

General Data on Wrought Aluminum Alloys -SAE J454 JUL81

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GENERAL DATA ON WROUGHT ALUMINUM ALLOYS—SAE J454 JUL81

SAE Information Report

Report of the Nonferrous Metals Division, approved June 1911, last revised by Nonferrous Metals Committee July 1981.

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 provides the characteristics required by a particular application, users may find it helpful to consult with the suppliers of aluminum alloy products.

Wrought aluminum alloys are generally classified as heat treatable and nonheat treatable. The heat treatable group includes alloys in which higher strengths are produced by heat treatment processes. The nonheat treatable group are alloys in which increased strengths are obtained by strain hardening developed by cold working methods.

Temper designation on the nonheat treatable alloys indicates whether the material has been brought to the final level of strength by cold working only (designation H1X), or by cold working followed by partial annealing (designation H2X), or by cold working followed by stabilizing (designation H3X). Basic temper designation and subdivision applicable to alloys described later in this section are shown in ANSI H351 and SAE J993. In addition, the following list describes special tempers that appear in the tabular data for the alloys listed:

Alloy 2218-T72—Die Forgings—Solution heat treated and stabilized by precipitation heat treatment.

2618-T61—Die Forgings—Solution heat treated and precipitation heat treated for good elevated temperature strength properties.

2024-T72—Sheet and Plate—Solution heat treated and artificially aged by the user to develop increased resistance to stress-corrosion cracking.

2024-T361—Sheet and Plate—Solution heat treated, cold-worked by reduction of approximately 6%.

2024-T861—Sheet and Plate—Solution heat treated, cold-worked by reduction of approximately 6% and artificially aged.

6063-T83, T831 and T832 Tempers—Drawn Tube—Solution heat treated, cold-worked with varying reductions and subsequently precipitation heat treated to develop the different levels of specified mechanical properties.

7075-T73, T7351, T73510, T73511 and T7352—Wrought Products—T73 temper products in any wrought form are solution heat treated and stabilized to develop the specified mechanical properties and high resistance to stress-corrosion cracking. The T7351 temper for plate, rolled rod or bar, or cold finished rod and bar and drawn tube is stress-relieved by stretching after solution heat treatment and prior to artificial aging.

Data on typical heat treatments for aluminum alloy mill products have been deleted, and instead the reader is referred to the section on Heat Treatments/Fabrication in the Aluminum Association Manual, Aluminum Standards and Data. Data are given for the recommended time and temperature for satisfactorily performing solution heat treatments, precipitation heat treatments, and annealing of aluminum alloy mill products used in automotive applications.

Data on Similar Specifications of SAE Wrought Aluminum Alloys has been deleted, and instead the reader is referred to the section on Specification Cross Reference/General Information in the Aluminum Association Manual, Aluminum Standards and Data, specifically, the tables Aluminum Mill Product Specifications and Specifications Covering Aluminum Mill Products.

The following data, presented in Tables 1–7, are excerpted from the AA Manual, Aluminum Standards Data, with the permission of the Aluminum Association:

1. Typical Characteristics and Applications of Wrought Aluminum Alloys (Table 1)
2. Wrought Aluminum Alloy Products and Tempers (Table 2)
3. Wrought Aluminum Alloy Specialty Mill Products and Tempers (Table 3)
4. Typical Physical Properties of Wrought Aluminum Alloys (Table 4)
5. Typical Mechanical Properties of Wrought Aluminum Alloys (Table 5)
6. Typical Tensile Properties at Various Temperatures (Table 6)
7. Nominal Chemical Composition—Wrought Alloys (Table 7)

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TABLE 1—TYPICAL CHARACTERISTICS AND APPLICATIONS OF WROUGHT ALUMINUM

Alloy and Temper	Resistance to Corrosion		Workability (Cold) ^e	Machinability ^e	Brazability ^f	Weldability ^f			Some Applications of Alloy
	General ^a	Stress-Corrosion Cracking ^b				Gas	Arc	Resistance Spot and Seam	
1060-0 H12 H14 H16 H18	A A A A A	A A A A A	A A A B B	E E D D D	A A A A A	A A A A A	A A A A A	B A A A A	Chemical equipment, railroad tank cars
1100-0 H12 H14 H16 H18	A A A A A	A A A A A	A A A B C	E E D D D	A A A A A	A A A A A	A A A A A	B A A A A	Sheet metal work, spun holloware, fin stock
1350-0 H12, H111 H14, H24 H16, H26 H18	A A A A A	A A A A A	A A A B B	E E D D D	A A A A A	A A A A A	A A A A A	B A A A A	Electrical conductors
2011-T3 T4, T451 T8	D ^c D ^c D	D D B	C B D	A A A	D D D	D D D	D D D	D D D	Screw machine products
2014-0 T3, T4, T451 T6, T651, T6510, T6511	— D ^c D	— C C	— C D	D B B	D D D	D D D	D B B	B B B	Truck frames, aircraft structures
2017-T4, T451	D ^c	C	C	B	D	D	B	B	Screw machine products, fittings
2018-T61	—	—	—	B	—	—	—	—	Aircraft engine cylinders, heads and pistons
2024-0 T4, T3, T351, T3510, T3511 T361 T6 T861, T81, T851, T8510, T8511 T72	— D ^c D ^c D D D	— C C B B	— C D C C	D B B B B	D D D D D	D C D D D	D B C C C	D B B B B	Truck wheels, screw machine products, aircraft structures
2025-T6	D	C	—	B	D	D	B	B	Forgings, aircraft propellers
2117-T4	C	A	B	C	D	D	B	B	

(Table continued on next page)

TABLE 1—TYPICAL CHARACTERISTICS AND APPLICATIONS OF WROUGHT ALUMINUM (CONTINUED)

Alloy and Temper	Resistance to Corrosion		Workability (Cold) ^c	Machinability ^e	Brazability ^f	Weldability ^f			Some Applications of Alloy
	General ^a	Stress-Corrosion Cracking ^b				Gas	Arc	Resistance Spot and Seam	
2218-T61 T72	D D	C C	— —	— B	— D	— D	— C	C B	Jet engine impellers and rings
2618-T61	D	C	—	B	D	D	C	B	Aircraft engines
3003-0 H12 H14 H16 H18 H25	A A A A A	A A A A A	A B C C B	E D D D D	A A A A A	A A A A A	A A A A A	A A A A A	Cooking utensils, chemical equipment, pressure vessels, sheet metal work, builder's hardware, storage tanks
3004-0 H32 H34 H36 H38	A A A A A	A A A A A	A B C C C	D D C C C	B B B B B	B B B B B	A A A A A	B A A A A	Sheet metal work, storage tanks
3105-0 H12 H14 H16 H18 H25	A A A A A	A A A A A	A B B C C B	E D D D D	B B B B B	B B B B B	A A A A A	B A A A A	Residential siding, mobile homes, rain carrying goods, sheet metal work
4032-T6	C	B	—	B	D	D	B	C	Pistons
5005-0 H12 H14 H16 H18 H32 H34 H36 H38	A A A A A A A A	A A A A A A A A	A B C C A B C C	E D D D E D D D	B B B B B B B B	A A A A A A A A	A A A A A A A A	B A A A A A A A	Appliances, utensils, architectural, electrical conductor
5050-0 H32 H34 H36 H38	A A A A A	A A A A A	A B C C C	E D D C C	B B B B B	A A A A A	A A A A A	B A A A A	Builder's hardware, refrigerator trim, coiled tubes
5052-0 H32 H34 H36 H38	A A A A A	A A A A A	A B C C C	D D C C C	C C C C C	A A A A A	A A A A A	B A A A A	Sheet metal work, hydraulic tube, appliances
5056-0 H111 H12, H32 H14, H34 H18, H38 H192 H392	A ^d A ^d A ^d A ^d A ^d A ^d	B ^d B ^d B ^d B ^d C ^d D ^d	A B B C D D	D D C C B B	D D D D D D	C C C C C C	A A A A A A	B A A A A A	Cable sheathing, rivets for magnesium, screen wire, zippers
5083-0 H321 H111	A ^d A ^d A ^d	B ^d B ^d B ^d	B C C	D D D	D D D	C C C	A A A	B A A	Unfired, welded pressure vessels, marine, auto aircraft cryogenics, TV towers, drilling rigs, transportation equipment, missile components
5086-0 H32, H116, H117 H34 H36 H38 H111	A ^d A ^d A ^d A ^d A ^d	A ^d A ^d B ^d B ^d A ^d	A B B C B	D D C C D	D D D D D	C C C C C	A A A A A	B A A A A	
5154-0 H32 H34 H36 H38	A ^d A ^d A ^d A ^d	A ^d A ^d A ^d A ^d	A B C C	D C C C	D D D D	C C C C	A A A A	B A A A	Welded structures, storage tanks, pressure vessels, salt water service
5252-H24 H25 H28	A A A	A A A	B B C	D C C	C C C	A A A	A A A	A A A	Automotive and appliance trim
5454-0 H32 H34 H111	A A A A	A A A A	A B B B	D C C D	D D D D	C C C C	A A A A	B A A A	Welded structures, pressure vessels, marine service

(Table continued on next page)

TABLE 1—TYPICAL CHARACTERISTICS AND APPLICATIONS OF WROUGHT ALUMINUM (CONTINUED)

Alloy and Temper	Resistance to Corrosion		Workability (Cold) ^a	Machinability ^a	Brazability ^f	Weldability ^f			Some Applications of Alloy
	General ^a	Stress-Corrosion Cracking ^b				Gas	Arc	Resistance Spot and Seam	
5456-0 H111 H321 ^e , H116	A ^d A ^d A ^d	B ^d B ^d B ^d	B C C	D D D	D D D	C C C	A A A	B A A	High strength welded structures, storage tanks, pressure vessels, marine applications
5457-0	A	A	A	E	B	A	A	B	
5657-H241 H25 H26 H28	A A A A	A A A A	A B B C	D D D D	B B B B	A A A A	A A A A	A A A A	Anodized automotive and appliance trim
6005-T5	B	A	C	C	A	A	A	A	Heavy-duty structures requiring good corrosion resistance,—truck and marine, railroad cars, furniture, pipelines
6053-0 T6, T61	— A	— A	— —	E C	A A	A A	A A	B A	Wire and rod for rivets
6061-0 T4, T451, T4510, T4511 T6, T651, T652, T6510, T6511	B B B	A B A	A B C	D C C	A A A	A A A	A A A	B A A	Heavy-duty structures requiring good corrosion resistance, truck and marine, railroad cars, furniture, pipelines
6063-T1 T4 T5, T52 T6 T83, T831, T832	A A A A A	A A A A A	B B B C C	D D C C C	A A A A A	A A A A A	A A A A A	A A A A A	Pipe railing, furniture, architectural extrusions
6151-T6, T652	—	—	—	—	—	—	—	—	Moderate strength intricate forgings for machine and automotive parts
6262-T6, T651, T6510, T6511 T9	B B	A A	C D	B B	A A	A A	A A	A A	Screw machine products
6463-T1 T5 T6	A A A	A A A	B B C	D C C	A A A	A A A	A A A	A A A	Extruded architectural and trim sections
7075-0 T6, T651, T652, T6510, T6511 T73, T7351	— C ^c C	— C B	— D D	D B B	D D D	D D D	C C C	B B B	Aircraft and other structures

^a Ratings A through E are relative ratings in decreasing order of merit, based on exposures to sodium chloride solution by intermittent spraying or immersion. Alloys with A and B ratings can be used in industrial and seacoast atmospheres without protection. Alloys with C, D, and E ratings generally should be protected at least on facing surfaces.

^b Stress-corrosion cracking ratings are based on service experience and on laboratory tests of specimens exposed to the 3.5% sodium chloride alternate immersion test.

A = No known instance of failure in service or in laboratory tests.

B = No known instance of failure in service; limited failures in laboratory tests of short transverse specimens.

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.

^e In relatively thick sections the rating would be E.

^d This rating may be different for material held at elevated temperature for long periods.

^f Ratings A through D for Workability (cold), and A through E for Machinability, are relative ratings in decreasing order of merit.

^f Ratings A through D for Weldability and Brazability are relative ratings defined as follows:

A = Generally weldable by all commercial procedures and methods.

B = Weldable with special techniques or for specific applications which justify preliminary trials or testing to develop welding procedure and weld performance.

C = Limited weldability because of crack sensitivity or loss in resistance to corrosion and mechanical properties.

D = No commonly used welding methods have been developed.

^g Material in this temper is not recommended for, and should not be used in, applications requiring exposure to sea water.

TABLE 2—WROUGHT ALUMINUM ALLOY PRODUCTS AND TEMPER

Alloy	Sheet	Plate	Tube		Pipe	Structural Shapes*	Extruded Wire, Rod, Bar and Shapes	Rolled or Cold Finished			Rivets	Forgings and Forging Stock
			Drawn	Extruded				Rod	Bar	Wire		
1060	0 H12 H14 H16 H18 H112	0 H12 H14 H112	0 H12 H14 H18 H112	0 H112								
1100	0 H12 H14 H16 H18 H112	0 H12 H14 H112	0 H12 H14 H16 H18	0 H112			0 H112	0 H112 F	0 H112 F	0 H112 H12 H14 H16 H18	0 H14	H112
1345								0 H12 H14 H16 H18 H19	0 H12 H14 H16 H18 H19	0 H12 H14 H16 H18 H19		
1350	0 H12 H14 H16 H18 H112	0 H12 H14 H112		H111	H111	H111	H111	0 H12 H14 H16 H22 H24 H26 H111	H12 H111 H112	0 H12 H14 H16 H19 H22 H24 H26		
2011								T3 T4 T451 T8	T3 T4 T451 T8	T3 T4 T451 T8		
2014	0 T3 T4 T6	0 T451 T651	0 T4 T6	0 T4 T4510 T4511 T6 T6510 T6511			0 T4 T4510 T4511 T6510 T6511	0 T4 T451 T6 T651	0 T4 T451 T6 T651			T4 T6 T652
Alclad 2014	0 T3 T4 T6	0 T451 T651										
2017								0 T4 T451	0 T4 T451	0 H13 T4	0 H13 T4	
2018												T61
2024	0 T3 T361 T4 T81 T861	0 T361 T351 T851 T861	0 T3	0 T4 T3510 T3511 T8510 T8511			0 T4 T3510 T3511 T81 T8510 T8511	0 H13 T4 T351 T81 T851	0 T351 T6 T81 T851	0 H13 T36 T4	0 H13 T4	
Alclad 2024	0 T3 T361 T4 T81 T861	0 T361 T351 T851 T861										
2117								0 H13 H15 T4		0 H13 H15 T4	0 H13 H15 T4	
2124		T851										
2618												T61
3003	0 H12 H14 H16 H18	0 H12 H14 H112	0 H12 H14 H16 H18 H25	0 H112	H18 H112		0 H112	0 H112 F	0 H112 F	0 H112 H12 H14 H16 H18	0 H14	H112

(Table continued on next page)

TABLE 2—WROUGHT ALUMINUM ALLOY PRODUCTS AND TEMPER (CONTINUED)

Alloy	Sheet	Plate	Tube		Pipe	Structural Shapes*	Extruded Wire, Rod, Bar and Shapes	Rolled or Cold Finished			Rivets	Forgings and Forging Stock
			Drawn	Extruded				Rod	Bar	Wire		
Alclad 3003	0 H12 H14 H16 H18	0 H12 H14 H112	0 H14 H18 H25	0 H112								
3004	0 H32 H34 H36 H38	0 H32 H34 H112	0 H34 H36 H38	0								
Alclad 3004	0 H32 H34 H36 H38	0 H32 H34 H112										
3005	0 H12 H14 H16 H18 H26 H28											
3105	0 H12 H14 H16 H18 H25											
4032												T6
4043										0		
5005	0 H12 H14 H16 H18 H32 H34 H36 H38	0 H12 H14 H32 H34 H112						0 H32		0 H12 H14 H16 H19 H22 H24 H26 H32	0 H32	
5050	0 H32 H34 H36 H38	0 H112	0 H32 H34 H36 H38					0 F	0 F	0 H32 H34 H36 H38		
5052	0 H32 H34 H36 H38	0 H32 H34 H112	0 H32 H34 H36 H38					0 F	0 F	0 H32 H34 H36 H38	0 H32	
5056								0 F	0 F	0 H111 H12 H14 H18 H32 H34 H38 H192 H392	0 H32	
Alclad 5056								H393		H192 H392		
5083	0 H321	0 H112 H321		0 H111 H112			0 H111 H112	0 H111 H112	0 H111 H112			H111 H112
5086	0 H32 H34 H36 H38 H112	0 H32 H34 H112	0 H32 H34 H36	0 H111 H112			0 H111 H112	0 H111 H112	0 H111 H112			

(Table continued on next page)

TABLE 2—WROUGHT ALUMINUM ALLOY PRODUCTS AND TEMPS (CONTINUED)

Alloy	Sheet	Plate	Tube		Pipe	Structural Shapes ^a	Extruded Wire, Rod, Bar, and Shapes	Rolled or Cold Finished			Rivets	Forgings and Forging Stock
			Drawn	Extruded				Red	Bar	Wire		
5154	0 H32 H34 H36 H38	0 H32 H34 H112	0 H34 H38	0 H112			0 H112	0 H112 F	0 H112 F	0 H112 H32 H34 H36 H38		
5252	H24 H25 H28											
5454	0 H32 H34	0 H32 H34 H112	H32 H34	0 H111 H112			0 H111 H112	0 H111 H112	0 H111 H112			
5456	0 H321 H323 H343	0 H112 H321		0 H111 H112			0 H111 H112	0 H111 H112	0 H111 H112			H112
5457	0											
5657	- H241 H25 H26 H28											
6005							T1 T5					
6053								0 H13 T61		0 H13 T61	0 H13 T61	T6
6061	0 T4 T6	0 T451 T6 T651	0 T4 T6	0 T4 T4510 T4511 T6 T6510 T6511	T6	T4 T6	0 T4 T4510 T4511 T6 T6510 T6511	0 T4 T451 T6 T651	0 T4 T451 T6 T651	0 H13 T6 T89 T93 T913 T94	0 H13 T6	T6 T652
Alclad 6061	0 T4 T6	0 T451 T651										
6063			0 T4 T6 T83 T831 T832	0 T1 T4 T5 T52 T6	T6		0 T1 T4 T5 T52 T6					
6151												T6 T652
6262			T6 T9	T6 T6510 T6511			T6 T6510 T6511	T6 T651 T9	T6 T651 T9	T6 T651 T9		
6463							T1 T5 T6 T62					
7075	0 T6 T73	0 T651 T73 T7351	0 T6 T73	0 T6 T6510 T6511 T73			0 T6 T6510 T6511 T73	0 H13 T6 T651 T73 T7351	0 T6 T651 T73 T7351	0 H13 T6	0 H13 T6	T6 T652 T73
Alclad 7075	0 T6	0 T651										
Alclad one side 7075	0 T6	0 T651										
Alclad one side 7079	0 T6											

^a Rolled or extruded.^b Products listed for these alloys are for electric conductors only.

NOTE: Additional alloys, tempers, and products are obtainable from some suppliers. See SAE J993. Suppliers should be consulted for current availability of alloys, tempers, and products.

TABLE 3—SPECIALTY MILL WROUGHT ALUMINUM PRODUCTS

Specialty Product Designation	Specialty Product Description			Specialty Product Designation	Specialty Product Description		
	Alloy	Temper	Form		Alloy	Temper	Form
Brazeing sheet Nos. 11 and 12 Nos. 21 and 22 Nos. 23 and 24	3003 clad with 4343 on one side (No. 11) or both (No. 12)	0 H12 H14	Sheet	Commercial roofing and siding Corrugated roofing and siding V-beam roofing and siding Ribbed roofing Ribbed siding	Alclad 3004 Alclad 3004 Alclad 3004		Sheet Sheet Sheet
	6951 clad with 4343 on one side (No. 21) or both (No. 22)	0 T42 T62	Sheet				
	6951 clad with 4045 on one side (No. 23) or both (No. 24)	0 T42 T62	Sheet	Duct sheet	Alloy and temper with min tensile strength of 16.0 ksi		Coiled or flat sheet
Reflector sheet Clad 1100 Clad 3003	1100 clad with 1175 on one or both sides		Sheet	Tread plate	6061	0 T4 T6	Sheet and plate with raised pattern on one surface
	3003 clad with 1175 on one or both sides		Sheet	Heat exchanger tube	1060 3003 Alclad 3003 5052 5454	H14 H14 H25 H14 H25 H32 H34 H32 H34	Tube
Painted sheet	1100 3003	0 H12 H14 H16 H18	Coiled sheet				
	3105	0 H12 H14 H16 H18 H25	Coiled sheet	Rigid electrical conduit	3003 6063	H12 T1	Tube
	5005 5050 5052	0 H32 H34 H36 H38	Coiled sheet				

NOTE: Other alloys and tempers may be available from individual producers for some of these products.

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TABLE 4A—TYPICAL PHYSICAL PROPERTIES OF WROUGHT ALUMINUM

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	Temper	Thermal Conductivity at 25°C (77°F)		Electrical Conductivity at 20°C (68°F), % IACS		Electrical Resistivity at 20°C (68°F)	
		cal/cm/cm ² /°C/s	Btu/in/ft ² /°F/h	Equal Volume	Equal Weight	μΩ-cm	Ω-cir mil, ft
1060	0	0.56	1625	62	204	2.8	17
	H18	0.55	1600	61	201	2.8	17
1100	0	0.53	1540	59	194	2.9	18
	H18	0.52	1510	57	187	3.0	18
1350	All	0.56	1625	62	204	2.8	17
2011	T3	0.36	1050	39	123	4.4	27
	T8	0.41	1190	45	142	3.8	23
2014	0	0.46	1340	50	159	3.4	21
	T4	0.32	930	34	108	5.1	31
	T6	0.37	1070	40	127	4.3	26
2017	0	0.46	1340	50	159	3.4	21
	T4	0.32	930	34	108	5.1	31
2018	T61	0.37	1070	40	127	4.3	26
2024	0	0.46	1340	50	160	3.4	21
	T3, T4, T361 ^b	0.29	840	30	96	5.7	35
	T6, T81, T861 ^b	0.36	1050	38	122	4.5	27
2117	T4	0.37	1070	40	130	4.3	26
3003	0	0.46	1340	50	163	3.4	21
	H12	0.39	1130	42	137	4.1	25
	H14	0.38	1100	41	134	4.2	25
	H18	0.37	1070	40	130	4.3	26
3004	All	0.39	1130	42	137	4.1	25
3105	All	0.41	1190	45	148	3.8	23
4032	0	0.37	1070	40	132	4.3	26
	T6	0.33	960	35	116	4.9	30
4043	0	0.39	1130	42	140	4.1	25
5005	All	0.48	1390	52	172	3.3	20
5050	All	0.46	1340	50	165	3.4	21
5052	All	0.33	960	35	116	4.9	30
5056	0	0.28	810	29	98	5.9	36
	H38	0.26	750	27	91	6.4	38
5083	0	0.28	810	29	98	5.9	36
5086	All	0.30	870	31	104	5.6	33
5154	All	0.30	870	32	107	5.4	32
5252	All	0.33	960	35	116	4.9	30
5454	0	0.32	930	34	113	5.1	31
	H38	0.32	930	34	113	5.1	31
5456	0	0.28	810	29	98	5.9	36
6005	T5	0.40	1160	43	142	4.0	24
6053	0	0.41	1190	45	148	3.8	23
	T4	0.37	1070	40	132	4.3	26
	T6	0.39	1130	42	139	4.1	25
6061	0	0.43	1250	47	155	3.7	22
	T4	0.37	1070	40	132	4.3	26
	T6	0.40	1160	43	142	4.0	24
6063	0	0.52	1510	58	191	3.0	18
	T1 ^c	0.46	1340	50	165	3.4	21
	T5	0.50	1450	55	181	3.1	19
	T6, T83	0.48	1390	53	175	3.3	20
6151	0	0.49	1420	54	178	3.2	19
	T4	0.39	1130	42	138	4.1	25
	T6	0.41	1190	45	148	3.8	23
6262	T9	0.41	1190	44	145	3.9	24
6463	T1 ^c	0.46	1340	50	165	3.4	21
	T5	0.50	1450	55	181	3.1	19
	T6	0.48	1390	53	175	3.3	20
7072	0	0.53	1540	59	193	2.9	18
7075	T6	0.31	900	33	105	5.2	31

^a Electric conductor grades, 99.45% min aluminum.

^b Tempers T361 and T861 were formerly designated T36 and T86, respectively.

^c Formerly designated T42.

^d Formerly designated T62.

TABLE 4B—TYPICAL PHYSICAL PROPERTIES OF WROUGHT ALUMINUM

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.

Alloy	Density		Specific Gravity kg/m ³ × 10 ³	Average Coefficient ^a of Thermal Expansion		Melting Range ^{b,c} Approx	
	lb/in ³	lb/ft ³		68–212°F, °F	20–100°C, °C	°F	°C
1060	0.098	169	2.70	13.1	23.6	1195–1215	646–657
1100	0.098	169	2.71	13.1	23.6	1190–1215	643–657
1350	0.098	169	2.70	13.2	23.8	1195–1215	646–657
2011	0.102	176	2.82	12.7	22.9	1005–1190	541–643*
2014	0.101	175	2.80	12.8	23.0	945–1180	507–638*
2017	0.101	174	2.79	13.1	23.6	955–1185	513–641*
2018	0.101	175	2.80	12.4	22.3	945–1180	507–638†
2024	0.100	173	2.77	12.9	23.2	935–1180	502–638*
2117	0.099	171	2.74	13.2	23.8	1030–1200	554–649†
2618	0.100	173	2.76	12.4	22.3	1040–1200	560–649
3003	0.099	170	2.73	12.9	23.2	1190–1210	643–654
3004	0.098	170	2.72	13.3	23.9	1165–1210	629–654
3105	0.098	169	2.71	13.1	23.6	1175–1210	635–654
4032	0.097	167	2.69	10.8	19.4	990–1060	532–571*
4043	0.097	167	2.69	—	—	1065–1170	574–632
4045	—	—	—	—	—	1065–1110	574–599
4343	—	—	—	—	—	1065–1135	574–613
5005	0.098	169	2.70	13.2	23.8	1170–1210	632–654
5050	0.097	168	2.69	13.2	23.8	1155–1205	624–652
5052	0.097	167	2.68	13.2	23.8	1125–1200	607–649
5056	0.095	165	2.64	13.4	24.1	1060–1180	571–638
5083	0.096	166	2.66	13.2	23.8	1075–1185	579–641
5086	0.096	166	2.66	13.2	23.8	1085–1185	585–641
5154	0.096	166	2.66	13.3	23.9	1100–1190	593–643
5252	0.097	167	2.68	13.2	23.8	1125–1200	607–649
5356	0.096	166	2.64	—	—	1065–1180	574–638
5454	0.097	167	2.68	13.1	23.6	1115–1195	602–646
5456	0.096	166	2.65	13.3	23.9	1060–1180	571–638
5457	0.097	167	2.68	13.1	23.6	1165–1210	629–654
5657	0.098	169	2.70	13.1	23.6	1180–1215	638–657
6005	0.098	169	2.70	13.1	23.6	1180–1205	638–652
6053	0.097	167	2.69	12.8	23.0	1070–1205	577–652†
6061	0.098	169	2.70	13.1	23.6	1080–1205	582–652†
6063	0.098	169	2.70	13.0	23.4	1140–1210	616–654
6151	0.098	169	2.70	12.9	23.2	1090–1200	588–649†
6253	—	—	—	—	—	1075–1205	579–652
6262	0.098	170	2.72	13.0	23.4	1080–1205	582–652†
6463	0.098	169	2.70	13.0	23.4	1140–1210	616–654
6951	0.098	169	2.70	13.0	23.4	1140–1210	616–654
7072	0.098	169	2.72	13.1	23.6	1195–1215	646–657
7075	0.101	175	2.80	13.1	23.6	890–1175	477–635*

^a Coefficient to be multiplied by 10⁶. Example: 12.2 × 10⁶ 0.0000122.

^b Melting ranges shown apply to wrought products of 1/4 in (6.35 mm) thickness or greater.

^c Based on typical composition of the indicated alloys.

^d Electric conductor grade: 99.45% minimum aluminum.

* Eutectic melting is not eliminated by homogenization.

† Eutectic melting can be completely eliminated by homogenization.

‡ Homogenization may raise eutectic melting temperature 10–20 deg, but usually does not eliminate eutectic melting.

TABLE 5—TYPICAL MECHANICAL PROPERTIES OF WROUGHT ALUMINUM (NOT FOR DESIGN PURPOSES)

NOTE: Typical mechanical properties are averages which take into account the variations introduced by type of wrought product, size, shape, and method of manufacture. Typical mechanical properties for all except O temper material are higher than specified minimum properties. For O temper products, typical ultimate and yield values are slightly lower than specified (maximum) values. 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	Tension						Hardness	Shear		Fatigue		Modulus		
	Strength				Elongation, % in 2 in			Brinell No., 500 kg load 10 mm ball	Ultimate Shearing Strength		Endurance ^a Limit		Modulus ^b of Elasticity	
	Ultimate		Yield		1/16 in Thick Specimen	1/2 in Dia Specimen			ksi	MPa	ksi	MPa	ksi × 10 ³	MPa × 10 ³
	ksi	MPa	ksi	MPa										
1060-0	10	69	4	28	43	—	19	7	48	3	21	10.0	69	
-H12	12	83	11	76	16	—	23	8	55	4	28	10.0	69	
-H14	14	97	13	90	12	—	26	9	62	5	34	10.0	69	
-H16	16	110	15	103	8	—	30	10	69	6.5	45	10.0	69	
-H18	19	131	18	124	6	—	35	11	76	6.5	45	10.0	69	
1100-0	13	90	5	34	35	45	23	9	62	5	34	10.0	69	
-H12	16	110	15	103	12	25	28	10	69	6	41	10.0	69	
-H14	18	124	17	117	9	20	32	11	76	7	48	10.0	69	
-H16	21	145	20	138	6	17	38	12	83	9	62	10.0	69	
-H18	24	165	22	152	5	15	44	13	90	9	62	10.0	69	
1350-0	12	83	4	28	—	— ^d	—	8	55	—	—	10.0	69	
-H12 ^c	14	97	12	83	—	—	—	9	62	—	—	10.0	69	
-H14 ^c	16	110	14	97	—	—	—	10	69	—	—	10.0	69	
-H16 ^c	18	124	16	110	—	—	—	11	76	—	—	10.0	69	
-H19 ^c	27	186	24	165	—	— ^e	—	15	103	7	48	10.0	69	
2011-T3	55	379	43	296	—	15	95	32	221	18	124	10.2	70	
-T8	59	407	45	310	—	12	100	35	241	18	124	10.2	70	
2014-0	27	186	14	97	—	18	45	18	124	13	90	10.6	73	
-T4,-T451	62	427	42	290	—	20	105	38	262	20	138	10.6	73	
-T6,-T651	70	483	60	414	—	13	135	42	290	18	124	10.6	73	
Alclad 2014-0	25	172	10	69	21	—	—	18	124	—	—	10.5	72	
-T3	63	434	40	276	20	—	—	37	255	—	—	10.5	72	
-T4,-T451	61	421	37	255	22	—	—	37	255	—	—	10.5	72	
-T6,-T651	68	469	60	414	10	—	—	41	283	—	—	10.5	72	
2017-0	26	179	10	69	—	22	45	18	124	13	90	10.5	72	
-T4,-T451	62	427	40	276	—	22	105	38	262	18	124	10.5	72	
2018-T61	61	421	46	317	—	12	120	39	269	17	117	10.8	74	
2024-0	27	186	11	76	20	22	47	18	124	13	90	10.6	73	
-T3	70	483	50	345	18	—	120	41	283	20	138	10.6	73	
-T4,-T351	68	469	47	324	20	19	120	41	283	20	138	10.6	73	
-T361 ^f	72	496	57	393	13	—	130	42	290	18	124	10.6	73	
Alclad 2024-0	26	179	11	76	20	—	—	18	124	—	—	10.6	73	
-T3	65	448	45	310	18	—	—	40	276	—	—	10.6	73	
-T4,-T351	64	441	42	290	19	—	—	40	276	—	—	10.6	73	
-T361 ^f	67	462	53	365	11	—	—	41	283	—	—	10.6	73	
-T81,-T851	65	448	60	414	6	—	—	40	276	—	—	10.6	73	
-T861 ^g	70	483	66	455	6	—	—	42	290	—	—	10.6	73	
2117-T4	43	296	24	165	—	27	70	28	193	14	97	10.3	71	
3003-0	16	110	6	41	30	40	28	11	76	7	48	10.0	69	
-H12	19	131	18	124	10	20	35	12	83	8	55	10.0	69	
-H14	22	152	21	145	8	16	40	14	97	9	62	10.0	69	
-H16	26	179	25	172	5	14	47	15	103	10	69	10.0	69	
-H18	29	200	27	186	4	10	55	16	110	10	69	10.0	69	
Alclad 3003-0	16	110	6	41	30	40	—	11	76	—	—	10.0	69	
-H12	19	131	18	124	10	20	—	12	83	—	—	10.0	69	
-H14	22	152	21	145	8	16	—	14	97	—	—	10.0	69	
-H16	26	179	25	172	5	14	—	15	103	—	—	10.0	69	
-H18	29	200	27	186	4	10	—	16	110	—	—	10.0	69	
3004-0	26	179	10	69	20	25	45	16	110	14	97	10.0	69	
-H32	31	214	25	172	10	17	52	17	117	15	103	10.0	69	
-H34	35	241	29	200	9	12	63	18	124	15	103	10.0	69	
-H36	38	262	33	228	5	9	70	20	138	16	110	10.0	69	
-H38	41	283	36	248	5	6	77	21	145	16	110	10.0	69	
Alclad 3004-0	26	179	10	69	20	25	—	16	110	—	—	10.0	69	
-H32	31	214	25	172	10	17	—	17	117	—	—	10.0	69	
-H34	35	241	29	200	9	12	—	18	124	—	—	10.0	69	
-H36	38	262	33	228	5	9	—	20	138	—	—	10.0	69	
-H38	41	283	36	248	5	6	—	21	145	—	—	10.0	69	
3105-0	17	117	8	55	24	—	—	12	83	—	—	10.0	69	
-H12	22	152	19	131	7	—	—	14	97	—	—	10.0	69	
-H14	25	172	22	152	5	—	—	15	103	—	—	10.0	69	
-H16	28	193	25	172	4	—	—	16	110	—	—	10.0	69	
-H18	31	214	28	193	3	—	—	17	117	—	—	10.0	69	
-H25	26	179	23	159	8	—	—	15	103	—	—	10.0	69	
4032-T6	55	379	46	317	—	9	120	38	262	16	110	11.4	79	
5005-0	18	124	6	41	25	—	28	11	76	—	—	10.0	69	
-H12	20	138	19	131	10	—	—	14	97	—	—	10.0	69	
-H14	23	159	22	152	6	—	—	14	97	—	—	10.0	69	
-H16	26	179	25	172	5	—	—	15	103	—	—	10.0	69	
-H18	29	200	28	193	4	—	—	16	110	—	—	10.0	69	
-H32	20	138	17	117	11	—	36	14	97	—	—	10.0	69	

(Table continued on next page)

TABLE 5—TYPICAL MECHANICAL PROPERTIES OF WROUGHT ALUMINUM (NOT FOR DESIGN PURPOSES) (CONTINUED)

Alloy and Temper	Tension						Hardness	Shear		Fatigue		Modulus	
	Strength				Elongation, % in 2 in		Brinell No., 500 kg load 10 mm ball	Ultimate Shearing Strength		Endurance ^a Limit		Modulus ^b of Elasticity	
	Ultimate		Yield		1/16 in Thick Specimen	1/2 in Dia Specimen		ksi	MPa	ksi	MPa	ksi × 10 ³	MPa × 10 ³
	ksi	MPa	ksi	MPa									
-H34	23	159	20	138	8	—	41	14	97	—	—	10.0	69
-H36	26	179	24	165	6	—	46	15	103	—	—	10.0	69
-H38	29	200	27	186	5	—	51	16	110	—	—	10.0	69
5050-0	21	145	8	55	24	—	36	15	103	12	83	10.0	69
-H32	25	172	21	145	9	—	46	17	117	13	90	10.0	69
-H34	28	193	24	165	8	—	53	18	124	13	90	10.0	69
-H36	30	207	26	179	7	—	58	19	131	14	97	10.0	69
-H38	32	221	29	200	6	—	63	20	138	14	97	10.0	69
5052-0	28	193	13	90	25	30	47	18	124	16	110	10.2	70
-H32	33	228	28	193	12	18	60	20	138	17	117	10.2	70
-H34	38	262	31	214	10	14	68	21	145	18	124	10.2	70
-H36	40	276	35	241	8	10	73	23	159	19	131	10.2	70
-H38	42	290	37	255	7	8	77	24	165	20	138	10.2	70
5056-0	42	290	22	152	—	35	65	26	179	20	138	10.3	71
-H18	63	434	59	407	—	10	105	34	234	22	152	10.3	71
-H38	60	414	50	345	—	15	100	32	221	22	152	10.3	71
5083-0	42	290	21	145	—	22	—	25	172	—	—	10.3	71
-H321	46	317	33	228	—	16	—	—	—	23	159	10.3	71
5086-0	38	262	17	117	22	—	—	23	159	—	—	10.3	71
-H32, -H116,													
-H34	47	324	37	255	10	—	—	27	186	—	—	10.3	71
-H112	39	269	19	131	14	—	—	—	—	—	—	10.3	71
5154-0	35	241	17	117	27	—	58	22	152	17	117	10.2	70
-H32	39	269	30	207	15	—	67	22	152	18	124	10.2	70
-H34	42	290	33	228	13	—	73	24	165	19	131	10.2	70
-H36	45	310	36	248	12	—	78	26	179	20	138	10.2	70
-H38	48	331	39	269	10	—	80	28	193	21	145	10.2	70
-H112	35	241	17	117	25	—	63	—	—	17	117	10.2	70
5252-H25	34	234	25	172	11	—	68	21	145	—	—	10.0	69
-H38, -H28	41	283	35	241	5	—	75	23	159	—	—	10.0	69
5454-0	36	248	17	117	22	—	62	23	159	—	—	10.2	70
-H32	40	276	30	207	10	—	73	24	165	—	—	10.2	70
-H34	44	303	35	241	10	—	81	26	179	—	—	10.2	70
-H111	38	262	26	179	14	—	70	23	159	—	—	10.2	70
-H112	36	248	18	124	18	—	62	23	159	—	—	10.2	70
5456-0	45	310	23	159	—	24	—	—	—	—	—	10.3	71
-H111	47	324	33	228	—	18	—	—	—	—	—	10.3	71
-H112	45	310	24	165	—	22	—	—	—	—	—	10.3	71
-H321 ¹ , -H116,													
5457-0	19	131	7	48	22	—	32	12	83	—	—	10.0	69
-H25	26	179	23	159	12	—	48	16	110	—	—	10.0	69
-H38, -H28	30	207	27	186	6	—	55	18	124	—	—	10.0	69
5657-H25	23	159	20	138	12	—	40	14	97	—	—	10.0	69
-H38, -H28	28	193	24	165	7	—	50	15	103	—	—	10.0	69
6061-0	18	124	8	55	25	30	30	12	83	9	62	10.0	69
-T4, -T451	35	241	21	145	22	25	65	24	165	14	97	10.0	69
-T6, -T651	45	310	40	276	12	17	95	30	207	14	97	10.0	69
Alclad 6061-0	17	117	7	48	25	—	—	11	76	—	—	10.0	69
-T4, -T451	33	228	19	131	22	—	—	22	152	—	—	10.0	69
-T6, -T651	42	290	37	255	12	—	—	27	186	—	—	10.0	69
6063-0	13	90	7	48	—	—	25	10	69	8	55	10.0	69
-T1*	22	152	13	90	20	—	42	14	97	9	62	10.0	69
-T4	25	172	13	90	22	—	—	—	—	—	—	10.0	69
-T5	27	186	21	145	12	—	60	17	117	10	69	10.0	69
-T6	35	241	31	214	12	—	73	22	152	10	69	10.0	69
-T83	37	255	35	241	9	—	82	22	152	—	—	10.0	69
-T831	30	207	27	186	10	—	70	18	124	—	—	10.0	69
-T832	42	290	39	269	12	—	95	27	186	—	—	10.0	69
6262-T9	58	400	55	379	—	10	120	35	241	13	90	10.0	69
6463-T1*	22	152	13	90	20	—	42	14	97	10	69	10.0	69
-T5	27	186	21	145	12	—	60	17	117	10	69	10.0	69
-T6	35	241	31	214	12	—	74	22	152	10	69	10.0	69
7075-0	33	228	15	103	17	16	60	22	152	—	—	10.4	72
-T6, -T651	83	572	73	503	11	11	150	48	331	23	159	10.4	72
Alclad 7075-0	32	221	14	97	17	—	—	22	152	—	—	10.4	72
-T6, -T651	76	524	67	462	11	—	—	46	317	—	—	10.4	72

* Based on 500,000,000 cycles of completely reversed stress using the R. R. Moore type of machine and specimen.

^b Average of tension and compression moduli. Compression modulus is about 2% greater than tension modulus.

^c Electrical conductor grade, 99.45% min aluminum.

^d 1350-0 wire will have an elongation of approximately 23% in 10 in.

* 1350-H19 wire will have an elongation of approximately 1-1/2% in 10 in.

^f Tempers T361 and T861 were formerly designated T36 and T86, respectively.

^g Formerly designated T42.

^h Based on 1/4 in thick specimen.

ⁱ Material in this temper is not recommended for, and should not be used in, applications requiring exposure to sea water.

TABLE 6—TYPICAL TENSILE PROPERTIES AT VARIOUS TEMPERATURES* (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		Tensile Strength				Elongation in 2 in, %	Alloy and Temper	Temperature		Tensile Strength				Elongation in 2 in, %
	°F	°C	Ultimate		Yield ^b				°F	°C	Ultimate		Yield ^b		
			ksi	MPa	ksi	MPa					ksi	MPa	ksi	MPa	
1100-O	-320	-196	25	172	6	41	50	2024-T6, -T651	-320	-196	84	579	68	469	11
	-112	- 80	15	103	5.5	38	43		-112	- 80	72	496	59	408	10
	- 18	- 28	14	97	5	34	40		- 18	- 28	70	483	58	400	10
	75	24	13	90	5	34	40		75	24	69	476	57	393	10
	212	100	10	69	4.6	32	45		212	100	65	448	54	372	10
	300	149	8	55	4.2	29	55		300	149	45	310	36	248	17
	400	204	6	41	3.5	24	65		400	204	26	179	19	131	27
	500	260	4	28	2.6	18	75		500	260	11	76	9	62	55
	600	316	2.9	20	2	14	80		600	316	7.5	52	6	41	75
	700	371	2.1	14	1.6	11	85		700	371	5	34	4	28	100
1100-H14	-320	-196	30	207	20	138	45	2024-T81, -T851	-320	-196	85	586	78	538	8
	-112	- 80	20	138	18	124	24		-112	- 80	74	510	69	476	7
	- 18	- 28	19	131	17	117	20		- 18	- 28	73	503	68	469	7
	75	24	18	124	17	117	20		75	24	70	482	65	448	7
	212	100	16	110	15	103	20		212	100	66	455	62	427	8
	300	149	14	97	12	83	23		300	149	55	379	49	338	11
	400	204	10	69	7.5	52	26		400	204	27	186	20	138	23
	500	260	4	28	2.6	18	75		500	260	11	76	9	62	55
	600	316	2.9	20	2	14	80		600	316	7.5	52	6	41	75
	700	371	2.1	14	1.6	11	85		700	371	5	34	4	28	100
1100-H18	-320	-196	34	234	26	179	30	2024-T861 ^c	-320	-196	92	634	85	586	5
	-112	- 80	26	179	23	158	16		-112	- 80	81	558	77	531	5
	- 18	- 28	25	172	23	158	15		- 18	- 28	78	538	74	510	5
	75	24	24	165	22	152	15		75	24	75	517	71	490	5
	212	100	21	145	19	131	15		212	100	70	483	67	462	6
	300	149	18	124	14	97	20		300	149	54	372	48	331	11
	400	204	6	41	3.5	24	65		400	204	21	145	17	117	28
	500	260	4	28	2.6	18	75		500	260	11	76	9	62	55
	600	316	2.9	20	2	14	80		600	316	7.5	52	6	41	75
	700	371	2.1	14	1.6	11	85		700	371	5	34	4	28	100
2011-T3	75	24	55	379	43	296	15	2117-T4	-320	-196	56	386	33	228	30
	212	110	47	324	34	234	16		-112	- 80	45	310	25	172	29
	300	149	23	193	19	131	25		- 18	- 28	44	303	24	165	28
	400	204	16	110	11	76	35		75	24	43	296	24	165	27
	500	260	6.5	45	3.8	26	45		212	100	36	248	21	145	16
	600	316	3.1	21	1.8	12	90		300	149	30	207	17	117	20
	700	371	2.3	16	1.4	10	125		400	204	16	110	12	83	35
2014-T6, -T651	-320	-196	84	579	72	496	14	2618-T61	-320	-196	78	538	61	420	12
	-112	- 80	74	510	65	448	13		-112	- 80	67	462	55	379	11
	- 18	- 28	72	496	62	427	13		- 18	- 28	64	441	54	372	10
	75	24	70	482	60	414	13		75	24	64	441	54	372	10
	212	100	63	434	57	393	15		212	100	62	427	54	372	10
	300	149	40	275	35	241	20		300	149	50	345	44	303	14
	400	204	16	110	13	90	38		400	204	32	221	26	179	24
	500	260	9.5	66	7.5	52	52		500	260	13	90	9	62	50
	600	316	6.5	45	5	34	65		600	316	7.5	52	4.5	31	80
	700	371	4.3	30	3.5	24	72		700	371	2.9	20	2	14	110
2017-T4, -T451	-320	-196	80	551	53	365	28	3003-0	-320	-196	33	227	8.5	59	46
	-112	- 80	65	448	42	290	24		-112	- 80	20	138	7	48	42
	- 18	- 28	64	441	41	283	23		- 18	- 28	17	117	6.5	45	41
	75	24	62	427	40	276	22		75	24	16	110	6	41	40
	212	100	57	393	39	269	18		212	100	13	90	5.5	38	43
	300	149	40	276	30	207	15		300	149	11	76	5	34	47
	400	204	16	110	13	90	35		400	204	8.5	59	4.3	30	60
	500	260	9	62	7.5	52	45		500	260	6	41	3.4	23	65
	600	316	6	41	5	34	65		600	316	4	28	2.4	16	70
	700	371	4.3	30	3.5	24	70		700	371	2.8	19	1.8	14	70
2024-T3 (sheet)	-320	-196	85	586	62	427	18	3003-H14	-320	-196	35	241	25	172	30
	-112	- 80	73	503	52	358	17		-112	- 80	24	165	22	152	18
	- 18	- 28	72	496	51	352	17		- 18	- 28	22	152	21	145	16
	75	24	70	482	50	345	17		75	24	22	152	21	145	16
	212	100	66	455	48	331	16		212	100	21	145	19	131	16
	300	149	55	379	45	310	11		300	149	18	124	16	110	16
	400	204	27	186	20	138	23		400	204	14	96	9	62	20
	500	260	11	76	9	62	55		500	260	7.5	52	4	28	60
	600	316	7.5	52	6	41	75		600	316	4	28	2.4	16	70
	700	371	5	34	4	28	100		700	371	2.8	19	1.8	12	70
2024-T4, -T351 (plate)	-320	-196	84	579	61	420	19	3003-H18	-320	-196	41	283	33	228	23
	-112	- 80	71	490	49	338	19		-112	- 80	32	221	29	200	11
	- 18	- 28	69	476	47	324	19		- 18	- 28	30	207	28	193	10
	75	24	68	469	47	324	19		75	24	29	200	27	186	10
	212	100	63	434	45	310	19		212	100	26	179	21	145	10
	300	149	45	310	36	248	17		300	149	23	158	16	110	11
	400	204	26	179	19	131	27		400	204	14	96	9	62	18
	500	260	11	76	9	62	55		500	260	7.5	52	4	28	60
	600	316	7.5	52	6	41	75		600	316	4	28	2.4	16	70
	700	371	5	34	4	28	100		700	371	2.8	19	1.8	12	70

(Table continued on next page)