can appear at low strain levels are often termed “Strain Marks of Type A.” Strain marks which appear between 45° and 55° to the straining direction are often termed “Strain Marks of Type B” or “Lüders Lines.”

Stretcher Grip—Transverse indentation at the ends of a product impressed by the grips of a stretching machine. See also “Mark—Stretcher Jaw.”

Stretcher Jaw—A cross hatched appearance left by jaws at the end(s) of metal that has been stretched if insufficient metal has been removed after the stretching operation.

Stretcher Strain—A permanent surface distortion in the form of either flamboyant patterns or Lüders lines that can appear under certain conditions on stretched extruded products. The onset of these markings varies according to the type of metal and the degree of stretching.

Tab—See “Buckle—Arbor.”

Tail—See “Mark—Roll Bruise.”

Take Up—See “Scratch—Tension.”

Traffic—Abrasions, typically dark in color, resulting from relative movement between metal surfaces during handling and transit, e. g. during the cooling of profiles on the run-out table. A mirror image of a traffic mark is observed on the adjacent contacting surface.

Vent—A small protrusion on a forging resulting from the entrance of metal into a die vent hole.

Whip—Surface abrasion on a rolled product, generally diagonal to the rolling direction, caused by a fluttering action of the metal as it enters the rolling mill.

Master Alloy—The term “master alloy” is used for different concepts in different parts of the world. In Europe the term refers to binary alloys obtained from melting, and in the US the term refers to an alloying additive combining several elements in a fixed ratio, which is added to molten aluminum to provide a finished alloy composition. See also “Hardener, Aluminum.”

Master Coil—A coil processed to final temper as a single unit, intended to be slit and/or cut into smaller coils or into individual sheets or plates. In North America, the preferred term is “Parent Coil” for this concept. See also “Plate—Master (Parent).”

Mean Diameter (of round rod/bar or tube)—Average of any two diameters measured at right angles in the same cross-sectional area.

Mean Wall Thickness (of tube)—Average of the largest and the smallest wall thickness of tube measured in the same plane perpendicular to the longitudinal axis of the tube.

Mechanical Properties—Properties of a material that are associated with elastic and inelastic reaction when force is applied, or that involve the relationship between stress and strain; for example, modulus of elasticity, tensile strength, endurance limit. These properties are often incorrectly referred to as “Physical Properties.” The mechanical properties obtained by a tensile test, e.g. modulus of elasticity in tension, tensile strength and elongation are often termed “Tensile Properties.”

Mechanical Polishing—Polishing with a flexible rotating mop carrying an abrasive compound.

Melt—Quantity of molten metal that has simultaneously undergone the same preparatory treatment in the furnace before the casting operation.

Microstructure—Structure of a metal as revealed by microscopic examination of a surface, typically after mechanical and/or chemical preparation, e. g. polishing and micro-etching. See also “Macrostructure.”

Mike Mark—See “Mark —Mike.”

Mismatch—Deviation of a die forging from the specified form caused by opposing die halves not being in perfect alignment.

Modifier—See “Hardener, Aluminum.”

Modulus of Elasticity (Young’s Modulus)—The ratio of stress applied to a material to corresponding strain throughout the range where they are proportional. As there are three kinds of stresses, so there are three kinds of moduli of elasticity for any material—modulus of elasticity in tension, modulus of elasticity in compression, and modulus of elasticity in shear (shear modulus).

Mottling, Pressure—Non-uniform surface appearance of a laminated product resulting from uneven pressure distribution between adjacent layers of the product.

Mullen Test—See “Test—Mullen.”

– N –

Natural Aging—See “Aging—Natural.”

Nick—Rolled products, see “Scratch.” Extrusions, see “Mark—Rub.”

Non-Heat-Treatable Alloy—See “Alloy—Non-Heat-Treatable.”

Nonfill—Deviation of a die forging from the specified form caused by failure of metal to fill a forging die impression.

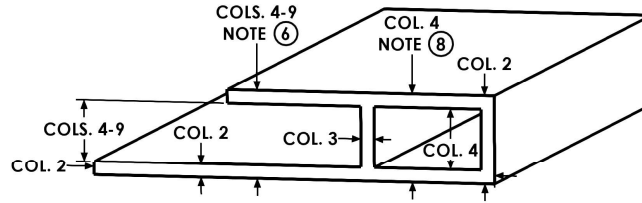
Notch, Double Shear—An abrupt deviation from straight on a sheared edge. This offset may occur if the flat sheet or plate product is longer than the blade for the final shearing operation.

– O –

Off Gauge—Deviation of a dimension of a product, e.g. width or wall thickness, from the specified tolerances.

TABLE 11.2 Cross-Sectional Dimension Tolerances—Profiles ①

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



SPECIFIED DIMENSION in.	TOLERANCE ②—in. plus and minus															
	METAL DIMENSIONS				SPACE DIMENSIONS											
	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE 75 PERCENT OR MORE OF THE DIMENSION IS METAL ⑨ ⑩				ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE MORE THAN 25 PERCENT OF THE DIMENSION IS SPACE ⑥ ⑧											
	All Except Those Covered by Column 3		Wall Thickness ④ Completely Enclosing Space 0.11 sq. in. and Over (Eccentricity)		At Dimensioned Points 0.250-0.624 inches from Base of Leg		At Dimensioned Points 0.625-1.249 inches from Base of Leg		At Dimensioned Points 1.250-2.499 inches from Base of Leg		At Dimensioned Points 2.500-3.999 inches from Base of Leg		At Dimensioned Points 4.000-5.999 inches from Base of Leg		At Dimensioned Points 6.000-8.000 inches from Base of Leg	
Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7		Col. 8		Col. 9		
Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	Standard Tolerance	Precision Tolerance	
All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	All Except 5XXX Alloys ⑪	All Except 5XXX Alloys	
CIRCUMSCRIBING CIRCLE SIZES LESS THAN 10 INCHES IN DIAMETER																
Up thru 0.124	0.006	0.004	±10% of specified dimension; ±0.010 min.	0.010	0.007	0.012	0.008	..	..	..	..	..	..	..	..	..
0.125-0.249	0.007	0.005		0.012	0.008	0.014	0.009	0.016	0.011
0.250-0.499	0.008	0.005	±10% of specified dimension; ±0.060 max. ±0.010 min.	0.014	0.009	0.016	0.011	0.018	0.012	0.020	0.013	0.022	0.015	..	..	..
0.500-0.749	0.009	0.006		0.016	0.011	0.018	0.012	0.020	0.013	0.020	0.013	0.022	0.015
0.750-0.999	0.010	0.007	0.018	0.012	0.020	0.013	0.022	0.015	0.022	0.015	0.025	0.017	0.030	0.020	..	..
1.000-1.499	0.012	0.008	±15% of specified dimension; ±0.090 max. ±0.015 min.	0.021	0.014	0.023	0.015	0.026	0.017	0.030	0.020	0.035	0.023	..	..	..
1.500-1.999	0.014	0.009		0.024	0.016	0.026	0.017	0.031	0.020	0.036	0.024	0.042	0.028	0.050	0.033	0.033
2.000-3.999	0.024	0.016	0.034	0.022	0.038	0.025	0.048	0.032	0.057	0.038	0.068	0.045	0.080	0.053	0.053	0.053
4.000-5.999	0.034	0.022	0.044	0.029	0.050	0.033	0.064	0.042	0.078	0.051	0.094	0.062	0.110	0.073	0.073	0.073
6.000-7.999	0.044	0.029	0.054	0.036	0.062	0.041	0.082	0.054	0.099	0.065	0.120	0.079	0.140	0.092	0.092	0.092
8.000-9.999	0.054	0.036	0.064	0.042	0.074	0.049	0.100	0.066	0.120	0.079	0.145	0.096	0.170	0.112	0.112	0.112
CIRCUMSCRIBING CIRCLE SIZES 10 INCHES IN DIAMETER AND OVER																
Up thru 0.124	0.014	0.009	±15% of specified dimension; ±0.090 max. ±0.015 min.	0.018	0.012	0.020	0.013	..	..	..	..	..	..	..	..	..
0.125-0.249	0.015	0.010		0.019	0.013	0.022	0.015	0.028	0.018
0.250-0.499	0.016	0.011	0.020	0.013	0.024	0.016	0.030	0.020	0.050	0.033	0.070	0.046	0.090	0.059	..	..
0.500-0.749	0.017	0.011	0.022	0.015	0.027	0.018	0.040	0.026	0.060	0.040	0.080	0.053	0.100	0.073	0.073	0.073
0.750-0.999	0.018	0.012	0.023	0.015	0.030	0.020	0.050	0.033	0.070	0.046	0.090	0.059	0.110	0.073	0.073	0.073
1.000-1.499	0.019	0.013	0.024	0.016	0.034	0.022	0.060	0.040	0.080	0.053	0.100	0.066	0.120	0.086	0.086	0.086
1.500-1.999	0.024	0.016	0.034	0.022	0.044	0.029	0.070	0.046	0.090	0.059	0.110	0.073	0.130	0.086	0.086	0.086
2.000-3.999	0.034	0.022	0.044	0.029	0.054	0.036	0.080	0.053	0.100	0.066	0.120	0.079	0.140	0.092	0.092	0.092
4.000-5.999	0.044	0.029	0.054	0.036	0.064	0.042	0.090	0.059	0.110	0.073	0.130	0.086	0.150	0.106	0.106	0.106
6.000-7.999	0.054	0.036	0.064	0.042	0.074	0.049	0.100	0.066	0.120	0.079	0.140	0.092	0.160	0.112	0.112	0.112
8.000-9.999	0.064	0.042	0.074	0.049	0.084	0.055	0.110	0.073	0.130	0.086	0.150	0.099	0.170	0.125	0.125	0.125
10.000-11.999	0.074	0.049	0.084	0.055	0.094	0.062	0.120	0.079	0.140	0.092	0.160	0.106	0.180	0.119	0.119	0.119
12.000-13.999	0.084	0.055	0.094	0.062	0.104	0.069	0.130	0.086	0.150	0.099	0.170	0.112	0.190	0.125	0.125	0.125
14.000-15.999	0.094	0.062	0.104	0.069	0.114	0.075	0.140	0.092	0.160	0.106	0.180	0.119	0.200	0.132	0.132	0.132
16.000-17.999	0.104	0.069	0.114	0.075	0.124	0.082	0.150	0.099	0.170	0.112	0.190	0.125	0.210	0.139	0.139	0.139
18.000-19.999	0.114	0.075	0.124	0.082	0.134	0.088	0.160	0.106	0.180	0.119	0.200	0.132	0.220	0.145	0.145	0.145
20.000-21.999	0.124	0.082	0.134	0.088	0.144	0.095	0.170	0.112	0.190	0.125	0.210	0.139	0.230	0.152	0.152	0.152
22.000-24.000	0.134	0.088	0.144	0.095	0.154	0.102	0.180	0.119	0.200	0.132	0.220	0.145	0.240	0.158	0.158	0.158

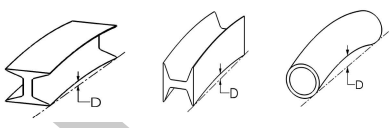
For all numbered footnotes, see page 11-8.

wire, rod, bar and profiles—extruded/standard tolerances

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

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

TABLE 11.6 Straightness ①—Rod, Bar and Profiles

PRODUCT	TEMPER	SPECIFIED DIAMETER (ROD): SPECIFIED WIDTH (BAR): CIRCUMSCRIBING CIRCLE DIAMETER R: (PROFILES) in.	SPECIFIED THICKNESS (RECTANGLES): MINIMUM THICKNESS: (PROFILES) in.	TOLERANCE ③—in.
				 IN TOTAL LENGTH OR IN ANY MEASURED SEGMENT OF ONE FT. OR MORE OF TOTAL LENGTH
Rod and Square, Hexagonal and Octagonal Bar	All except: 0, TX510 ②, TX511 ②	All	..	0.0125 × Measured length, ft.
	0	0.500 and over	..	0.050 × Measured length, ft.
	TX510 ②	0.500 and over	..	0.050 × Measured length, ft.
	TX511 ②	0.500 and over	..	0.0125 × Measured length, ft.
Rectangular Bar	All except: 0, TX510 ②, TX511 ②	Up thru 1.499	Up thru 0.094 ⑦	0.050 × Measured length, ft.
			0.095 and over	0.0125 × Measured length, ft.
		1.500 and over	All	0.0125 × Measured length, ft.
	0	Over 0.500	0.500 and over	0.050 × Measured length, ft.
	TX510 ②	Over 0.500	0.500 and over	0.050 × Measured length, ft.
	TX511 ②	Over 0.500	0.500 and over	0.0125 × Measured length, ft.
Profiles	All except: 0, TX510 ② ⑤, TX511 ②	Up thru 1.499	Up thru 0.094 ⑦	0.050 × Measured length, ft.
			0.095 and over	0.0125 × Measured length, ft.
		1.500 and over	All	0.0125 × Measured length, ft.
	0	0.500 and over	Up thru 0.094 ⑦	0.200 × Measured length, ft.
			0.095 and over	0.050 × Measured length, ft.
	TX511 ②	0.500 and over	Up thru 0.094 ⑦	0.050 × Measured length, ft.
		0.095 and over	0.0125 × Measured length, ft.	

Footnotes for Tables 11.5 through 11.8

- ① These Standard Tolerances are applicable to the average profile; wider tolerances may be required for some profiles, and closer tolerances may be possible for others.
- ② TX510 and TX511 are general designations for the following stress relieved tempers: T3510, T4510, T61510, T6510, T8510, T73510, T76510 and T3511, T4511, T61511, T6511, T8511, T73511, T76511, respectively.
- ③ When weight of piece on the flat surface minimizes deviation.
- ④ The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the cross section of the extruded product.
- ⑤ Tolerances for T3510, T4510, T6510, T73510, T76510, and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.
- ⑥ Twist is normally measured by placing the extruded section on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the extruded section and the flat surface. From this measurement, the actual deviation from straightness of the extruded section at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface.

The following values are used to convert angular tolerances to linear deviation:

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

- ⑦ Applies only if the thickness along at least 1/3 of the total perimeter is 0.094 or less. Otherwise use the tolerance shown for 0.095 and over.
- ⑧ Tolerance for "0" temper material is four times the standard tolerances shown.
- ⑨ Straightness must be met in all orientations, including orientations which are not self-supporting.