TABLE 11.1 Mechanical Property Limits—Extruded Wire, Rod, Bar and Profiles ⑥

ALLOY AND TEMPER	SPECIFIED DIAMETER OR THICKNESS ① OR MINIMUM DISTANCE ACROSS FLATS in.	AREA sq. in.	TENSILE STRENGTH—ksi				ELONGATION ② percent min. in 2 in. or 4D ③
			ULTIMATE		YIELD		
			min.	max.	min.	max.	
1100							
1100-O	All	All	11.0	15.5	3.0	..	25
1100-H112	All	All	11.0	..	3.0	..	..
2014							
2014-O	All	All	..	30.0	..	18.0	12
2014-T4, T4510 ⑤ ⑦ and T4511 ⑤ ⑦	All	All	50.0	..	35.0	..	12
2014-T42 ④ ⑧	All	All	50.0	..	29.0	..	12
2014-T6, T6510 ⑤ and T6511 ⑤	Up thru 0.499	All	60.0	..	53.0	..	7
	0.500–0.749	All	64.0	..	58.0	..	7
	0.750 and over	Up thru 25	68.0	..	60.0	..	7
	0.750 and over	Over 25 thru 32	68.0	..	58.0	..	6
2014-T62 ④ ⑧	Up thru 0.749	All	60.0	..	53.0	..	7
	0.750 and over	Up Thru 25	60.0	..	53.0	..	7
	0.750 and over	Over 25 thru 32	60.0	..	53.0	..	6
2024							
2024-O	All	All	..	35.0	..	19.0	12
2024-T3, T3510 ⑤ ⑦ and T3511 ⑤ ⑦	Up thru 0.249	All	57.0	..	42.0	..	12
	0.250–0.749	All	60.0	..	44.0	..	12
	0.750–1.499	All	65.0	..	46.0	..	10
	1.500 and over	Up thru 25	70.0	..	52.0	..	10
	1.500 and over	Over 25 thru 32	68.0	..	48.0	..	8
2024-T42 ④ ⑧	Up thru 0.749	All	57.0	..	38.0	..	12
	0.750–1.499	All	57.0	..	38.0	..	10
	1.500 and over	Up thru 25	57.0	..	38.0	..	10
	1.500 and over	Over 25 thru 32	57.0	..	38.0	..	8
2024-T81, T8510 ⑤ and T8511 ⑤	0.050–0.249	All	64.0	..	56.0	..	4
	0.250–1.499	All	66.0	..	58.0	..	5
	1.500 and over	Up thru 32	66.0	..	58.0	..	5
2219							
2219-O	All	All	..	32.0	..	18.0	12
2219-T31, T3510 ⑤ ⑦ and T3511 ⑤ ⑦	Up thru 0.499	Up thru 25	42.0	..	26.0	..	14
	0.500–2.999	Up thru 25	45.0	..	27.0	..	14
2219-T62 ④ ⑧	Up thru 0.999	Up thru 25	54.0	..	36.0	..	6
	1.000 and over	Up thru 32	54.0	..	36.0	..	6
2219-T81, T8510 ⑤ and T8511 ⑤	Up thru 2.999	Up thru 25	58.0	..	42.0	..	6
3003							
3003-O	All	All	14.0	19.0	5.0	..	25
3003-H112	All	All	14.0	..	5.0	..	..
5083							
5083-O	Up thru 5.000	Up thru 32	39.0	51.0	16.0	..	14
5083-H111	Up thru 5.000	Up thru 32	40.0	..	24.0	..	12
5083-H112	Up thru 5.000	Up thru 32	39.0	..	16.0	..	12
5086							
5086-O	Up thru 5.000	Up thru 32	35.0	46.0	14.0	..	14
5086-H111	Up thru 5.000	Up thru 32	36.0	..	21.0	..	12
5086-H112	Up thru 5.000	Up thru 32	35.0	..	14.0	..	12
5154							
5154-O	All	All	30.0	41.0	11.0	..	..
5154-H112	All	All	30.0	..	11.0	..	..
5454							
5454-O	Up thru 5.000	Up thru 32	31.0	41.0	12.0	..	14
5454-H111	Up thru 5.000	Up thru 32	33.0	..	19.0	..	12
5454-H112	Up thru 5.000	Up thru 32	31.0	..	12.0	..	12
6005							
6005-T1	Up thru 0.500	All	25.0	..	15.0	..	16
6005-T5	Up thru 0.124	All	38.0	..	35.0	..	8
	0.125–1.000	All	38.0	..	35.0	..	10

For all numbered footnotes, see page 11-5.

TABLE 11.1 Mechanical Property Limits—Extruded Wire, Rod, Bar and Profiles ⑥ (continued)

ALLOY AND TEMPER	SPECIFIED DIAMETER OR THICKNESS ① OR MINIMUM DISTANCE ACROSS FLATS in.	AREA sq. in.	TENSILE STRENGTH—ksi				ELONGATION ② percent min. in 2 in. or 4D ③
			ULTIMATE		YIELD		
			min.	max.	min.	max.	
6005A							
6005A-T1	Up thru 0.249	All	25.0	..	14.5	..	15
6005A-T5	Up thru 0.249	All	38.0	..	31.0	..	7
	0.250-0.999	All	38.0	..	31.0	..	9
6005A-T61	Up thru 0.249	All	38.0	..	35.0	..	8
	0.250-1.000	All	38.0	..	35.0	..	10
6061							
6061-O	All	All	..	22.0	..	16.0	16
6061-T1	Up thru 0.625	All	26.0	..	14.0	..	16
6061-T4, T4510 ⑤ ⑦ and T4511 ⑤⑦	All	All	26.0	..	16.0	..	16
6061-T42 ④ ⑧	All	All	26.0	..	12.0	..	16
6061-T51	Up thru 0.625	All	35.0	..	30.0	..	8
6061-T6, T62 ④ ⑧, T6510 ⑤	Up thru 0.249	All	38.0	..	35.0	..	8
andT6511 ⑤	0.250 and over	All	38.0	..	35.0	..	10
6063							
6063-O	All	..	..	19.0	..		18
6063-T1	Up thru 0.500	All	17.0	..	9.0	..	12
	0.501–1.000	All	16.0	..	8.0	..	12
6063-T4 and T42 ④ ⑧	Up thru 0.500	All	19.0	..	10.0	..	14
	0.501–1.000	All	18.0	..	9.0	..	14
6063-T5	Up thru 0.500	All	22.0	..	16.0	..	8
	0.501–1.000	All	21.0	..	15.0	..	8
6063-T52 ⑭	Up thru 1.000	All	22.0	30.0	16.0	25.0	8
6063-T6 and T62 ④ ⑧	Up thru 0.124	All	30.0	..	25.0	..	8
	0.125–1.000	All	30.0	..	25.0	..	10
6066							
6066-O	All	All	..	29.0	..	18.0	16
6066-T4, T4510 ⑤ ⑦ and T4511 ⑤ ⑦	All	All	40.0	..	25.0	..	14
6066-T42 ④ ⑧	All	All	40.0	..	24.0	..	14
6066-T6, T6510 ⑤ and T6511 ⑤	All	All	50.0	..	45.0	..	8
6066-T62 ④ ⑧	All	All	50.0	..	42.0	..	8
6070							
6070-T6 and T62 ④ ⑧	Up thru 2.999	Up thru 32	48.0	..	45.0	..	6
6082							
6082-T6, T6511	0.200-0.750	All	45.0	..	38.0	..	6
	0.751-6.000	All	45.0	..	38.0	..	8
	6.001-8.000	All	41.0	..	35.0	..	6
6105							
6105-T1	Up thru 0.500	All	25.0	..	15.0	..	16
6105-T5	Up thru 0.500	All	38.0	..	35.0	..	8
6162							
6162-T5, T5510 ⑤ and T5511 ⑤	Up thru 1.000	All	37.0	..	34.0	..	7
6162-T6, T6510 ⑤	Up thru 0.249	All	38.0	..	35.0	..	8
and T6511 ⑤	0.250–0.499	All	38.0	..	35.0	..	10
6262							
6262-T6, T62 ④ ⑧, T6510 ⑤ and T6511 ⑤	All	All	38.0	..	35.0	..	10
6351							
6351-T1	Up thru 0.499	Up thru 20	26.0	..	13.0	..	15
6351-T4	Up thru 0.749	All	32.0	..	19.0	..	16
6351-T5	Up thru 0.249	All	38.0	..	35.0	..	8
	0.250–1.000	All	38.0	..	35.0	..	10
6351-T51	0.125–1.000	Up thru 20	36.0	..	33.0	..	10
6351-T54	Up thru 0.500	Up thru 20	30.0	..	20.0	..	10
6351-T6	Up thru 0.124	All	42.0	..	37.0	..	8
	0.125–0.749	All	42.0	..	37.0	..	10

For all numbered footnotes, see page 11-5.

TABLE 11.1 Mechanical Property Limits—Extruded Wire, Rod, Bar and Profiles ⑥ (concluded)

ALLOY AND TEMPER	SPECIFIED DIAMETER OR THICKNESS ① OR MINIMUM DISTANCE ACROSS FLATS in.	AREA sq. in.	TENSILE STRENGTH—ksi				ELONGATION ② percent min. in 2 in. or 4D ③
			ULTIMATE		YIELD		
			min.	max.	min.	max.	
6463							
6463-T1	Up thru 0.500	Up thru 20	17.0	..	9.0	..	12
6463-T5	Up thru 0.500	Up thru 20	22.0	..	16.0	..	8
6463-T6 and T62 ④ ⑧	Up thru 0.124	Up thru 20	30.0	..	25.0	..	8
	0.125–0.500	Up thru 20	30.0	..	25.0	..	10
7005							
7005-T53	Up thru 0.750	All	50.0	..	44.0	..	10
7050							
7050-T73510 ⑤ ⑨ and T73511 ⑤ ⑨	Up thru 5.000	Up thru 32	70.0	..	60.0	..	8
7050-T74510 ⑤ ⑪ ⑬ and T74511 ⑤ ⑪ ⑬	Up thru 5.000	Up thru 32	73.0	..	63.0	..	7
7050-T76510 ⑫ and T76511 ⑫	Up thru 0.499	Up thru 32	77.0	..	68.0	..	7
	0.500–5.000	Up thru 32	79.0	..	69.0	..	7
7075							
7075-O	All	All	..	40.0	..	24.0	10
7075-T6, T62 ④ ⑧, T6510 ⑤ and T6511 ⑤	Up thru 0.249	All	78.0	..	70.0	..	7
	0.250–0.499	All	81.0	..	73.0	..	7
	0.500–1.499	All	81.0	..	72.0	..	7
	1.500–2.999	All	81.0	..	72.0	..	7
	3.000–4.499	Up thru 20	81.0	..	71.0	..	7
	3.000–4.499	Over 20 thru 32	78.0	..	70.0	..	6
	4.500–5.000	Up thru 32	78.0	..	68.0	..	6
7075-T73 ⑨, T73510 ⑤ ⑨ and T73511 ⑤ ⑨	0.062–0.249	Up thru 20	68.0	..	58.0	..	7
	0.250–1.499	Up thru 25	70.0	..	61.0	..	8
	1.500–2.999	Up thru 25	69.0	..	59.0	..	8
	3.000–4.499	Up thru 20	68.0	..	57.0	..	7
	3.000-4.499	Over 20 thru 32	65.0	..	55.0	..	7
	4.500-5.000	Up thru 36	65.0	..	53.0	..	7
7075-T76 ⑩, T76510 ⑤ ⑩ and T76511 ⑤ ⑩	Up thru 0.049	All	73.0	..	63.0	..	7
	0.050–0.124	All	74.0	..	64.0	..	7
	0.125–0.249	Up thru 20	74.0	..	64.0	..	7
	0.250–0.499	Up thru 20	75.0	..	65.0	..	7
	0.500–1.000	Up thru 20	75.0	..	65.0	..	7
	1.001–2.000	Up thru 20	75.0	..	65.0	..	7
	2.001–3.000	Up thru 20	74.0	..	64.0	..	7
	3.001–4.000	Up thru 20	74.0	..	63.0	..	7
7178							
7178-O	All	Up thru 32	..	40.0	..	24.0	10
7178-T6, T6510 ⑤ and T6511 ⑤	Up thru 0.061	All	82.0	..	76.0	..	..
	0.062–0.249	Up thru 20	84.0		76.0	..	5
	0.250-1.499	Up thru 25	87.0	..	78.0	..	5
	1.500–2.499	Up thru 25	86.0	..	77.0	..	5
	1.500–2.499	Over 25 thru 32	84.0	..	75.0	..	5
	2.500–2.999	Up thru 32	82.0	..	71.0	..	5
7178-T62 ④ ⑧	Up thru 0.061	All	79.0	..	73.0	..	..
	0.062–0.249	Up thru 20	82.0	..	74.0	..	5
	0.250–1.499	Up thru 25	86.0	..	77.0	..	5
	1.500–2.499	Up thru 25	86.0	..	77.0	..	5
	2.500–2.999	Up thru 32	82.0	..	71.0	..	7
7178-T76 ⑩, T76510 ⑤ ⑩ and T76511 ⑤ ⑩	0.125–0.249	Up thru 20	76.0	..	66.0	..	7
	0.250–0.499	Up thru 20	77.0	..	67.0	..	7
	0.500–1.000	Up thru 20	77.0	..	67.0	..	7
7475							
7475-T62	1.001–2.000	All	75.0	..	66.0	..	7

For all numbered footnotes, see page 11-5.

Footnotes for Table 11.1

① The thickness of the cross section from which the tension test specimen is taken determines the applicable mechanical properties. The data base and criteria upon which these mechanical property limits are established are outlined on page 6-1 under "Mechanical Properties."

② For material of such dimensions that a standard test specimen cannot be taken, or for profiles thinner than 0.062 inch, the test for elongation is not required.

③ D represents specimen diameter.

④ These properties can usually be obtained by the user when the material is properly solution heat treated or solution and precipitation heat treated from the O (annealed) or F (as fabricated) temper. These properties also apply to samples of material in the O or F tempers that are solution heat treated or solution and precipitation treated by the producer to determine that the material will respond to proper heat treatment. Properties attained by the user, however, may be lower than those listed if the material has been formed or otherwise cold or hot worked, particularly in the annealed temper, prior to solution heat treatment.

⑤ For stress-relieved tempers the characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic temper.

⑥ Processes such as flattening, leveling, or straightening coiled products subsequent to shipment by the producer may alter the mechanical properties of the metal (refer to Certification Documentation, Section 4).

⑦ Upon artificial aging, T31, T3510, T3511, T4, T4510 and T4511 temper material shall be capable of developing the mechanical properties applicable to the T81, T8510, T8511, T6, T6510 and T6511 tempers, respectively.

⑧ This temper is not available from the material producer.

⑨ Material in this temper, 0.750 inch and thicker, when tested in accordance with ASTM G47 in the short transverse direction at a stress level of 75 percent of the specified minimum yield strength, will exhibit no evidence of stress corrosion cracking. Capability of individual lots to resist stress corrosion is determined by testing the previously selected tensile test sample in accordance with the applicable lot acceptance criteria outlined on pages 6-7 through 6-10.

⑩ Material in this temper, when tested in accordance with ASTM G34, will exhibit exfoliation less than that shown in Photo EB, Figure 2 of ASTM G34. Also, material 0.750 inch and thicker, when tested in accordance with ASTM G47 in the short transverse direction at a stress level of 25 ksi, will exhibit no evidence of stress corrosion cracking. Capability of individual lots to resist exfoliation corrosion and stress corrosion cracking is determined by testing the previously selected tensile test sample in accordance with the applicable lot acceptance criteria outlined on pages 6-7 through 6-10.

⑪ Material in this temper, when tested at the t/10 plane in accordance with ASTM G34, will exhibit exfoliation less than that shown in Photo EB, Figure 2 of ASTM G34. Also, material 0.750 inch and thicker, when tested in accordance with ASTM G47 in the short transverse direction at a stress level of 35 ksi, will exhibit no evidence of stress corrosion cracking. Capability of individual lots to resist exfoliation corrosion and stress corrosion cracking is determined by testing the previously selected tensile test sample in accordance with the applicable lot acceptance criteria outlined on pages 6-7 through 6-10.

⑫ Material in this temper, when tested at the t/10 plane in accordance with ASTM G34, will exhibit exfoliation less than that shown in Photo EB, Figure 2 of ASTM G34. Also, material 0.750 inch and thicker, when tested in accordance with ASTM G47 in the short transverse direction at a stress level of 17 ksi, will exhibit no evidence of stress corrosion cracking. Capability of individual lots to resist exfoliation corrosion and stress corrosion cracking is determined by testing the previously selected tensile test sample in accordance with the applicable lot acceptance criteria outlined on pages 6-7 through 6-10.

⑬ T74 type tempers, although not previously registered, have appeared in the literature and in some specifications as T736 type tempers.

⑭ 6063-T52 is a producer temper and is an exception to ANSI H35.1/H35.1(M) paragraphs A2.2 Temper Designation for Purchaser/User Heat-Treatment, A2.3 Temper Designations for Producer/Supplier Demonstration of Response to Temper Conversion, and A2.4 Temper Designation for Purchaser/User Heat-Treatment.