

(R) GENERAL DATA ON WROUGHT ALUMINUM ALLOYS

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. **Scope**—The SAE Standards for wrought aluminum alloys cover materials with a considerable range of properties and other characteristics, but do not include all of the commercially available materials. If none of the materials listed in Tables 1 through 7 provides the characteristics required by a particular application, users may find it helpful to consult with the suppliers of aluminum alloy products. See companion document, SAE J1434.

2. **References**

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1434—Wrought Aluminum Applications Guidelines

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 557M—Method of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)

ASTM E 29—Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

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TABLE 1—ALLOY, TEMPER AND PRODUCT FORM USED IN
AUTOMOTIVE APPLICATIONS

Application	Alloy and Temper ⁽¹⁾	Product Form
Body Sheet, Panels		
Body Panels	2036-T4	Sheet
	2038-T4	Sheet
	5052-0, H32, H34	Sheet
	5182-0, O2 ⁽²⁾	Sheet
	6010-T4, T6	Sheet
	6111-T4, T6	Sheet
Interior Panels, Components	3004-0, H32	Sheet
	5052-0, H32, H34	Sheet
	5182-0, O2 ⁽²⁾	Sheet
	6009-T4, T62	Sheet
Bumper Components⁽³⁾		
Reinforcements	6061-T4, T6	Sheet, Extrusions
Face Bar, Reinforcements	6009-T4, T6 ⁽⁴⁾	Sheet
	7021-T61 ⁽⁴⁾	Sheet
	7029-T5, T6 ⁽⁵⁾⁽⁴⁾	Sheet, Extrusions
	7116-T5 ⁽⁴⁾	Extrusions
	7129-T6 ⁽⁴⁾	Extrusions
Structural & Weldable		
	5083-H111, H112, H116, H321	Sheet, Plate, Extrusions
	5086-H32, H34, H111	Sheet, Plate, Extrusions, Tube
	5182-0, O2 ⁽²⁾	Sheet
	5454-0, H32, H34, H111	Sheet, Plate, Extrusions, Tube
	6009-T4, T62	Sheet
	6061-T4, T6, T651	Sheet, Plate, Extrusions, Forgings, Structural Shapes, Tube, Rod, Bar
General Purpose		
	3003-H14, H24	Sheet
	3004-0, H32	Sheet
	5052-0, H32, H34	Sheet
	5454-0, H32, H34	Sheet, Plate, Extrusions, Tube
	6061-T4, T6, T651	Sheet, Plate, Extrusions, Forgings, Structural Shapes, Tube, Rod, Bar
	6463-T521 ⁽⁵⁾	Extrusions
	6063-T1, T5, T6	Extrusions, Tube
Trim		
Name Plates, Appliques	1100-0	Sheet
	3002-0	Sheet
	5005-0	Sheet
Strength Paramount	5252-H2X ⁽⁶⁾	Sheet
	5457-H3X ⁽⁶⁾	Sheet

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**TABLE 1—ALLOY, TEMPER AND PRODUCT FORM USED IN
AUTOMOTIVE APPLICATIONS (CONTINUED)**

Application	Alloy and Temper ⁽¹⁾	Product Form
Brightness Paramount	5657-H2X ⁽⁶⁾	Sheet
Wheels⁽⁷⁾, Fabricated	5454-0, H32, H34 H111, H112	Sheet, Plate, Extrusions
Fasteners (Mechanical)	2017-T4 2024-T4 2117-T4 6053-T61 6061-T4	Rivet and Cold Heading Wire and Rod
Heat Exchangers	A wide variety of alloys and tempers are currently specified or under consideration for heat-exchangers.	

1. Only the commonly used tempers are listed for the alloys shown. Other tempers of these alloys are available. For temper definitions, see SAE J1434.
2. Registered temper for a material which reduces incidence of stretcher strain.
3. Normally supplied with mill finish for bumper components if anodized or chrome plated finish is not required.
4. Suitable for bright dip and anodizing.
5. Suitable for chrome plating.
6. A wide variety of tempers are available to meet specific customer requirements. Normally a 2X temper is supplied.
7. Aluminum automotive wheels are also produced by the casting process.

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TABLE 2A—TYPICAL MECHANICAL PROPERTIES AND COMPARATIVE CHARACTERISTICS

Typical Mechanical Properties ⁽¹⁾⁽²⁾														
Alloy and Temper ⁽⁴⁾	Tension		Elongation	Shear	Fatigue	Modulus	Resistance to Corrosion		Comparative Characteristics					
	Strength						Modulus ⁽⁵⁾ of Elasticity MPa x 10°	Stress ⁽⁷⁾ corrosion Cracking	Toughness ⁽⁸⁾	Workability ⁽⁹⁾ cold	Machability ⁽⁹⁾	Weldability ⁽³⁾		
	Ultimate MPa	Yield 0.2% Offset MPa	percent in 50 mm (1.60 mm Thick Specimen)	Ultimate Shear Strength MPa	Endurance Limit MPa	General ⁽⁶⁾						Resistance spot and Seam	Gas	Arc
1100-0	90	35	35	60	35 ⁽¹⁰⁾	69	A	A	A	E	A	A	A	B
2017-T4	425	275	20 ⁽¹¹⁾	260	125 ⁽¹⁰⁾	75	D	C	C	B	N/A	N/A	N/A	N/A
2024-T4	470	325	20	285	140 ⁽¹⁰⁾	73	D	C	C	B	N/A	N/A	N/A	N/A
2036-T4	340	195	24	205	125 ⁽¹²⁾	71	C	A2 ⁽¹³⁾	A	B	C	—	B	B
2038-T4	325	170	25	205	125 ⁽¹²⁾	71	C	A2 ⁽¹³⁾		B	C	—	B	B
2117-T4	295	165	24 ⁽¹¹⁾	195	95 ⁽¹⁰⁾	71	C	A		B	C	N/A	N/A	N/A
3002-0	95	40	33	70		69	A	A		A	E	A	A	B
3003-H14,H24	150	145	8	95	60 ⁽¹⁰⁾	69	A	A		B	D	A	A	A
3004-0	180	70	20	110	95 ⁽¹⁰⁾	69	A	A	B	A	D	B	A	B
-H32	215	170	10	115	105 ⁽¹⁰⁾	69	A	A		B	D	B	A	A
5005-0	125	40	25	75		69	A	A		A	E	A	A	B
5052-0	195	90	25	125	110 ⁽¹⁰⁾	70	A	A	A	A	D	A	A	B
-H32	230	195	12	140	115 ⁽¹⁰⁾	70	A	A		B	D	A	A	A
-H34	260	215	10	145	125 ⁽¹⁰⁾	70	A	A	B	B	C	A	A	A
5083-H321,H116	315	230	14 ⁽¹¹⁾		160 ⁽¹⁰⁾	71	A	B		C	D	C	A	A
5086-H32	290	205	12			71	A	A		B	D	C	A	A
-H34	325	255	10	185		71	A	B		B	C	C	A	A
-H112	270	130	14			71	A	A		A	D	C	A	B
5182-0	275	130	21	165	140 ⁽¹²⁾	71	A-B	A2 ⁽¹⁴⁾		A	D	C	A	B
-02	270	125	23			71	A-B	A2 ⁽¹⁴⁾		A	D	C	A	B
5252-H25	235	170	11	145		69	A	A		B	C	A	A	A
5454-0	250	115	22	160		70	A	A	A	A	D	C	A	B
-H32	275	205	10	165		70	A	A		B	D	C	A	A
-H34	305	240	10	180		70	A	A	B	B	C	C	A	A
5457-H25	180	160	12	110		69	A	A		A	E	A	A	B
5657-H25	160	140	12	95		69	A	A		B	D	A	A	A
6009-T4	220	125	25	150	115 ⁽¹²⁾	69	B	A2	A	A	C	A	A	A
6010-T4	290	165	24	195	125 ⁽¹²⁾	69	B	A2	A	B	C	A	A	A
6053-T61						69	A	A	—	—	C	N/A	N/A	N/A

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TABLE 2A—TYPICAL MECHANICAL PROPERTIES AND COMPARATIVE CHARACTERISTICS (CONTINUED)

Typical Mechanical Properties ⁽¹⁾⁽²⁾														
Alloy and Temper ⁽⁴⁾	Tension		Elongation	Shear	Fatigue	Modulus	Resistance to Corrosion		Comparative Characteristics					
	Strength						Stress ⁽⁷⁾ corrosion Cracking	Toughness ⁽⁸⁾	Workability ⁽⁹⁾ cold	Machinability ⁽⁹⁾	Weldability ⁽³⁾			Resistance spot and Seam
	Ultimate MPa	Yield 0.2% Offset MPa	percent in 50 mm (1.60 mm Thick Specimen)	Ultimate Shear Strength MPa	Endurance Limit MPa	Modulus ⁽⁵⁾ of Elasticity MPa x 10 ⁹					General ⁽⁶⁾	Gas	Arc	
6061-T4	240	145	22	165	95 ⁽¹⁰⁾	69	B	B	A	B	C	A	A	A
-T6,T651	310	275	12	205	95 ⁽¹⁰⁾	69	B	A	B	C	C	A	A	A
6063-T1	150	90	20	95	60 ⁽¹⁰⁾	69	A	A		B	D	A	A	A
-T5	185	145	12	115	70 ⁽¹⁰⁾	69	A	A		B	C	A	A	A
-T6	240	215	12	150	70 ⁽¹⁰⁾	69	A	A		C	C	A	A	A
6111-T1	290	160	26		69	69	B	A2	A	B	C	A	A	B
6463-T52	185	145	12	115		69	A	A		B	C	A	A	A
7021-T61	430	380	13		140 ⁽¹⁰⁾	71	B	A2 ⁽¹⁵⁾						
7029-T5,T6	430	380	15	270		70	B	A2 ¹⁵						
7116-T5	360	315	16				B	A1 ¹⁵		C				
7129-T6	430	380	15	270	145 ⁽¹⁶⁾	70	B	A2 ¹⁵						

- Typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.
- The indicated typical mechanical properties for all except the 0 temper material are higher than the specified minimum properties. For 0 temper products, typical ultimate and yield values are slightly lower than specified (maximum) values.
- Ratings A through D for weldability are relative ratings as follows:
 - A—Generally weldable by all commercial procedures and methods.
 - B—Weldable with special techniques.
 - C—Limited weldability due to crack sensitivity, loss in corrosion resistance, loss in mechanical properties.
 - D—No commonly used welding methods have been developed.
 - N/A—Rating not applicable for end use application requirements, that is, rivets.
- Only the commonly used tempers are listed for the alloys shown. Other tempers of these alloys are available.
- Average of tension and compression moduli. Compression modulus is about 2% greater than tension modulus.
- General corrosion ratings are based on exposures to sodium chloride solution by intermittent spraying or immersion. Ratings A through D are relative ratings in decreasing order of merit. The ratings do not necessarily imply acceptable performance in the intended application.
- Stress-corrosion cracking ratings are based on service experience and on laboratory tests of specimens exposed to the 35% sodium chloride alternate immersion test for 2XXX, 6XXX, and copper containing 7XXX series alloys and total immersion in boiling sodium chloride solution for 96 h for copper free 7XXX series alloys.
 - A—No known instance of failure in service or in laboratory tests.
 - A2—Insufficient service experience; no known instance of failure in laboratory tests.
 - B—No known instance of failure in service; limited failures in laboratory service.
 - B2—Insufficient service experience; limited failures in laboratory service.
 - C—Service failures with sustained tension stress acting in short transverse direction relative to grain structure; limited failures in laboratory tests of long transverse specimens.
 - D—Limited service failures with sustained longitudinal or long transverse stress.
- Toughness ratings are based upon Kahn Tear Test of 1.60 mm thick sheet specimens in both longitudinal and transverse directions. This data is based on a limited number of tests and should be used for general comparisons only.
 - Ratings A—over 175 000 Nm/m²
 - B—over 140 000 thru 175 000 Nm/m²
 - C—over 105 000 thru 140 000 Nm/m²
 - D—0 through 105 000 Nm/m²
- Ratings A through D for workability (cold) and A through E for machinability are relative ratings in decreasing order of merit.
- Based upon 500 000 000 cycles of completely reversed stress using the RR Moore type of machine and specimen.
- Elongation in 50 mm apply for thicknesses up through 12.50 mm and in 5D (5.65√A) for thicknesses over 12.50 mm where D and A are the diameter and cross-sectional area of the specimen. Values for elongations in 5D (5.65√A) are shown in brackets.

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12. Based upon a single series of tests, 10 000 000 cycles sheet flexural specimens.
13. This rating would be B 2 for material exposed to elevated temperatures.
14. This rating may be different for material held at elevated temperatures for long periods.
15. Improved resistance to stress corrosion cracking can be realized by using controlled quenching and artificial aging practices in heat-treatable 7XXX aluminum alloys.
16. Based upon 50 000 000 cycles in a single series of tests using the RR Moore type of machine and specimen.

TABLE 2B—MECHANICAL PROPERTY LIMITS⁽¹⁾⁽²⁾

Alloy and Temper	Product Form	Specified ⁽³⁾ Thickness or Diameter over mm	Specified ⁽³⁾ Thickness or Diameter thru mm	Area mm ² thru	Tensile Strength ⁽⁴⁾ Ultimate min MPa	Tensile Strength ⁽⁴⁾ Ultimate max MPa	Tensile Strength ⁽⁴⁾	Elongation ⁽⁵⁾ % in 50 mm min
							Yield min 0.2% Offset MPa	
1100-0	Sheet	0.15	0.32		75	105	25	15
		0.32	0.63		75	105	25	17
		0.63	1.20		75	105	25	22
		1.20	6.30		75	105	25	30
2017-T4	Rivet and Cold Heading Wire and Rod	1.60	25.00		380		220	(10)
2024-T4	Rivet and Cold Heading Wire and Rod	1.60	25.00		425		275	(9)
2036-T4	Sheet	0.63	3.20		290		160	20
2038-T4	Sheet	0.63	1.80		275		140	20
2117-T4	Rivet and Cold Heading Wire and Rod	1.60	25.00		260		125	(10)
3002-0	Sheet	0.63	0.80		75	110	20	20
		0.80	1.20		75	110	20	23
		1.20	1.60		75	110	20	25
		0.20	0.32		140	180	115	1
3003-H14,24	Sheet	0.32	0.63		140	180	115	2
		0.63	1.20		140	180	115	3
		1.20	6.30		140	180	115	5
		0.15	0.32		150	200	60	9
3004-0	Sheet	0.32	0.63		150	200	60	12
		0.63	1.20		150	200	60	15
		1.20	6.30		150	200	60	18
		0.40	0.63		190	240	145	1
-H32	Sheet	0.63	1.20		190	240	145	3
		1.20	6.30		190	240	145	5
		0.15	0.32		105	145	35	12
5005-0	Sheet	0.32	0.63		105	145	35	16
		0.63	1.20		105	145	35	19
		1.20	6.30		105	145	35	21
		0.15	0.32		170	215	65	13
5052-0	Sheet	0.32	0.63		170	215	65	15
		0.63	1.20		170	215	65	17
		1.20	6.30		170	215	65	19
		0.40	0.63		215	265	160	4
-H32	Sheet	0.63	1.20		215	265	160	5
		1.20	6.30		215	265	160	7
		0.20	0.32		235	285	180	3
5052-H34	Sheet	0.32	0.63		235	285	180	3
		0.63	1.20		235	285	180	4
		1.20	6.30		235	285	180	6
		6.30	12.50		275		125	12
5083-H112	Plate	6.30	12.50		275		125	12
-H321	Sheet & Plate	4.00	12.50		305	385	215 ⁽⁶⁾	12
-H116	Sheet & Plate	1.60	12.50		305		215	10
-H111	Extrusions		130.00		275		165	12

Notes:

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TABLE 2B—MECHANICAL PROPERTY LIMITS⁽¹⁾⁽²⁾ (CONTINUED)

Alloy and Temper	Product Form	Specified ⁽³⁾ Thickness or Diameter over mm	Specified ⁽³⁾ Thickness or Diameter thru mm	Area mm ² thru	Tensile Strength ⁽⁴⁾ Ultimate min MPa	Tensile Strength ⁽⁴⁾ Ultimate max MPa	Tensile Strength ⁽⁴⁾	Elongation ⁽⁵⁾ % in 50 mm min
							Yield min 0.2% Offset MPa	
-H112	Extrusions		130.00	20 000	270		110	12
5086-H32	Sheet & Plate	0.50	0.63		275	325	195	6
		0.63	1.20		275	325	195	6
		1.20	6.30		275	325	195	8
		6.30	50.00		275	325	195	12(10)
5086-H34	Sheet & Plate	0.20	0.32		300	350	235	4
		0.32	0.63		300	350	235	4
		0.63	1.20		300	350	235	5
		1.20	6.30		300	350	235	6
		6.30	25.00		300	350	235	10(9)
5086-H112	Extrusions		130.00	20 000	240		95	12
	Tubing	All	All	20 000	240		95	12
5182-0	Sheet	0.63	3.20		255	325	110	18
-02	Sheet	0.63	3.20		250	315	110	18
5252-H25	Sheet	0.63	2.50		215	270		9
5454-0	Sheet & Plate	0.50	0.63		215	285	85	12
		0.63	1.20		215	285	85	13
		1.20	6.30		215	285	85	16
		6.30	80.00		215	285	85	18(16)
-H32	Sheet & Plate	0.50	0.63		250	305	180	5
		0.63	1.20		250	305	180	6
		1.20	6.30		250	305	180	8
		6.30	50.00		250	305	180	12(10)
5454-H34	Sheet & Plate	0.50	0.63		270	325	200	4
		0.63	1.20		270	325	200	5
		1.20	6.30		270	325	200	6
		6.30	25.00		270	325	200	10(9)
5454-0	Extrusions		130.00	20 000	215	285	85	14
-H111	Extrusions		130.00	20 000	230		130	12
5454-0	Tube	All	All	20 000	215	285	85	14
-H111	Tube	All	All	20 000	230		130	12
5457-H-25	Sheet	0.75	2.50		160	215		7
5657-H25	Sheet	0.63	2.50		140	195		8
6009-T4	Sheet	0.50	1.80		185		105	21
		1.80	3.20		165		90	21
6009-T62	Sheet	0.50	1.80		270		235	9
6010-T4	Sheet	0.50	1.80		240		140	20
6010-T62	Sheet	0.50	1.80		340		310	8
6053-T61	Rivet and Cold Heading Wire and Rod	1.60	25.00		205		135	(12)
6061-T4	Sheet	0.15	0.20		205		110	10
		0.20	0.25		205		110	12
		0.25	0.50		205		110	14
		0.50	6.30		205		110	16
		0.15	0.20		290		240	4
6061-T6	Sheet	0.20	0.25		290		240	6
		0.25	0.50		290		240	8
		0.50	6.30		290		240	10
		6.30	12.50		290		240	10
6061-T651	Plate	12.50	25.00		290		240	(8)
		25.00	50.00		290		240	(7)

Notes:

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TABLE 2B—MECHANICAL PROPERTY LIMITS⁽¹⁾⁽²⁾ (CONTINUED)

Alloy and Temper	Product Form	Specified ⁽³⁾	Specified ⁽³⁾	Area mm ² thru	Tensile Strength ⁽⁴⁾	Tensile Strength ⁽⁴⁾	Tensile Strength ⁽⁴⁾	Elongation ⁽⁵⁾ % in 50 mm min
		Thickness or Diameter over mm	Thickness or Diameter thru mm		Ultimate min MPa	Ultimate max MPa	Yield min 0.2% Offset MPa	
6061-T4	Extrusions & Tube	All	All	All	180		110	16
6061-T6	Extrusions & Tube		6.30	All	260		240	8
		6.30		All	260		240	10
6061-T6	Rivet and Cold Heading Wire and Rod	1.60	25.00		290		240	(9)
6061-T6	Forgings Extension (Die Forgings)		100.00		260		240	7(6) ⁽⁷⁾
								5(4) ⁽⁸⁾
6063-T1	Extrusions & Tube		12.50	All	115		60	12
		12.50	25.00	All	110		55	
6063-T5	Extrusions & Tube		12.50	All	150		110	8
		12.50	25.00	All	145		105	
6063-T6	Extrusions & Tube		3.20	All	205		170	8
		3.20	25.00	All	205		170	10
6111-T4	Sheet	0.50	1.80		275		140	22
6111-T6	Sheet	0.50	1.80		320		275	10
6463-T521	Extrusions		25.00		150		95	8(7)
7021-T61	Sheet	1.60	6.30		380		345	8
7029-T5,T6	Extrusions	2.50	6.30		380		340	10
	Sheet							
7116-T5	Extrusions	3.20	12.50		330		290	8
7129-T5,T6	Extrusions		6.30		380		340	9

Notes:

1. Tensile property limits are based on producer analysis of data accumulated from standard production material which has been sampled and tested using standard procedures as detailed in the Quality Control Section of "Aluminum Standards and Data" published by The Aluminum Association Inc. The limits are established after sufficient test data has been accumulated to adequately determine the form of the frequency distribution curve and to provide a reliable estimate of the population mean and standard deviation. In most instances, the distribution is normal in form and properties are based on the results of a minimum of 100 tests from at least 10 different lots of material. The limits are subsequently established at levels at which 99% of the material is expected to conform at a confidence level of 0.95.
2. Ultimate Shearing Strength for Rivet and Cold Heading Wire & Rod

Alloy and Temper	Ultimate Shearing Strength min, MPa
2017-T4	225
2024-T4	255
2117-T4	180
6053-T6	135
6061-T6	170

3. Thicknesses shown are provided as a guide to the designer and should not be used for ordering purposes. Consult material supplier for details.
4. Tensile values are determined in accordance with ASTM B557M "Method of Tension Testing Aluminum and Magnesium Alloys."
5. Elongations in 50 mm apply for thicknesses up through 12.50 mm and in 5D (5.65√A) for thicknesses over 12.50 mm where D and A are the diameter and cross-sectional area of the specimen. Values for elongations in 5D (5.65√A) are shown in brackets.
6. Yield Maximum = 295 MPa for Alloy 5083-H321 Sheet and Plate
= 180 MPa for Alloy 6463-T521 Extrusions
7. Specimen from forging axis parallel to direction of grain flow.
8. Specimen from forging axis not parallel to direction of grain flow.

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TABLE 3—CHEMICAL COMPOSITION LIMITS⁽¹⁾⁽²⁾

AA Number	UNS Number	Si	Fe	Cu	Mn	Mg	Cr	Zn		Ti	Other ⁽³⁾ Each	Other ⁽³⁾ Total ⁽⁴⁾	Aluminum ⁽⁵⁾ Min
1100	A91100	0.95	Si + Fe	0.05–0.20	0.05	—	—	0.10	—	—	0.05	0.15	99.00
2017	A92017	0.20–0.8	0.7	3.5–4.5	0.40–1.0	0.40–0.8	0.10	0.25	—	0.15	0.05	0.15	Remainder
2024	A92024	0.50	0.50	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	—	0.15	0.05	0.15	
2036	A92036	0.50	0.50	2.2–3.0	0.10–0.40	0.30–0.6	0.10	0.25	—	0.15	0.05	0.15	
2038	A92038	0.50–1.3	0.6	0.8–1.8	0.10–0.40	0.40–1.0	0.20	0.50	0.05V–0.05Ga	0.15	0.05	0.15	
2117	A92117	0.8	0.7	2.2–3.0	0.20	0.20–0.50	0.10	0.25	—	—	0.05	0.15	
3002	A93002	0.08	0.10	0.15	0.05–0.25	0.05–0.20	—	0.05	0.05V	0.03	0.03	0.10	
3003	A93003	0.6	0.7	0.05–0.20	1.0–1.5	—	—	0.10	—	—	0.05	0.15	
3004	A93004	0.30	0.7	0.25	1.0–1.5	0.8–1.3	—	0.25	—	—	0.05	0.15	
5005	A95005	0.30	0.7	0.20	0.20	0.50–1.1	0.10	0.25	—	—	0.05	0.15	
5052	A95052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	—	—	0.05	0.15	
5083	A95083	0.40	0.40	0.10	0.40–1.0	4.0–4.9	0.05–0.25	0.25	—	0.15	0.05	0.15	
5086	A95086	0.40	0.50	0.10	0.20–0.7	3.5–4.5	0.05–0.25	0.25	—	0.15	0.05	0.15	
5182	A95182	0.20	0.35	0.15	0.20–0.50	4.0–5.0	0.10	0.25	—	0.10	0.05	0.15	
5252	A95252	0.08	0.10	0.10	0.10	2.2–2.8	—	0.05	0.05V	—	0.03	0.10	
5454	A95454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	—	0.20	0.05	0.15	
5457	A95457	0.08	0.10	0.20	0.15–0.45	0.8–1.2	—	0.05	0.05V	—	0.03	0.10	
5657	A95657	0.08	0.10	0.10	0.03	0.6–1.0	—	0.05	0.05V–0.03Ga	—	0.02	0.05	
6009	A96009	0.6–1.0	0.50	0.15–0.6	0.20–0.8	0.40–0.8	0.10	0.25	—	0.10	0.05	0.15	
6010	A96010	0.8–1.2	0.50	0.15–0.6	0.20–0.8	0.6–1.0	0.10	0.25	—	0.10	0.05	0.15	
6053	A96053	(6)	0.35	0.10	—	1.1–1.4	0.15–0.35	0.10	—	—	0.05	0.15	
6061	A96061	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.35	0.25	—	0.15	0.05	0.15	
6063	A96063	0.20–0.6	0.35	0.10	0.10	0.45–0.9	0.10	0.10	—	0.10	0.05	0.15	
6111	A96111	0.7–1.1	0.40	0.50–0.9	0.15–0.45	0.50–1.0	0.10	0.15	—	0.10	0.05	0.15	
6463	A96463	0.20–0.6	0.15	0.20	0.05	0.45–0.9	—	0.05	—	—	0.05	0.15	
7021	A97021	0.25	0.40	0.25	0.10	1.2–1.8	0.05	5.0–6.0	0.08–0.18Zr	0.10	0.05	0.15	
7029	A97029	0.10	0.12	0.50–0.9	0.03	1.3–2.0	—	4.2–5.2	0.05V	0.05	0.03	0.10	
7116	A97116	0.15	0.30	0.50–1.1	0.05	0.8–1.4	—	4.2–5.2	0.05v–0.03Ga	0.05	0.05	0.15	
7129	A97129	0.15	0.30	0.50–0.9	0.10	1.3–2.0	0.10	4.2–5.2	0.05V–0.03Ga	0.05	0.05	0.15	

1. Composition in percent maximum unless shown as a range.
2. For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis is rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limit in accordance with the rounding-off method of ASTM E 29.
3. Analysis is required for elements other than aluminum for which specific limits are shown. Analysis for other elements is made when their presence is suspected to be, or in the course of routine analysis is indicated to be, in excess of the specified limits.
4. Other elements total is the sum of those other metallic elements 0.010 or more, each expressed to the second decimal before determining the sum.
5. The aluminum content for unalloyed aluminum not made by a refining process is the difference between 100.0% and the sum of all other metallic elements present in amounts of 0.010% or more each expressed to the second decimal before determining the sum.
6. 45% to 65% of actual Mg.

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TABLE 4—TYPICAL HEAT TREATMENTS FOR ALUMINUM ALLOY MILL PRODUCTS⁽¹⁾

Alloy	Product	Solution Heat ⁽²⁾ Treatment Metal ⁽³⁾ Temperature °C	Solution Heat ⁽²⁾ Treatment Temperature Designation	Precipitation Heat Treatment Metal ⁽³⁾ Temperature °C	Precipitation Heat Treatment Approx. ⁽⁴⁾ Time at Temperature Hours	Precipitation Heat Treatment Temperature Designation
2036	Sheet	(5)	T4			
2038	Sheet	(5)	T4			
6009	Sheet	(5)	T4	200–210°	1	T6 ⁽⁶⁾
6010	Sheet	(5)	T4	200–210°	1	T6 ⁽⁶⁾
6061	Sheet	515–550	T4	155–165	18	T6
	Plate	515–550	T451	155–165	18	T651
	Extrusions, Tube, Rod, Bar Forgings	515–550 ⁽⁷⁾	T4	170–180	8	T6
6063	Extrusions, Tube	(7)	T1	175–185 ⁽⁸⁾	3	T5
		515–525 ⁽⁷⁾	T4	170–180 ⁽⁹⁾	8	T6
6111	Sheet	(5)	T4	200–210	1	T6
6463	Extrusions	(7)	T1	175–185 ⁽⁸⁾	1	T5
		515–525	T4	170–180 ⁽⁹⁾	8	T6
7021	Sheet	395–405 ⁽¹⁰⁾	W	(11)	(11)	T61
7029	Extrusions	480–520 ⁽¹²⁾	W	(13)	(13)	T5, T6
7116	Extrusions	425–540	W	(14)	(14)	T5
7129	Extrusions	480–520	S	(13)	(13)	T5, T6

Notes:

- The times and temperatures shown are typical for various forms, sizes and methods of manufacture and may not exactly describe the optimum treatment for a specific item.
- Material should be quenched in water or by high velocity fans from the solution heat-treating temperature as rapidly as possible and with minimum delay after removal from the furnace. Unless otherwise indicated, when material is quenched by total immersion in water, the water should be at room temperature and suitably cooled to remain below 35 °C during the quench cycle. The use of high velocity, high volume jets of cold water is also effective for some material.
- The metal temperature should be attained as rapidly as possible. When a temperature range exceeding 10 °C is shown, a temperature range of 10 degrees within the listed range should be selected and maintained during the time at temperature.
- The time at temperature will depend on the time required for load to reach temperature. The times shown are based on rapid heating with soaking time measured from the time the load reaches the 10 °C range listed or selected.
- These alloys are supplied in the solution heat-treated condition. For optimum properties, subsequent re-heat treatment is not recommended.
- Mechanical properties of material will meet tensile property limits of T6 temper as specified in Table 2B.
- By suitable control of extrusion temperature, product may be quenched directly from extrusion press to provide specified properties for this temper. Some products may be adequately quenched in air blast at room temperature.
- An alternate treatment comprised of 1 to 2 h at 200 to 210 °C may be used.
- An alternate treatment comprised of 6 h at 175 to 185 °C may be used.
- Quenched at a minimum average cooling rate of 35 °C/s as measured over the range 385 to 205 °C.
- A minimum of 8 h at room temperature followed by 2 h at 95 to 105 °C plus 4 h at 155 to 165 °C.
- 10 minute soak at temperature followed by cold water quench.
- 5 h at 95 to 105 °C plus 5 h at 155 to 165 °C.
- 5 h at 95 to 105 °C plus 5 h at 160 to 170 °C.

TABLE 5—TYPICAL PHYSICAL PROPERTIES⁽¹⁾

Average ⁽²⁾ Coefficient of Thermal Expansion 20 to 100 °C Per °C	Average ⁽²⁾ Coefficient of Thermal Expansion 20 to 100 °C Per °C	Approx. ⁽³⁾⁽⁴⁾ Melting Range °C	Temper	Thermal Conductivity at 25 °C W/mK	Electrical ⁽⁵⁾ Conductivity at 20 °C (68 °F) Equal Volume	Electrical ⁽⁵⁾ Conductivity at 20 °C (68 °F) Equal Mass	Electrical Resistivity at 20 °C Ohm mm/m	Density 10 kg/m
1100	23.6	640–655	0	222	59	194	0.029	2.71
2036	23.4	555–650	T4	159	41	135	0.042	2.75
2038	23.4	555–650	T4	155	40	132	0.043	2.73
3002								2.70
3003	23.2	640–655	H14	159	41	134	0.042	2.73
3004	23.9	630–655	All	163	42	137	0.042	2.72
5005	23.8	630–655	All	201	52	172	0.033	2.70
5052	23.8	605–650	All	138	35	116	0.050	2.68
5083	23.8	580–640	0	117	29	98	0.059	2.66
5086	23.8	585–640	All	126	31	104	0.056	2.66
5182	24.1	575–640	All	121	31	110	0.056	2.65
5252	23.8	605–650	All	138	35	116	0.050	2.67
5454	23.6	600–640	0	134	34	113	0.050	2.69
			H38	134	34	113	0.050	
5457	23.8	630–655	All	176	46	153	0.037	2.69
6009	23.4	605–650	All	167	44	144	0.039	2.71
6010	23.2	585–650	All	151	39	128	0.044	2.71
6061	23.6	580–650	T4	155	40	132	0.043	2.70
			T6	167	43	142	0.040	
6063	23.4	615–655	T1	193	50	165	0.034	2.70
			T5	209	55	181	0.031	2.70
			T6	201	53	175	0.032	2.70
6111	23.4	585–650	T4	154	40	131	0.043	2.71
			T6	174	45	147	0.038	2.71
6463	23.4	615–655	T5	209	55	181	0.031	2.69
			T6	201	53	175	0.032	2.69
7021	22.8	595–645	T61	176	43	135	0.040	2.78
7029	22.8	585–645	T5,T6	163	42	133	0.041	2.77
7116	23.4	600–645	T5	176	46	148	0.037	2.78
7129	22.8	585–615	T5,T6	163	42	133	0.041	2.78

Notes:

1. Typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.
2. Coefficient to be multiplied by 10^{-6} . Example: $23.6 \times 10^{-6} = 0.0000236$.
3. Melting ranges shown apply to wrought products of 6 mm or greater thickness.
4. Based on typical composition of the indicated alloy.
5. IACS—International Annealed Copper Standard.

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
1100-0	-320	-196	25	172	6	41	50
	-112	-80	15	103	5.5	38	43
	-18	-28	14	97	5	34	40
	75	24	13	90	5	34	40
	212	100	10	69	4.6	32	45
	300	149	8	55	4.2	29	55
	400	204	6	41	3.5	24	65
	500	260	4	28	2.6	18	75
	600	316	2.9	20	2	14	80
700	371	2.1	14	1.6	11	85	
1100-H14	-320	-196	30	207	20	138	45
	-112	-80	20	138	18	124	24
	-18	-28	19	131	17	117	20
	75	24	18	124	17	117	20
	212	100	16	110	15	103	20
	300	149	14	97	12	83	23
	400	204	10	69	7.5	52	26
	500	260	4	28	2.6	18	75
	600	316	2.9	20	2	14	80
700	371	2.1	14	1.6	11	85	
1100-H18	-320	-196	34	234	26	179	30
	-112	-80	26	179	23	158	16
	-18	-28	25	172	23	158	15
	75	24	24	165	22	152	15
	212	100	21	145	19	131	15
	300	149	18	124	14	97	20
	400	204	6	41	3.5	24	65
	500	260	4	28	2.6	18	75
	600	316	2.9	20	2	14	80
700	371	2.1	14	1.6	11	85	
2011-T3	75	24	55	379	43	296	15
	212	110	47	324	34	234	16
	300	149	23	193	19	131	25
	400	204	16	110	11	76	35
	500	260	6.5	45	3.8	26	45
	600	316	3.1	21	1.8	12	90
700	371	2.3	16	1.4	10	125	

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
2014-T6, -T651	-320	-196	84	579	72	496	14
	-112	-80	74	510	65	448	13
	-18	-28	72	496	62	427	13
	75	24	70	482	60	414	13
	212	100	63	434	57	393	15
	300	149	40	275	35	241	20
	400	204	16	110	13	90	38
	500	260	9.5	66	7.5	52	52
	600	316	6.5	45	5	34	65
	700	371	4.3	30	3.5	24	72
2017-T4, -T451	-320	-196	80	551	53	365	28
	-112	-80	65	448	42	290	24
	-18	-28	64	441	41	283	23
	75	24	62	427	40	276	22
	212	100	57	393	39	269	18
	300	149	40	276	30	207	15
	400	204	16	110	13	90	35
	500	260	9	62	7.5	52	45
	600	316	6	41	5	34	65
	700	371	4.3	30	3.5	24	70
2024-T3 (sheet)	-320	-196	85	586	62	427	18
	-112	-80	73	503	52	358	17
	-18	-28	72	496	51	352	17
	75	24	70	482	50	345	17
	212	100	66	455	48	331	16
	300	149	55	379	45	310	11
	400	204	27	186	20	138	23
	500	260	11	76	9	62	55
	600	316	7.5	52	6	41	75
	700	371	5	34	4	28	100
2024-T4, -T351 (plate)	-320	-196	84	579	61	420	19
	-112	-80	71	490	49	338	19
	-18	-28	69	476	47	324	19
	75	24	68	469	47	324	19
	212	100	63	434	45	310	19
	300	149	45	310	36	248	17
	400	204	26	179	19	131	27
	500	260	11	76	9	62	55
	600	316	7.5	52	6	41	75
	700	371	5	34	4	28	100

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
2024-T6, -T651	-320	-196	84	579	68	469	11
	-112	-80	72	496	59	408	10
	-18	-28	70	483	58	400	10
	75	24	69	476	57	393	10
	212	100	65	448	54	372	10
	300	149	45	310	36	248	17
	400	204	26	179	19	131	27
	500	260	11	76	9	62	55
	600	316	7.5	52	6	41	75
	700	371	5	34	4	28	100
2024-T81, -T851	-320	-196	85	586	78	538	8
	-112	-80	74	510	69	476	7
	-18	-28	73	503	68	469	7
	75	24	70	482	65	448	7
	212	100	66	455	62	427	8
	300	149	55	379	49	338	11
	400	204	27	186	20	138	23
	500	260	11	76	9	62	55
	600	316	7.5	52	6	41	75
	700	371	5	34	4	28	100
2024-T861 ⁽³⁾	-320	-196	92	634	85	586	5
	-112	-80	81	558	77	531	5
	-18	-28	78	538	74	510	5
	75	24	75	517	71	490	5
	212	100	70	483	67	462	6
	300	149	54	372	48	331	11
	400	204	21	145	17	117	28
	500	260	11	76	9	62	55
	600	316	7.5	52	6	41	75
	700	371	5	34	4	28	100

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
2117-T4	-320	-196	56	386	33	228	30
	-112	-80	45	310	25	172	29
	-18	-28	44	303	24	165	28
	75	24	43	296	24	165	27
	212	100	36	248	21	145	16
	300	149	30	207	17	117	20
	400	204	16	110	12	83	35
	500	260	7.5	52	5.5	38	55
	600	316	4.7	32	3.3	23	80
	700	371	2.9	20	2	14	110
2618-T61	-320	-196	78	538	61	420	12
	-112	-80	67	462	55	379	11
	-18	-28	64	441	54	372	10
	75	24	64	441	54	372	10
	212	100	62	427	54	372	10
	300	149	50	345	44	303	14
	400	204	32	221	26	179	24
	500	260	13	90	9	62	50
	600	316	7.5	52	4.5	31	80
	700	371	5	34	3.5	24	120
3003-0	-320	-196	33	227	8.5	59	46
	-112	-80	20	138	7	48	42
	-18	-28	17	117	6.5	45	41
	75	24	16	110	6	41	40
	212	100	13	90	5.5	38	43
	300	149	11	76	5	34	47
	400	204	8.5	59	4.3	30	60
	500	260	6	41	3.4	23	65
	600	316	4	28	2.4	16	70
	700	371	2.8	19	1.8	14	70
3003-H14	-320	-196	35	241	25	172	30
	-112	-80	24	165	22	152	18
	-18	-28	22	152	21	145	16
	75	24	22	152	21	145	16
	212	100	21	145	19	131	16
	300	149	18	124	16	110	16
	400	204	14	96	9	62	20
	500	260	7.5	52	4	28	60
	600	316	4	28	2.4	16	70
	700	371	2.8	19	1.8	12	70

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TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
3003-H18	-320	-196	41	283	33	228	23
	-112	-80	32	221	29	200	11
	-18	-28	30	207	28	193	10
	75	24	29	200	27	186	10
	212	100	26	179	21	145	10
	300	149	23	158	16	110	11
	400	204	14	96	9	62	18
	500	260	7.5	52	4	28	60
	700	371	4	28	2.4	16	70
3004-0	-320	-196	42	290	13	90	38
	-112	-80	28	193	11	76	30
	-18	-28	26	179	10	69	26
	75	24	26	179	10	69	25
	212	100	26	179	10	69	25
	300	149	22	152	10	69	35
	400	204	14	96	9.5	66	55
	500	260	10	69	7.5	52	70
	700	371	5	34	3	21	90
3004-H34	-320	-196	52	358	34	234	26
	-112	-80	38	262	30	207	16
	-18	-28	36	248	29	200	13
	75	24	35	241	29	200	12
	212	100	34	234	29	200	13
	300	149	28	193	25	172	22
	400	204	21	145	15	103	35
	500	260	14	96	7.5	52	55
	700	371	5	34	3	21	80

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
3004-H38	-320	-196	58	400	43	296	20
	-112	-80	44	303	38	262	10
	-18	-28	42	290	36	248	7
	75	24	41	283	36	248	6
	212	100	40	276	36	248	7
	300	149	31	214	27	186	15
	400	204	22	152	15	103	30
	500	260	12	83	7.5	52	50
	600	316	7.5	52	5	34	80
	700	371	5	34	3	21	90
4032-T6	-320	-196	66	455	48	331	11
	-112	-80	58	400	46	317	10
	-18	-28	56	386	46	317	9
	75	24	55	379	46	317	9
	212	100	50	345	44	303	9
	300	149	37	255	33	228	9
	400	204	13	90	9	62	30
	500	260	8	55	5.5	28	50
	600	316	5	34	3.2	22	70
	700	371	3.4	23	2	14	90
5050-0	-320	-196	37	255	10	69	—
	-112	-80	22	152	8.5	59	—
	-18	-28	21	145	8	55	—
	75	24	21	145	8	55	—
	212	100	21	145	8	55	—
	300	149	19	131	8	55	—
	400	204	14	96	7.5	52	—
	500	260	9	62	6	41	—
	600	316	6	41	4.2	29	—
	700	371	3.9	27	2.6	18	—
5050-H34	-320	-196	44	303	30	207	—
	-112	-80	30	207	25	172	—
	-18	-28	28	193	24	165	—
	75	24	28	193	24	165	—
	212	100	28	193	24	165	—
	300	149	25	172	22	152	—
	400	204	14	96	7.5	52	—
	500	260	9	62	6	41	—
	600	316	6	41	4.2	29	—
	700	371	3.9	27	2.6	18	—

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TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
5050-H38	-320	-196	46	317	36	248	—
	-112	-80	34	234	30	207	—
	-18	-28	32	221	29	200	—
	75	24	32	221	29	200	—
	212	100	31	214	29	200	—
	300	149	27	186	25	172	—
	400	204	14	96	7.5	52	—
	500	260	9	62	6	41	—
	600	316	6	41	4.2	29	—
	700	371	3.9	27	2.6	18	—
5052-0	-320	-196	44	303	16	110	46
	-112	-80	29	200	13	90	35
	-18	-28	28	193	13	90	32
	75	24	28	193	13	90	30
	212	100	28	193	13	90	36
	300	149	23	158	13	90	50
	400	204	17	117	11	76	60
	500	260	12	83	7.5	52	80
	600	316	7.5	52	5.5	38	110
	700	371	5	34	3.1	21	130
5052-H34	-320	-196	55	379	36	248	28
	-112	-80	40	276	32	221	21
	-18	-28	38	262	31	214	18
	75	24	38	262	31	214	16
	212	100	38	262	31	214	18
	300	149	30	207	27	186	27
	400	204	24	165	15	103	45
	500	260	12	83	7.5	52	80
	600	316	7.5	52	5.5	38	110
	700	371	5	34	3.1	21	130

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
5052-H38	-320	-196	60	414	44	303	25
	-112	-80	44	303	38	262	18
	-18	-28	42	290	37	255	15
	75	24	42	290	37	255	14
	212	100	40	276	36	248	16
	300	149	34	234	28	193	24
	400	204	25	172	15	103	45
	500	260	12	83	7.5	52	80
	600	316	7.5	52	5.5	38	110
	700	371	5	34	3.1	21	130
5083-0	-320	-196	59	407	24	165	36
	-112	-80	43	296	21	145	30
	-18	-28	42	290	21	145	27
	75	24	42	29	21	145	25
	212	100	40	276	21	145	36
	300	149	31	214	19	131	50
	400	204	22	152	17	117	60
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130
5086-0	-320	-196	55	379	19	131	46
	-112	-80	39	269	17	117	35
	-18	-28	38	262	17	117	32
	75	24	38	262	17	117	30
	212	100	38	262	17	117	36
	300	149	29	200	16	110	50
	400	204	22	152	15	103	60
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130
5154-0	-320	-196	52	358	19	131	46
	-112	-80	36	248	17	117	35
	-18	-28	35	241	17	117	32
	75	24	35	241	17	117	30
	212	100	35	241	17	117	36
	300	149	29	200	16	110	50
	400	204	22	152	15	103	60
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130

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TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
5454-0	-320	-196	54	372	19	131	39
	-112	-80	37	255	17	117	30
	-18	-28	36	248	17	117	27
	75	24	36	248	17	117	25
	212	100	36	248	17	117	31
	300	149	29	200	16	110	50
	400	204	22	152	15	103	60
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130
5454-H32	-320	-196	59	407	36	248	32
	-112	-80	42	290	31	214	23
	-18	-28	41	283	30	207	20
	75	24	40	276	30	207	18
	212	100	39	269	29	200	20
	300	149	32	221	26	179	37
	400	204	25	172	19	131	45
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130
5454-H34	-320	-196	63	434	41	283	30
	-112	-80	46	317	36	248	21
	-18	-28	44	303	35	241	18
	75	24	44	303	35	241	16
	212	100	43	296	34	234	18
	300	149	34	234	28	193	32
	400	204	26	179	19	131	45
	500	260	17	117	11	76	80
	600	316	11	76	7.5	52	110
	700	371	6	41	4.2	29	130

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**TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES⁽¹⁾
(NOT FOR DESIGN PURPOSES) (CONTINUED)**

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms, and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

Alloy and Temper	Temperature °F	Temperature °C	Tensile Strength Ultimate ksi	Tensile Strength Ultimate MPa	Tensile Strength Yield ⁽²⁾ ksi	Tensile Strength Yield ⁽²⁾ MPa	Elongation in 2 in, %
5456-0	-320	-196	62	427	26	179	32
	-112	-80	46	317	23	158	25
	-18	-28	45	310	23	158	22
	75	24	45	310	23	158	20
	212	100	42	290	22	152	31
	300	149	31	214	20	137	50
	400	204	22	152	17	117	60
	500	260	17	117	11	76	80
	700	371	6	41	4.2	29	130
6053-T6, -T651	75	24	37	255	32	221	13
	212	100	32	221	28	193	13
	300	149	25	172	24	165	13
	400	204	13	90	12	83	25
	500	260	5.5	38	4	28	70
	600	316	4	28	2.7	19	80
	700	371	2.9	20	2	14	90
6061-T6, -T651	-320	-196	60	414	47	324	22
	-112	-80	49	338	42	290	18
	-18	-28	47	324	41	283	17
	75	24	45	310	40	276	17
	212	100	42	290	38	262	18
	300	149	34	234	31	214	20
	400	204	19	131	15	103	28
	500	260	7.5	52	5	34	60
	600	316	4.6	32	2.7	19	85
	700	371	3	21	1.8	12	95
6063-T1	-320	-196	34	234	16	110	44
	-112	-80	26	179	15	103	36
	-18	-28	24	165	14	96	34
	75	24	22	152	13	90	33
	212	100	22	152	14	96	18
	300	149	21	145	15	103	20
	400	204	9	62	6.5	45	40
	500	260	4.5	31	3.5	24	75
	600	316	3.2	22	2.5	17	80
	700	371	2.3	16	2	14	105