



Aviation Mechanic HANDBOOK



EIGHTH EDITION

Based on original text by **Dale Crane**
Edited by **Keith Anderson**

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AVIATION SUPPLIES & ACADEMICS, INC.
NEWCASTLE, WASHINGTON

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Eighth Edition
Based on the original text by Dale Crane
Edited by Keith Anderson

Aviation Supplies & Academics, Inc.
7005 132nd Place SE
Newcastle, Washington 98059
asa@asa2fly.com | 425-235-1500 | asa2fly.com

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Introduction

Even though ways to look up mechanics reference information via the internet are widely available today, there is still significant benefit to keeping a printed “quick reference” guide handy in a toolbox or workbench drawer. Your time as an aviation mechanic is too valuable to be spent looking through stacks and pages of reference books to find a particular chart, formula or diagram you need on a particular job. The editorial staff at ASA has done this job for you and compiled this *Aviation Mechanic Handbook* to be a handy toolbox source of useful information.

For your convenience, this handbook is arranged in 18 sections with a table of contents at the beginning of each section, as well as complete contents at the front of the book and index at the back.

This information has been compiled from a large number of industry and government publications, and every effort has been made to ensure its applicability and accuracy.

The *ASA Aviation Mechanic Handbook* is a companion volume to the *ASA Dictionary of Aeronautical Terms*. The two books are the core of ASA’s training materials for aircraft mechanics.

ASA is dedicated to providing quality training materials for the aviation industry. Your feedback regarding our books will help us to continue to produce the materials you need. Visit the ASA website often (asa2fly.com) to find updates to operations and procedures due to FAA changes that may affect this publication.

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Section 6: Aircraft Materials

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6.1 Composition of Wrought Aluminum Alloys

Percent of alloying elements; aluminum and normal impurities constitute remainder of metal.

Alloy Number	Silicon	Copper	Manganese	Magnesium	Chromium	Zinc
1100	—99.00% aluminum minimum—					
2017		4.0	0.5	0.5		
2024		4.5	0.6	1.5		
2117		2.5		0.3		
3003			1.2			
5052				2.5	0.25	
5056			0.10	5.2	0.10	
6061	0.6	0.25		1.0	0.25	
7075		1.6		2.5	0.30	5.6

6.2 Four-Digit Designation System for Wrought Aluminum Alloys

First digit: Principal alloying element

Second digit: A measure of the limits for impurities

Third and fourth digits: The amount of the alloying element in the metal

Type of Alloy	Number Group
Aluminum 99% or greater	1xxx
Copper	2xxx
Manganese	3xxx
Silicon	4xxx
Magnesium	5xxx
Magnesium and silicon	6xxx
Zinc	7xxx
Other elements	8xxx
Unused series	9xxx

Pure aluminum is the softest and most corrosion-resistant form of aluminum, but it is not generally used in aircraft construction or maintenance. 1100 is the most widely used form of commercially pure aluminum used in aircraft maintenance. It can only be used in nonstructural applications, such as fairings.

Copper is alloyed with aluminum to increase its strength and make it heat-treatable, but this makes it susceptible to corrosion. 2024 is the most widely used alloy in this series. To make a 2024 sheet more corrosion-resistant, a thin layer of pure aluminum is rolled onto its surface when the sheet metal is made. This process is called "cladding." Most of the rivets used in sheet metal construction are made of 2117, 2017, or 2024.

Manganese makes the aluminum stronger and easier to weld. 3003 is the most widely used alloy in this series because it is soft and easy to form. It is used for cowlings, propeller spinners, and wheel pants.

Magnesium adds strength to the aluminum, which makes it more difficult to form. 5052 is widely used for fluid lines; in its sheet form it is used for fuel tanks because it is weldable and reasonably corrosion-resistant. 5052 is not heat-treatable.

Magnesium and silicon give aluminum strength, malleability, and weldability. 6061 is used in applications in which heat treatability, ease of forming, medium strength and corrosion-resistance are important.

Zinc gives aluminum high strength, but makes it expensive and difficult to form. 7075 is the alloy used in modern aircraft where high strength and light weight are the primary considerations.

6.3 Weldable and Unweldable Aluminum Alloys

Most aluminum alloys are readily weldable using GTAW or GMAW. However, some are not. Following are the common families of aluminum alloys and their weldability characteristics:

Aluminum Alloy Families	Weldability Characteristics (shaded rows are unweldable)
1XXX alloys	Essentially pure aluminum (99%); used to carry electrical current, or for corrosion resistance in specific environments, these are all readily weldable. The most common filler metal is 1100.
3XXX alloys	Comprised of medium-strength alloys that are very formable; often used for heat exchangers and air conditioners. All are readily weldable using either 4043 or 5356 filler metal.
4XXX alloys	Usually used as welding or brazing filler alloys. They are sometimes used as base materials and in that case, they are readily welded with 4043 filler metal.
5XXX alloys	High-strength sheet and plate alloys, all of which are easily welded using 5356 filler metal—although 5183 or 5556 should be used for the stronger alloys such as 5083.
6XXX alloys	Primarily the extrusion alloys, but are available in sheet and plate as well. Prone to be crack-sensitive, but with the proper techniques, they can all be readily welded using 4043 or 5356.
2XXX alloys	High-strength aerospace alloys in sheet or plate form whose chemistry makes most of them unweldable using GTAW or GMAW due to hot cracking. The exceptions are 2219 and 2519, which are both readily welded using 2319 or 4043 filler metal. In any case, never weld 2024—it is very common and very high in strength, but extremely crack-sensitive.
7XXX alloys	High-strength aerospace alloys that, like the 2XXX alloys, most are unweldable using GTAW or GMAW due to hot-cracking and stress-corrosion concerns. The exceptions are 7003 and 7005 extrusion alloys and 7039 plate alloy. All three of these are readily weldable using 5356 filler. Never weld 7075.

6.4 Mechanical Properties of Aluminum Alloys

Bearing strength is the amount of force applied to an installed rivet that will cause the rivet to elongate the rivet hole in the sheet metal.

Alloy and temper*	Tensile strength, psi		Brinell hardness 500 kg load, 10 mm ball
	Ultimate	Yield	
1100-O	13,000	5,000	23
1100-H18	24,000	22,000	44
2017-O	26,000	10,000	45
2017-T4	62,000	40,000	105
2024-O	27,000	11,000	47
2024-T36	72,000	57,000	130
2024-T4	68,000	47,000	120
Alclad 2024-O	26,000	11,000	na
Alclad 2024-T36	67,000	53,000	na
3003-O	16,000	6,000	40
3003-H18	29,000	27,000	10
5052-O	28,000	13,000	47
5052-H38	42,000	37,000	77
6061-O	18,000	8,000	30
6061-T6	45,000	40,000	95
7075-O	33,000	15,000	60
7075-T6	83,000	73,000	150
Alclad 7075-O	32,000	14,000	na
Alclad 7075-T6	76,000	67,000	na

*See Section 6.5, "Temper Designations"

6.5 Temper Designations for Aluminum Alloys

Heat-Treatable Alloys

- O.....Annealed temper of wrought alloys
- FAs-fabricated condition for wrought alloys and as-cast for casting alloys
- T2Annealed temper of casting alloys
- T3Solution heat-treated followed by strain hardening; a second digit, if used, indicates the amount of strain hardening
- T4Solution heat-treated followed by natural aging at room temperature
- T5Artificially aged at an elevated temperature
- T6Solution heat-treated followed by artificial aging
- T7Solution heat-treated followed by stabilization
- T8Solution heat-treated followed by strain hardening, then artificial aging
- T9Solution heat-treated followed by artificial aging, then strain hardening

Non-Heat-Treatable Alloys

- O.....Annealed
- H1Strain hardened by cold-working; a second digit indicates the degree of strain hardening
- H12.....1/4 hard
- H14.....1/2 hard
- H18.....Full hard
- H19.....Extra hard
- H2.....Strain hardened by cold-working, then partially annealed
- H3.....Strain hardened and stabilized

6.6 Temperatures for Heat Treatment of Aluminum Alloys

Alloy	Annealing		Solution temp °F	Heat treat. temper	Precip. temp °F	Heat treat.	
	temp °F	time hours				time hours	temper
1100	650	2-3					
2017	775	2-3	940	-T4			
2024	775	2-3	920	-T4	375	7-9	-T86
2117	775	2-3	940	-T4			
3003	775	2-3					
5052	650	2-3					
6061	775	2-3	970	-T4	320	16-20	-T6
7075	775	2-3	870	-W	250	24-28	-T6

6.7 Bearing Strength (in pounds) of Aluminum Alloy Sheet

Bearing strength is the amount of force applied to an installed rivet that will cause the rivet to elongate the rivet hole in the sheet metal.

Sheet Thickness (inches)	Diameter of rivet (inches)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
0.014	71	107	143	179	215	287	358	430
0.016	82	123	164	204	246	328	410	492
0.018	92	138	184	230	276	369	461	553
0.020	102	153	205	256	307	410	512	615
0.025	128	192	256	320	284	512	640	768
0.032	164	245	328	409	492	656	820	984
0.036	184	276	369	461	553	738	922	1,107
0.040	205	307	410	512	615	820	1,025	1,230
0.045	230	345	461	576	691	922	1,153	1,383
0.051	261	391	522	653	784	1,045	1,306	1,568
0.064		492	656	820	984	1,312	1,640	1,968
0.072		553	738	922	1,107	1,476	1,845	2,214
0.081		622	830	1,037	1,245	1,660	2,075	2,490
0.091		699	932	1,167	1,398	1,864	2,330	2,796
0.102		784	1,046	1,307	1,569	2,092	2,615	3,138
0.125		961	1,281	1,602	1,922	2,563	3,203	3,844
0.156		1,198	1,598	1,997	2,397	3,196	3,995	4,794
0.188		1,445	1,927	2,409	2,891	3,854	4,818	5,781
0.250		1,921	2,562	3,202	3,843	5,125	6,405	7,686
0.313		2,405	3,208	4,009	4,811	6,417	7,568	9,623
0.375		2,882	3,843	4,803	5,765	7,688	9,068	11,529
0.500		3,842	5,124	6,404	7,686	10,250	12,090	15,372

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