(167 Btu/lb)
Thermal conductivity. T551 temper: 117 W/m·K (67.7 Btu/ft·h·°F) at 25 °C (77 °F)

Electrical Properties

Electrical conductivity. Volumetric, T551 temper: 29% IACS at 20 °C (68 °F)
Electrical resistivity. T551 temper: 59.5 nΩ·m at 20 °C (68 °F)

Fabrication Characteristics

Melting temperature. 675 to 816 °C (1250 to 1500 °F)
Casting temperature. 675 to 788 °C (1250 to 1450 °F)
Solution temperature. 515 to 520 °C (955 to 965 °F); hold 8 h at temperature; cool in water at 65 to 100 °C (150 to 212 °F)
Aging temperature. 170 to 175 °C (335 to 345 °F); hold at temperature 14 to 18 h to obtain T5 temper from as-cast material; 12 to 26 h to obtain T6 temper from solution heat treated material
Joining. Rivet compositions: 6053-T4, 6053-T6, 6053-T61. Soft solder with Alcoa No. 802; no flux. Rub-tin with Alcoa No. 802. Metal-arc wled with 4043 alloy; Alcoa No. 27 flux. Carbon-arc weld with 4043 alloy; Alcoa No. 24 flux (automatic); Alcoa No. 27 flux (manual). Tungsten-arc argon-atmosphere weld with 4043 alloys no flux. Resistance welding: spot, seam, and flash methods

354.0
9Si-1.8Cu-0.5Mg

Specifications

Former ASTM. SC92A
UNS number. AC3540
Government. MIL-A-21180

Chemical Composition

Composition limits. 1.6 to 2.0 Cu; 0.4 to 0.6 Mg; 0.10 max Mn; 8.6 to 9.5 Si; 0.2 max Fe; 0.1 max Zn; 0.2 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al

Applications

Typical uses. Permanent mold castings used in applications requiring high strengths and heat treatability

Table 12 Minimum mechanical properties for castings of alloy 354.0-T61

Class(a)	Tensile strength(b) MPa	ksi	Tensile yield strength(b)(c) MPa	ksi	Elongation(b)(d), %	Compressive yield strength(e) MPa	ksi
1	324	47	248	36	3	248	36
2	345	50	290	42	2	290	42
10	324	47	248	36	3	248	36
11	296	43	227	33	2	227	33

(a) Classes 1 and 2 (levels of properties) obtainable only at designated areas of casting; classes 10 and 11 may be obtained at any location in casting. (b) Specified in MIL-A-21180. (c) 0.2% offset. (d) In 50 mm, 2 in. or $4d$, where d is diameter of reduced section of tensile-test specimen. (e) Design values; not specified.

Mechanical Properties

Tensile properties. See Tables 12 and 13.
Compressive yield strength. See Table 12.
Elastic modulus. Tension, 73.1 GPa (10.6×10^6 psi); shear, 27.6 GPa (4.0×10^6 psi); compression, 74.5 GPa (10.8×10^6 psi)
Fatigue strength. See Table 14.
Creep-rupture characteristics. See Table 15.

Mass Characteristics

Density. 2.71 Mg/m^3 (0.098 lb/in.^{3})

Thermal Properties

Coefficient of thermal expansion. Linear: 20.9 μm/m·K (11.6 μin./in.·°F) at 20 to 100 °C (68 to 212 °F)
Specific heat. 963 J/kg·K (0.230 Btu/lb·°F) at 100 °C (212 °F)
Thermal conductivity. 128 W/m·K (74 Btu/ft·h·°F)

Fabrication Characteristics

Solution temperature. 525 °C (980 °F); hold at temperature 10 to 12 h; quench in hot water 60 to 80 °C (140 to 176 °F)
Aging temperature. To obtain T61 temper from solution heat treated material, room temperature for 8 to 16 h; 155 °C (310 °F); hold at temperature for 10 to 12 h

355.0, C355.0
5Si-1.3Cu-0.5Mg

Specifications

AMS. 4210, 4212, 4214, 4280, 4281
Former ASTM. 355.0: SC51A. C355.0: SC51B
SAE. 322
UNS number. A03550
Government. 355.0: sand castings, QQ-A-601, class 10; permanent mold castings, QQ-A-596, class 6. C355.0: MIL-A-21180
Foreign. Canada: CSA SC51

Chemical Composition

Composition limits. 355.0: 1.0 to 1.5 Cu; 0.40 to 0.60 Mg; 0.50 max Mn; 4.5 to 5.5 Si; 0.6 max Fe; 0.25 max Cr; 0.35 max Zn; 0.25 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al (If Fe exceeds 0.45, Mn content may not be less than ½ Fe content.). C355.0: 1.0 to 1.5 Cu; 0.40 to 0.60 Mg; 0.10 max Mn; 4.5 to 5.5 Si; 0.20 max Fe; 0.10 max Zn; 0.20 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al
Consequence of exceeding impurity limits. High iron decreases ductility. Nickel decreases resistance to corrosion. Tin reduces mechanical properties.

Applications

Typical uses. Aircraft supercharger covers, fuel-pump bodies, air-compressor pistons, liquid-cooled cylinder heads, liquid-cooled aircraft engine crankcases, water jackets, and blower housings. Other applications where good castability, weldability, and pressure tightness are required. The presence of copper in 355.0 increases strength but reduces corrosion resistance and ductility.

Mechanical Properties

Tensile properties. See Tables 16, 17 and 18.
Compressive yield strength. See Table 16.
Poisson's ratio. 0.33
Elastic modulus. 355.0: tension, 70.3 GPa (10.2×10^6 psi) at 25 °C (75 °F), 67.6 GPa (9.8×10^6 psi) at 149 °C

Table 13 Typical mechanical properties for separately cast test bars of alloy 354.0-T61 at various temperatures

Temperature °C	Temperature °F	Time at temperature, h	At indicated temperature: Tensile strength MPa	Tensile strength ksi	Yield strength MPa	Yield strength ksi	Elongation(a), %	At room temperature after heating: Tensile strength MPa	Tensile strength ksi	Yield strength MPa	Yield strength ksi	Elongation(a), %
−196	−320	...	470	68	340	49	5	...	...	...	...	...
−80, −28	−112, −18	...	400	58	290	42	5	...	...	...	...	...
24	75	...	380	55	285	41	6	380	55	285	41	6
100	212	0.5	345	50	285	41	6	380	55	285	41	6
		10	350	51	285	41	6	385	56	290	42	6
		100	360	52	290	42	6	400	58	295	43	6
		1000	370	54	310	45	6	420	61	310	45	6
		10 000	415	60	340	49	6	435	63	350	51	5
150	300	0.5	325	47	275	40	6	380	55	290	42	6
		10	345	50	295	43	6	395	57	305	44	5
		100	350	51	315	46	6	425	62	345	50	5
		1000	340	49	305	44	6	405	59	360	52	4
		10 000	290	42	240	35	6	340	49	275	40	6
175	350	0.5	310	45	270	39	6	380	55	295	43	6
		10	325	47	290	42	6	405	59	340	49	4
		100	295	43	260	38	8	405	59	350	51	5
		1000	230	33	195	28	13	325	47	255	37	8
		10 000	130	19	95	14	24	205	30	115	17	16
205	400	0.5	290	42	270	39	6	405	59	340	49	5
		10	270	39	250	36	9	400	58	340	49	5
		100	205	30	180	26	17	330	48	255	37	7
		1000	130	19	105	15	30	220	32	125	18	14
		10 000	105	15	75	11	45	185	27	90	13	20
230	450	0.5	255	37	240	35	9	400	58	345	50	5
		10	195	28	170	25	15	315	46	250	36	8
		100	125	18	95	14	25	240	35	140	20	11
		1000	95	14	75	11	40	195	28	95	14	17
		10 000	80	12	60	8.5	55	170	25	75	11	22
260	500	0.5	195	28	170	25	16	360	52	290	42	6
		10	115	17	105	15	22	250	36	150	22	11
		100	80	12	65	9.5	35	205	30	105	15	15
		1000	65	9.5	50	7.5	50	185	27	80	12	19
		10 000	60	8.5	40	6	65	165	24	70	10	11
315	600	0.5	90	13	80	12	29	260	38	145	21	13
		10	60	8.5	50	7	60	205	30	90	13	17
		100	40	6	35	5	85	185	27	75	11	19
		1000	...	...	...	...	...	170	25	65	9.5	21
		10 000	...	...	...	...	...	160	23	60	8.5	23

(a) In 50 mm, 2 in. or 4*d*, where *d* is diameter of reduced section of tensile test specimen.

Table 14 Fatigue strengths for separately cast test bars of alloy 354.0-T61(a)

Temperature °C	Temperature °F	Cycles: 10^4 MPa	10^4 ksi	10^5 MPa	10^5 ksi	10^6 MPa	10^6 ksi	10^7 MPa	10^7 ksi	10^8 MPa	10^8 ksi	5×10^8 MPa	5×10^8 ksi
24	75	345	50	275	40	215	31	175	25.5	145	21	135	19.5
150	300	...	...	255	37	200	29	150	21.5	115	17	110	16
205	400	...	...	215	31	150	22	105	15	70	10	60	9
260	500	195	28	140	20.5	96	14	60	9	40	6	40	6
315	600	...	...	75	11	55	8	40	6	30	4	30	4

(a) R. R. Moore type test.

Table 15 Creep-rupture properties for separately cast test bars of alloy 354.0-T61

Temperature °C	Temperature °F	Time under stress, h	Rupture stress MPa	Rupture stress ksi	Stress for creep of: 1% MPa	1% ksi	0.5% MPa	0.5% ksi	0.2% MPa	0.2% ksi	0.1% MPa	0.1% ksi
177	350	0.1	305	44	295	43	285	41	290	39	255	37
		1.0	295	43	290	42	285	41	290	39	255	37
		10	285	41	285	41	275	40	255	37	240	35
		100	240	35	235	34	230	33	205	30	115	17
		1000	170	25	165	24	165	24	138	20	76	11
205	400	0.1	285	41	275	40	270	39	255	37	240	35
		1.0	255	37	250	36	250	36	235	34	215	31
		10	220	32	215	31	205	30	180	26	125	18
		100	160	23	160	23	150	22	125	18	69	10
		1000	90	13	90	13	83	12	83	12	48	7

(300 °F), 64.1 GPa (9.3 × 10^6 psi) at 204 °C (400 °F), 56.5 GPa (8.2 × 10^6 psi) at 260 °C (500 °F); shear, 26.2 GPa (3.8 × 10^6 psi). C355.0: tension, 69.6 GPa (10.1 × 10^6 psi); shear, 26.5 GPa (3.85 × 10^6 psi); compression, 71 GPa (10.3 × 10^6 psi)

Fatigue strength. See Table 19.

Creep-rupture characteristics. See Table 20.

Mass Characteristics

Density. 2.71 Mg/m³ (0.098 lb/in.³) at 20 °C (68 °F)

Thermal Properties

Liquidus temperature. 620 °C (1150 °F)

Solidus temperature. 545 °C (1071 °F)

Coefficient of thermal expansion. Linear:

Temperature range °C	Temperature range °F	Average coefficient µm/m·K	Average coefficient µin./in.·°F
20–100	68–212	22.4	12.4
20–200	68–392	23	12.8
20–300	68–572	24	13.3

Specific heat. 963 J/kg·K (0.230 Btu/lb·°F) at 100 °C (212 °F)

Thermal conductivity. At 25 °C (77 °F):

Temper and form	Conductivity W/m·K	Conductivity Btu/ft·h·°F
T51 (sand)	167	96
T6, T61 (sand)	152	88
T7 (sand)	163	94
T6 (permanent mold)	151	87

Table 16 Minimum mechanical properties for alloy C355.0-T61 castings

Class(a)	Tensile strength(b) MPa	Tensile strength(b) ksi	Tensile yield strength(b)(c) MPa	Tensile yield strength(b)(c) ksi	Elongation(d), %	Compressive yield strength(e) MPa	Compressive yield strength(e) ksi
1	285	41	215	31	3	215	31
2	305	44	230	33	3	230	33
3	345	50	275	40	2	275	40
10	285	41	215	31	3	215	31
11	255	37	205	30	1	205	30
12	240	35	195	28	1	195	28

(a) Classes 1, 2 and 3 (levels of properties) obtainable only at designated areas of casting; classes 10, 11 and 12 may be obtained from any location in casting. (b) Specified in MIL-A-21180. High properties are obtained by advanced foundry techniques and by careful control of trace elements at lower levels than specified for alloy 355.0 castings. (c) 0.2% offset. (d) In 4*d*, where *d* is diameter of reduced section of tensile-test specimen. (e) Design values; not specified.

Table 17 Typical mechanical properties for separately cast test bars of alloy 355.0

Temper	Tensile strength MPa	Tensile strength ksi	Tensile yield strength MPa	Tensile yield strength ksi	Elongation, %	Hardness(a), HB	Shear strength MPa	Shear strength ksi	Fatigue strength(b) MPa	Fatigue strength(b) ksi	Compressive yield strength MPa	Compressive yield strength ksi
Sand Cast												
T51	195	28	160	23	1.5	65	150	22	55	8.0	165	24
T6	240	35	170	25	3.0	80	195	28	62	9.0	180	26
T61	270	39	240	35	1.0	90	215	31	66	9.5	255	37
T7	260	38	250	36	0.5	85	195	28	69	10.0	260	38
T71	172	35	200	29	1.5	75	180	26	69	10.0	205	30
Permanent Mold Cast												
T51	205	30	165	24	2.0	75	165	24	...	...	165	24
T6	290	42	185	27	4.0	90	235	34	69	10	185	27
T62	310	45	275	40	1.5	105	250	36	69	10	275	40
T7	275	40	205	30	2.0	85	205	30	69	10	205	30
T71	250	36	215	31	3.0	85	185	27	69	10	215	31

(a) 500-kg load; 10-mm ball. (b) At 5 x 10^8 cycles; R. R. Moore type test.

Electrical Properties

Electrical conductivity. Volumetric:

Temper and form	Conductivity, % IACS
T51 (sand)	43
T6 (sand)	36
T61 (sand)	39
T7 (sand)	42
T6 (permanent mold)	39

Electrical resistivity. At 20 °C (68 °F):

Temper and form	Resistivity, nΩ·m
T51 (sand)	40.1
T6 (sand)	47.9
T61 (sand)	44.2
T7 (sand)	41.0
T6 (permanent mold)	44.2

Electrolytic solution potential. T4 temper, −0.78 V and T6 temper, −0.79 V vs 0.1*N* calomel electrode in an aqueous solution containing 53 g NaCl plus 3 g H_2O_2 per litre

Fabrication Characteristics

Melting temperature. 675 to 815 °C (1250 to 1500 °F)
Casting temperature. 675 to 790 °C (1250 to 1450 °F)
Solution temperature. See Table 21.
Aging temperature. See Table 21.
Joining. Same as alloy 514.0

Table 18 Typical tensile properties of separately cast test bars of alloy 355.0 at elevated temperatures

Temperature °C	Temperature °F	Tensile strength(a) MPa	Tensile strength(a) ksi	Yield strength(a) MPa	Yield strength(a) ksi	Elongation(a)(b), %
T6 Temper, Sand Cast						
25	75	240	35	170	25	3
150	300	230	33	170	25	1.5
205	400	115	17	90	13	8
260	500	65	9.5	35	5	16
315	600	40	6	25	3	36
T6 Temper, Permanent Mold Cast						
25	75	290	42	180	27	4
150	300	220	32	170	25	10
205	400	130	19	90	13	20
260	500	65	9.5	35	5	40
315	600	40	6	25	3	50
T51 Temper, Sand Cast						
25	75	195	28	160	23	1.5
150	300	165	24	130	19	3
205	400	95	14	70	10	8
260	500	65	9.5	35	5	16
315	600	40	6	25	3	36

(a) Strengths and elongations remain unchanged or improve at low temperatures. (b) In 50 mm or 2 in.

Table 19 Fatigue properties for separately cast test bars of alloy C355.0-T61

Temperature °C	Temperature °F	No. of cycles	Fatigue strength(a) MPa	Fatigue strength(a) ksi
24	75	10^5	195	28.0
		10^6	130	19.0
		10^7	110	16.0
		10^8	100	14.5
		5×10^8	95	14.0
260	500	10^5	125	18.0
		10^6	80	11.5
		10^7	50	7.5
		10^8	40	5.5
		5×10^8	35	5.0

(a) Based on rotating-beam tests at room temperature and cantilever beam (rotating load) tests at elevated temperature.

356.0, A356.0 7Si-0.3Mg

Specifications

AMS. 356.0: 4217, 4260, 4261, 4284, 4285, 4286. A356.0: 4218
Former ASTM. 356.0, SG70A; A356.0, SG70B
SAE. 356.0: J452, 323
UNS number. 356.0: A03560. A356.0: A13560
Government. 356.0: QQ-A-601, QQ-A-596. A356.0: MIL-C-21180 (class 12)
Foreign. ISO: AlSi7Mg

Chemical Composition

Composition limits. 356.0: 0.25 max Cu; 0.20 to 0.45 Mg; 0.35 max Mn; 6.5 to 7.5 Si; 0.6 max Fe; 0.35 max Zn; 0.25 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al. A356.0: 0.20 max Cu; 0.25 to 0.45 Mg; 0.10 max Mn; 6.5 to 7.5 Si; 0.20 max Fe; 0.10 max Zn; 0.20 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al
Consequence of exceeding impurity limits. High copper or nickel decreases ductility and resistance to corrosion. High iron decreases strength and ductility.

Applications

Typical uses. 356.0: aircraft pump parts, automotive transmission cases, aircraft fittings and control parts, water-cooled cylinder blocks. Other applications where excellent castability and good weldability, pressure tightness, and good resistance to corrosion are required. A356.0: aircraft structures and engine controls, nuclear energy installations, and other applications where high strength permanent mold or investment castings are required

Mechanical Properties

Tensile properties. See Tables 22, 23 and 24.
Compressive yield strength. See Table 22.
Poisson's ratio. 0.33
Elastic modulus. Tension, 72.4 GPa

Table 20 Creep-rupture properties for separately cast test bars of alloy C355.0-T61

Temperature °C	Temperature °F	Time under stress, h	Rupture stress MPa	Rupture stress ksi	Stress for creep of: 1% MPa	1% ksi	0.5% Mpa	0.5% ksi	0.2% MPa	0.2% ksi	0.1% MPa	0.1% ksi
150	300	0.1	285	41	275	40	270	39	240	35	230	33
		1	285	41	270	39	260	38	235	34	220	32
		10	275	40	260	38	250	36	230	33	205	30
		100	260	38	250	36	235	34	215	31	170	25
		1000	220	32	215	31	206	30	185	27	140	20
205	400	0.1	250	36	250	36	240	35	230	33	170	25
		1	230	33	220	32	205	30	170	25	140	20
		10	180	26	120	25	160	23	130	19	110	16
		100	130	19	130	19	125	18	97	14	...	...
		1000	97	14	90	13	83	12	...	...	...	...
260	500	0.1	165	24	145	21	130	19	105	15	83	12
		1	125	18	110	16	97	14	83	12	59	8.5
		10	90	13	83	12	76	11	59	8.5	41	6
		100	62	9	62	9	55	8	41	6	...	...
		1000	45	6.5	45	6.5	41	6	...	...	...	...

(10.5 × 10^6 psi); shear, 27.2 GPa (3.95 × 10^6 psi)

Creep-rupture characteristics. See Table 25.

Mass Characteristics

Density. 2.685 Mg/m^3 (0.097 $lb/in.^3$) at 20 °C (68 °F)

Thermal Properties

Liquidus temperature. 615 °C (1135 °F)

Solidus temperature. 555 °C (1035 °F)

Coefficient of thermal expansion. Linear:

Temperature range °C	Temperature range °F	Average coefficient µm/m·K	Average coefficient µin./in.·°F
20–100	68–212	21.5	11.9
20–200	68–392	22.5	12.5
20–300	68–572	23.5	13.1

Specific heat. 963 J/kg·K (0.230 Btu/lb·°F) at 100 °C (212 °F)

Latent heat of fusion. 389 kJ/kg

Thermal conductivity. At 25 °C (77 °F):

Temper and form	Conductivity W/m·K	Conductivity Btu/ft·h·°F
T51 (sand)	167	96
T6 (sand)	151	87
T7 (sand)	155	90
T6 (permanent mold)	159	92

Table 21 Heat treatments for separately cast test bars of alloy 355.0

Purpose (and resulting temper)	Temperature °C	Temperature °F	Time at temperature, h
Sand Castings			
Solution	520 to 530	970 to 990	12(a)(b)
Aging			
T51(c)	225 to 230	435 to 445	7 to 9
T6(d)	150 to 155	305 to 315	3 to 5
T61(d)	150 to 160	300 to 320	8 to 10
T7(d)(e)	225 to 230	435 to 445	7 to 9
T71(d)(e)	245 to 250	470 to 480	4 to 6
Permanent Mold Castings			
Solution	520 to 530	970 to 980	8(a)(b)
Aging(f)			
T62(d)	170 to 175	335 to 345	14 to 18

(a) Soaking time periods required for average castings after load has reached specified temperature. Time can be decreased or may have to be increased, depending on experience with particular castings. (b) Cool in water at 65 to 100 °C (150 to 212 °F). (c) No solution heat treatment. (d) Start with solution heat treated material. (e) U. S. Patent 1,822,877. (f) Except for temper listed under this head, temperature values for all tempers are the same as for sand castings.

Table 22 Minimum mechanical properties for alloy A356.0-T61 castings

Class(a)	Tensile strength(b) MPa	Tensile strength(b) ksi	Tensile yield strength(b)(c) MPa	Tensile yield strength(b)(c) ksi	Elongation(d), %	Compressive yield strength(e) MPa	Compressive yield strength(e) ksi
1	260	38	195	28	5	195	28
2	275	40	205	30	3	205	30
3	310	45	235	34	3	235	34
10	260	38	195	28	5	195	28
11	230	33	185	27	3	185	27
12	220	32	150	22	2	150	22

(a) Classes 1, 2, and 3 (levels of properties) obtainable only at designated areas of casting; classes 10, 11, and 12 may be specified at any location in casting. (b) Specified in MIL-A-21180. (c) 0.2% offset. (d) In 4*d*, where *d* is diameter of reduced section of tensile test specimen. (e) Design values; not specified.

Table 23 Typical mechanical properties for separately cast test bars of alloy 356.0

Temper	Tensile strength MPa	ksi	Yield strength MPa	ksi	Elongation(a), %	Hardness(b), HB	Shear strength MPa	ksi	Fatigue strength(c) MPa	ksi	Compressive yield strength MPa	ksi
Sand Cast												
T51	172	25	140	20	2.0	60	140	20	55	8.0	145	21
T6	228	33	165	24	3.5	70	180	26	60	8.5	170	25
T7	234	34	205	30	2.0	75	165	24	60	9.0	215	31
T71	193	28	145	21	3.5	60	140	20	60	8.5	150	22
Permanent Mold												
T6	262	38	185	27	5.0	80	205	30	90	13	185	27
T7	221	32	165	24	6.0	70	170	25	75	11	165	24

(a) In 50 mm or 2 in. (b) 500-kg load; 10-mm ball. (c) At 5 x 10^8 cycles; R. R. Moore type test.

Electrical Properties

Electrical conductivity. Volumetric:

Temper and form	IACS, %
T51 (sand)	43
T6 (sand)	39
T7 (sand)	40
T6 (permanent mold)	41

Electrical resistivity. At 20 °C (68 °F):

Temper and form	Resistivity, nΩ·m
T51 (sand)	40.1
T6 (sand)	44.2
T7 (sand)	43.1
T6 (permanent mold)	42.1

Electrolytic solution potential. T6 temper (sand): −0.82 V vs 0.1*N* calomel electrode in an aqueous solution containing 53 g NaCl plus 3 g H_2O_2 per litre

Nuclear Properties

Effect of neutron irradiation. See Table 26.

Fabrication Characteristics

Melting temperature. 675 to 815 °C (1250 to 1500 °F)

Casting temperature. 675 to 790 °C (1250 to 1450 °F)

Solution temperature. See Table 27.

Aging temperature. See Table 27.

Joining. Same as alloy 514.0

Table 24 Typical tensile properties of separately cast test bars of alloy 356.0-T6

Temperature °C	Temperature °F	Tensile strength(a) MPa	Tensile strength(a) ksi	Yield strength(a) Mpa	Yield strength(a) ksi	Elongation(a)(b), %
24	75	230	33	165	24	3.5
150	300	160	23	140	20	6.0
205	400	85	12	60	8.5	18
260	500	50	7.5	35	5.0	35
315	600	30	4.0	25	3.0	60

(a) Strengths and elongations remain unchanged or improve at low temperatures. (b) In 50 mm or 2 in.

Table 25 Creep-rupture properties for separately cast test bars of alloy A356.0-T61

Temperature °C	Temperature °F	Time under stress, h	Rupture stress MPa	Rupture stress ksi	Stress for creep of: 1% MPa	1% ksi	0.5% MPa	0.5% ksi	0.2% MPa	0.2% ksi	0.1% MPa	0.1% ksi
150	300	0.1	235	34	215	31	205	30	195	28	185	27
		1	235	34	215	31	200	29	185	27	180	26
		10	230	33	205	30	195	28	180	26	170	25
		100	200	29	195	28	185	27	170	25	165	24
		1000	165	24	165	24	160	23	...	...	...	...

Table 26 Effect of neutron radiation on tensile properties of alloy A356.0-T61(a)

Fast neutron flux, n/cm²	Tensile strength MPa	Tensile strength ksi	Yield strength MPa	Yield strength ksi	Elongation, %
Control sample	230	33	180	26	4
2.0 x 10^{19}	255	37	200	29	6
1.2 x 10^{20}	290	42	230	33	6
5.6 x 10^{20}	315	46	290	42	6
9.8 x 10^{20}	375	54	360	52	3

(a) Separately cast test bars; irradiation temperature, 50 °C (120 °F).

357.0, A357.0 7Si-0.5Mg

Specifications

UNS number. 357.0: A03570. A357.0: A13570
Government. A357.0: MIL-A-21180

Chemical Composition

Composition limits. 357.0: 0.05 max Cu; 0.45 to 0.6 Mg; 0.03 max Mn; 6.5 to 7.5 Si; 0.15 max Fe; 0.05 max Zn; 0.20 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al. A357.0: 0.20 max Cu; 0.40 to 0.7 Mg; 0.10 max Mn; 6.5 to 7.5 Si; 0.20 max Fe; 0.10 max Zn; 0.10 to 0.20 Ti; 0.04 to 0.07 Be; 0.05 max others (each); 0.15 max others (total); rem Al

Applications

Typical uses. Critical aerospace applications and other uses requiring heat treatable permanent mold casting that combines ready weldability with high strength and good toughness

Mechanical Properties

Tensile properties. See Tables 28 and 29.
Compressive yield strength. See Table 28.
Hardness. A357.0, T61 temper: 100 HB
Elastic modulus. A357.0: tension, 71.7 GPa (10.4 × 10^6 psi); shear, 26.8 GPa (3.9 × 10^6 psi); compression, 72.4 GPa (10.5 × 10^6 psi)
Fatigue strength. A357.0-T62 (rotating-beam tests):

No. of cycles	Stress MPa	Stress ksi
10^5	255	37
10^6	195	28
10^7	145	21
10^8	115	17
5 x 10^8	110	16

Mass Characteristics

Density. 2.68 Mg/m^3 (0.097 lb/$in.^3$)

Thermal Properties

Liquidus temperature. A357.0: 615 °C (1135 °F)
Solidus temperature. 555 °C (1035 °F)
Coefficient of thermal expansion. Linear, 21.6 μm/m·K (12.0 μin./in.·°F) at 17 to 100 °C (63 to 212 °F)
Specific heat. 963 J/kg·K (0.230 Btu/lb·°F) at 100 °C (212 °F)
Thermal conductivity. 152 W/m·K (88 Btu/ft·h·°F) at 25 °C (77 °F)

Fabrication Characteristics

Solution temperature. 540 °C (1005 °F); hold at temperature for 8 h; hot water quench
Aging temperature. T6 temper: 170 °C (340 °F); hold at temperature 3 to 5 h
Joining. Because of the beryllium content, care should be taken not to inhale fumes during welding

Table 27 Heat treatments for separately cast test bars of alloys 356.0 and A356.0

Purpose (and resulting temper)	Temperature °C	Temperature °F	Time at temperature, h
Sand Castings			
Solution	535 to 540	995 to 1005	12(a)(b)
Aging			
T51(c)	225 to 230	435 to 445	7 to 9
T6(d)	150 to 155	305 to 315	2 to 5
T7(d)(e)	225 to 230	435 to 445	7 to 9
T71(d)	245 to 250	470 to 480	2 to 4
Permanent Mold Castings			
Solution	535 to 540	995 to 1005	8(a)(b)
Aging(f)			
T6(d)	150 to 155	305 to 315	3 to 5

(a) Soaking-time periods required for average casting after load has reached specified temperature. Time can be decreased or may have to be increased, depending on experience with particular castings. (b) Cool in water at 65 to 100 °C (150 to 212 °F). (c) No solution heat treatment. (d) Start with solution heat treated material. (e) U. S. Patent 1,822,877. (f) Except for temper listed under this head, temperature values for all tempers are the same as for sand castings.

Table 28 Minimum mechanical properties for alloy A357.0 castings

Class(a)	Tensile strength(b) MPa	Tensile strength(b) ksi	Tensile yield strength(b)(c) MPa	Tensile yield strength(b)(c) ksi	Elongation(b)(d), %	Compressive yield strength(e) MPa	Compressive yield strength(e) ksi
T61, Permanent Mold Castings							
1	317	46	248	36	3	...	...
10	283	41	214	31	3	...	...
T62 Castings							
1	310	45	241	35	3	241	35
2	345	50	276	40	5	276	40
10	262	38	193	28	5	193	28
11	283	41	214	31	3	214	31

(a) Classes 1 and 2 (levels of properties obtainable only at designated areas of casting; classes 10 and 11 may be obtained from any location in castings. (b) Specified in MIL-A-21180. (c) 0.2% offset. (d) In 4*d*, where *d* is diameter of reduced section of tensile-test specimen. (e) Design values; not specified.

359.0 9Si-0.6Mg

Specifications

Former ASTM. SG91A
UNS number. A03590
Government. MIL-A-21180

Chemical Composition

Composition limits. 0.20 max Cu; 0.50 to 0.7 Mg; 0.10 max Mn; 8.5 to 9.5 Si; 0.20 max Fe; 0.10 max Zn; 0.20 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al

Applications

Typical uses. A moderately high strength permanent mold casting alloy having superior casting characteristics

Table 29 Typical mechanical properties of separately cast test bars of alloy A357.0-T62 at various temperatures

Temperature °C	Temperature °F	Time at temperature, h	Tensile strength MPa	Tensile strength ksi	Yield strength MPa	Yield strength ksi	Elongation(a), %
−196	−320	...	425	62	330	48	6
−80	−112	...	380	55	310	45	6
−28	−18	...	370	54	305	44	6
24	75	...	360	52	290	42	8
100	212	0.5 thru 100	315	46	270	39	10
		1000	315	46	275	49	8
		10 000	330	48	310	45	6
150	300	0.5	270	39	240	35	10
		10	285	41	255	37	9
		100	290	42	275	40	7
		1000	260	38	250	36	7
		10 000	160	23	145	21	20
175	350	0.5	255	37	235	34	7
		10	275	40	260	38	6
		100	240	35	230	33	7
		1000	150	22	140	20	19
		10 000	90	13	75	11	35
205	400	0.5	250	36	240	35	6
		10	205	30	195	28	7
		100	160	23	145	21	23
		1000	85	12	70	10	40
		10 000	70	10	50	7.5	50
230	450	0.5	215	31	105	30	9
		10	130	19	125	18	13
		100	95	14	90	13	45
260	500	0.5	160	23	150	22	16
		10	85	12	75	11	23
		100	55	8	50	7	55
315	600	0.5	70	10	65	9.5	35

(a) In $4d$, where d is diameter of reduced section of tensile test specimen.

Table 30 Minimum mechanical properties for alloy 359.0-T61

Class(a)	Tensile strength(b) MPa	Tensile strength(b) ksi	Tensile yield strength(b)(c) MPa	Tensile yield strength(b)(c) ksi	Elongation(b)(d), %	Compressive yield strength(e) MPa	Compressive yield strength(e) ksi
1	310	45	241	35	4	241	35
2	324	47	262	38	3	262	38
10	310	45	234	34	4	234	34
11	276	40	207	30	3	207	30

(a) Classes 1 and 2 (levels of properties) obtainable only from designated areas of casting; classes 10 and 11 may be obtained from any location in casting. (b) Specified in MIL-A-21180. (c) 0.2% offset. (d) In $4d$, where d is diameter of reduced section of tensile-test specimen. (e) Design values; not specified.

Mechanical Properties

Tensile properties. See Tables 30 and 31.

Compressive yield strength. See Table 30.

Elastic modulus. Tension, 72.4 GPa (10.5 × 10^6 psi); shear, 27.6 GPa (4.0 × 10^6 psi); compression, 73.8 GPa (10.7 × 10^6 psi)

Fatigue strength. Rotating-beam tests, T61 temper:

No. of cycles	Stress MPa	Stress ksi
10^5	255	37
10^6	195	28
10^7	145	21
10^8	115	17
5 x 10^8	110	16

Mass Characteristics

Density. 2.685 Mg/m^3 (0.097 lb/in.^{3})

Thermal Properties

Liquidus temperature. 615 °C (1135 °F)

Solidus temperature. 555 °C (1035 °F)

Coefficient of thermal expansion. Linear, 20.9 μm/m·K (11.6 μin./in.·°F) at 20 to 100 °C (68 to 212 °F)

Specific heat. 963 J/kg·K (0.230 Btu/lb·°F)

Thermal conductivity. 138 W/m·K (80 Btu/ft·h·°F)

Fabrication Characteristics

Solution temperature. 540 °C (1000 °F); hold at temperature 10 to 14 h; hot water quench 60 to 80 °C (140 to 175 °F)

Aging temperature. Room temperature for 8 to 16 h after solution treatment then 155 °C (310 °F) for 10 to 12 h (T61 temper) or 170 °C (340 °F) for 6 to 10 h (T62 temper)

360.0, A360.0 9.5Si-0.5Mg

Specifications

AMS. 360.0: 4290F

Former ASTM. 360.0: SG100B. A360.0: SG100A

SAE. A360.0: J452, 309

UNS number. 360.0: A03600. A360.0: A13600

Government. 360.0: QQ-A-591

Chemical Composition

Composition limits. 360.0: 0.6 max Cu; 0.40 to 0.6 Mg; 0.35 max Mn; 9.0 to 10.0 Si; 2.0 max Fe; 0.50 max Ni; 0.50 max Zn; 0.15 max Sn; 0.25 max others (total); rem Al. A360.0: 0.6 max Cu; 0.40 to 0.6 Mg; 0.35 max Mn; 9.0 to 10.0 Si; 1.3 max Fe; 0.50 max Ni; 0.50 max Zn; 0.15 max Sn; 0.25 max others (total); rem Al

Consequence of exceeding impurity limits. Increasing copper limits lowers resistance to corrosion; increasing iron lowers ductility. Decreasing silicon reduces castability.

Applications

Typical uses. Die castings requiring improved corrosion resistance compared to 3800. Other applications where excellent castability, pressure tightness, resistance to hot cracking, strength at elevated temperatures and ability to be electroplated are required. Poor weldability and braze-