AVIATION MECHANIC HANDBOOK

Based on the original text by

DALE CRANE

Edited by

TERRY MICHMERHUIZEN

7TH EDITION

Aviation Mechanic Handbook, Seventh Edition
(Original text by Dale Crane)
Edited by Terry Michmerhuizen

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8.1 Standards

In the past, most manufacturers used standard aircraft parts that had been engineered and approved by the Army and Navy, with their specifications issued as AN standards. AN standard parts were easy to identify and their numbering system was relatively simple. But with the introduction of the turbine engine and high-speed, high-performance aircraft, aircraft hardware has become a much more complex and critical field. AN standards were replaced by Air Force-Navy standards; then other standards were developed—some of the more important standards are listed below:

AN—Air Force / Navy Standards
NAS—National Aerospace Standards
MS—Military Standards
AMS—Aeronautical Material Specifications
SAE—Society of Automotive Engineers
MIL—Military Specifications

The task of looking at markings on a part and measuring it to determine its part number is now a thing of the past. Many parts look alike, but their materials or tolerances can be quite different. **Any replacement hardware must be the part number specified in the aircraft or engine parts manual, and each piece of hardware must be purchased from a source known to be reputable.** Look-alike parts that might be of inferior strength can jeopardize the safety of an aircraft. The most commonly used parts and pertinent facts about their proper use are listed in this Section. AMTs should become familiar with the parts manuals for the aircraft and engines he or she is working on to find the correct part number for each piece of hardware used.

8.2 Threaded Fasteners

Bolts

The most common type of threaded fastener, available in a number of materials such as nickel steel, aluminum alloy, corrosion-resistant steel, and titanium. Different types of heads for special purposes and different thread pitches adapt them to special functions.

Genuine A/C Hardware AN3–AN20 Bolts

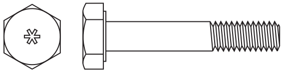
Diameter/Head Size/Hole Sizes

AN # BASIC	THREAD DIA/PITCH	DIA. MAX	DIA. MIN	WRENCH SIZE	HOLE, SHANK +.010. -.000	HOLE, HEAD +.010. -.000	COMMONLY USED STEEL COTTER	COMMONLY USED STAINLESS COTTER
AN3	10–32	.189	.186	3/8"	.070	.046	MS24665-132	MS24665-151
AN4	1/4–28	.249	.246	7/16"	.076	.046	MS24665-132	MS24665-151
AN5	5/16–24	.312	.309	1/2"	.076	.070	MS24665-210	MS24665-229
AN6	3/8–24	.374	.371	9/16"	.106	.070	MS24665-283	MS24665-300
AN7	7/16–20	.437	.433	5/8"	.106	.070	MS24665-283	MS24665-300
AN8	1/2–20	.499	.495	3/4"	.106	.070	MS24665-285	MS24665-302
AN9	9/16–18	.562	.558	7/8"	.141	.070	MS24665-353	MS24665-370
AN10	5/8–18	.624	.620	15/16"	.141	.070	MS24665-355	MS24665-372
AN12	3/4–16	.749	.744	1+1/16"	.141	.070	MS24665-355	MS24665-372
AN14	7/8–14	.874	.869	1+1/4"	.141	.070	MS24665-357	MS24665-374
AN16*	1"–14	.999	.993	1+1/2"	.141	.070	MS24665-359	MS24665-376
AN17	1"–12	.999	.993	1+1/2"	.141	.070	MS24665-359	MS24665-376
AN18	1 1/8–12	1.124	1.118	1+5/8"	.141	.070	MS24665-359	MS24665-376
AN20	1 1/4–12	1.249	1.243	1+7/8"	.141	.070	MS24665-360	MS24665-377

*The thread pitch 1"–14 became INACTIVE FOR DESIGN after June 1966.

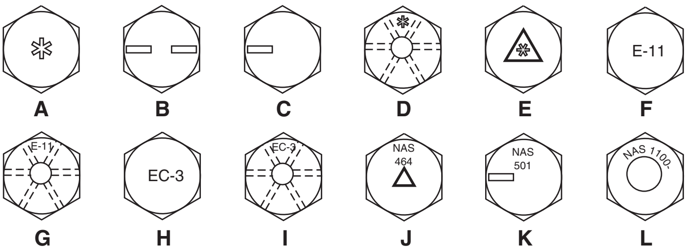
Table reproduced with permission from General Aircraft Hardware Company catalog (www.gen-aircraft-hardware.com)

Hex-Head Bolts



The standard bolt used in airframe and powerplant construction, designed for both tensile and shear loads. They depend on the proper application of torque for the strength of the joint. Available with both UNC and UNF threads, made of SAE 2330 nickel steel, 2024 aluminum alloy, corrosion resistant steel, and titanium. Most have a medium (class 3) fit and most of the steel bolts are cadmium-plated. Also available with holes drilled through the head for safety wire, and/or with a hole through the shank for a cotter pin. The material or bolt type is identified by marks on the head. Close-tolerance bolts, identified by a triangle, are ground to a fit of ±0.0005 inch and the ground surface is not plated, but is protected from rust with grease.

Bolt Head Identification Marks



A AN3-AN20—Standard alloy steel hex-head aircraft bolt

B AN3DD-AN20DD—Standard aluminum alloy hex-head aircraft bolt

C AN3C-AN20C—Standard corrosion resistant steel hex-head aircraft bolt

D AN73-AN81—Drilled-head aircraft bolt

E AN173-AN182—Close-tolerance bolt

F AN101001-AN103600—Alloy steel hex-head aircraft bolt

G AN103701-AN104600—Drilled-head aircraft bolt

H AN104601-AN105500—Corrosion resistant steel aircraft bolt

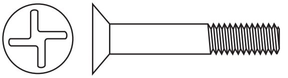
I AN107301-AN108200—Corrosion resistant steel drilled-head aircraft bolt

J NAS464—Close-tolerance bolt

K NAS501—Corrosion resistant steel hex-head aircraft bolt

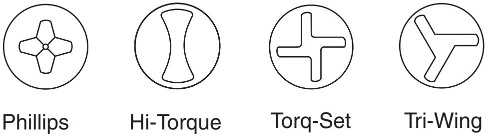
L NAS1103-NAS1112—Alloy steel hex-head aircraft bolt

Flush-Head Bolts

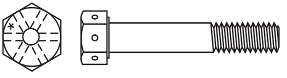


Many modern aircraft applications require high-strength bolts with heads that can be flush with the outside skin of the aircraft. Most bolts in the NAS and MS series have a 100° head, but some have an 82° head. These high-strength bolts are made of alloy steel and titanium and some have self-locking inserts in the threads.

Head Recesses

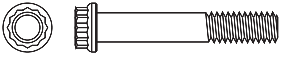


Drilled-Head Bolts



Drilled-head airframe bolts are used in locations where a high tensile strength is required and where the bolt is safetied with safety wire. There is no hole in the shank for a cotter pin.

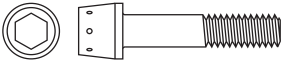
Twelve-Point, Washer-Head Bolts



Designed for special high-strength and high-temperature airframe and powerplant applications; available in both NAS and MS series. The heads of many of these bolts are drilled for safety wire.

Internal Wrenching Bolts

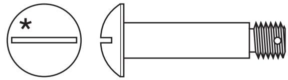
NAS144, MS2004



These are the typical high-strength alloy steel bolts used in special airframe applications where severe loads are imposed on the structure. They have a radius between the shank and the head, and a special chamfered, heat-treated steel washer (such as the NAS 143C) is used under the head to provide a bearing surface. Turned with a hex wrench which fits into the socket in the head.

Clevis Bolts

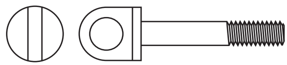
AN21 to AN36 series



Designed for shear loads only. To prevent them from being used for tensile loads, the head is shallow and has a slot or recess for turning with a screwdriver. The threads are short to take a thin nut, and there is a notch between the threads and the shank. Most have a drilled shank so a cotter pin can be used to prevent the nut from backing off. A typical application is the attachment of a cable to a control horn: the bolt is installed and the nut is tightened just enough that the cable terminal is free to move on the horn.

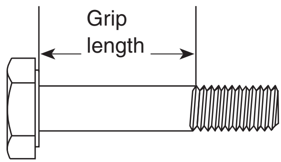
Eye Bolts

AN42 to AN49 series



Used to attach wires and cables to aircraft structure; made of alloy steel, cadmium-plated, and available with or without drilled shanks.

Bolt Installation



Almost all hex-head bolts have a round, smooth, washer-like bearing surface just below the head. This surface prevents the edges of the head from damaging the surface of the component into which the bolt is installed. If there is no such surface, a washer should be placed under the head. Also, always place a washer under the nut to provide a good bearing surface and prevent damage to the component as the nut is tightened.

The bolt length should be chosen so that the grip length (the length of the unthreaded shank) is the same as the thickness of the materials being joined. The nut must never be screwed down against the last thread on the bolt. If the grip length is too long, use plain washers to act as shims to prevent the nut reaching the last thread. **Bolts must be installed in exactly the way the aircraft or engine maintenance manual specifies.** If there is no information of this nature, bolts should be installed with the head upward, forward, or inboard. These orientations normally aid in preventing the bolt from falling out if the nut were not screwed on.

Some bolts have holes drilled in the threaded portion of the shank for cotter pins to secure a castellated nut. If a self-locking nut is to be used on a drilled shank bolt, be sure that the edges of the hole are chamfered to prevent the sharp edges from cutting threads in the nut insert.

Bolt Fits

If there is any looseness or play in a threaded joint, vibration can produce a cyclic stress that can further loosen the fastener and lead to destruction. Aircraft design engineers calculate the stresses that will affect every joint, and the fasteners are designed to produce a stress within the joint greater than any anticipated applied stress. This bolt stress is determined by the fit of the bolt in the bolt hole, and by the torque applied (*see* Pages 160–163). The maintenance manual usually specifies the drill size for all bolt holes. If no drill size is specified, it is normally satisfactory to use the next larger number drill (smaller number) than the shank diameter of the bolt being installed. Example: a #12 drill (0.1890) can be used for a 3/16-inch (0.1875) bolt. Some manuals specify a type of drive fit for the bolt in which the hole is drilled slightly undersize and reamed to the diameter that will provide the desired fit (*see* table below):

Type of fit	How to drill/ream hole
Loose fit	Use a drill number one size larger than the diameter of bolt. Hole is 0.002 to 0.005 inch larger than bolt shank.
Push fit	Reamed fit—allows bolt to be forced into the hole by hard, steady push against bolt head.
Tight-drive fit	Requires bolt to be driven into the hole with sharp blows from a 12- or 14-ounce hammer.
Interference fit	Bolt diameter is larger than reamed diameter of hole. The component with the hole must be heated to expand the hole—the bolt is chilled with dry ice to shrink it. When bolt is installed, and the component and the bolt reach the same temperature, the bolt cannot be moved.

Screws

Normally differ from a bolt because they have a slot or recess in the head so they can be turned with a screwdriver rather than a wrench, and their threads extend all of the way to the head. However, this distinction has been blurred: a number of high-strength bolts also exist with flush heads so they can be installed on the outside of an aircraft structure and not cause wind resistance.

THE AVIATION STANDARD

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Handy toolbox-size reference for mechanics, aircraft owners, and pilots. All the information critical to maintaining an aircraft.

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- Mathematics, conversions, formulas
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