



AEROSPACE STANDARD

AS7470™**REV. D**

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Revised 2019-03

Superseding AS7470C

(R) Bolts and Screws, Steel, Corrosion and Moderate Heat Resistant
Heat Treated, Roll Threaded

RATIONALE

AS6416 added, 1.4 added, 3.7.1.1.1 rewritten, 3.7.1.3.2 added, 3.7.2 magnification increased to X200, 3.7.2.2 revised, specs updated, photo of bolt head deleted, figures redrawn, Table 2 16 TPI thread value changed, Table 3 rounding of some test loads.

1. SCOPE

1.1 Type

This procurement specification covers aircraft quality bolts and screws made from a corrosion and moderate heat-resistant martensitic iron base alloy of the type identified under the Unified Numbering System as UNS S41800 and of 140000 psi and 152000 psi tensile strengths at room temperature.

1.2 Application

Primarily for aerospace propulsion system applications where corrosion and moderate heat resistance is required.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and process described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.4 Usage of Existing Manufactured Stock

Unless otherwise specified, part inventory manufactured to previous revisions of this specification may be procured and used until stock is depleted.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2750	Pyrometry
AMS5616	Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings, 13Cr - 2.0Ni - 3.0W Annealed
AS1132	Bolts, Screws, and Nuts - External Wrenching UNJ Thread, Inch - Design Standard
AS3062	Bolts, Screws, and Studs - Screw Thread Requirements
AS3063	Bolts, Screws, and Studs - Geometric Control Requirements
AS6416	Bolts, Screws, Studs and Nuts, Definitions for Design, Testing and Procurement
AS8879	Screw Threads - UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org/.

ASTM D3951	Standard Practice for Commercial Packaging
ASTM E8/E8M	Standard test Methods for Tension Testing of Metallic Materials
ASTM E140	Standard Hardness Tables for Metals
ASTM E1444/E1444M	Standard practice for Magnetic Particle Examination

2.1.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
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2.1.4 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NASM1312-6	Fastener Test Methods, Method 6, Hardness
NASM1312-8	Fastener Test Methods, Method 8, Tensile strength
NASM1312-12	Fastener Test Methods, Plating Thickness

2.2 Definitions

Refer to AS6416.

2.3 Unit Symbols

A - ampere

°C - degree Celsius

°F - degree Fahrenheit

g - gram (mass)

cm³ - cubic centimeter

h - hour

in - inch

in² - square inch

min - minute of time

% - percent (1% = 1/100)

lbf - pounds force

psi - pounds force per square inch

sp gr - specific gravity

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS5616 steel, unless otherwise specified on the part drawing.

3.2 Design

Finished (completely manufactured) parts shall conform to the following requirements:

3.2.1 Dimensions

The dimensions of finished parts, after all processing, including plating, shall conform to the part drawing. Dimensions apply after plating but before coating with solid film lubricants.

3.2.2 Surface Texture

Surface texture of finished parts, prior to plating or coating, shall conform to the requirements as specified on the part drawing, determined in accordance with ASME B46.1.

3.2.3 Threads

Screw thread UNJ profile and dimensions shall be in accordance with AS8879, unless otherwise specified on the part drawing.

3.2.3.1 Incomplete Threads

Incomplete threads are permissible at the chamfered end at the juncture of the unthreaded portion of the shank or adjacent to the head as specified in AS3062.

3.2.3.2 Chamfer

The entering end of the thread shall be chamfered as specified on the part drawing.

3.2.4 Geometric Tolerances

Part features shall be within the geometric tolerances specified on the part drawing and, where applicable, controlled in accordance with AS3063.

3.3 Fabrication

3.3.1 Blanks

Heads shall be formed by hot or cold forging or machining. Lightening holes may be produced by any suitable method. Wrenching recesses may be forged or machined. Flash or chip clearance in machined recesses shall not cause recess dimension to exceed the specified limits.

3.3.2 Heat Treatment

Headed and machined blanks shall, before finishing the shank and the bearing surface of the head, cold working the head-to-shank fillet radius when specified, and rolling the threads, be heat treated as follows:

3.3.2.1 Heating Equipment

Furnaces may be any type ensuring uniform temperature throughout the parts being heated and shall be equipped with, and operated by, automatic temperature controllers and data recorders conforming to AMS2750. The heating medium or atmosphere shall cause no surface hardening by carburizing or nitriding.

3.3.2.2 Hardening

Blanks of AMS5616 shall be uniformly heated to $1750\text{ }^{\circ}\text{F} \pm 25\text{ }^{\circ}\text{F}$, held at heat for 15 to 20 minutes, and suitably quenched. For other steels, the temperature, time, and quenching medium shall be as agreed by purchaser and vendor.

3.3.2.3 Tempering

Hardened blanks shall be tempered by heating uniformly to a temperature necessary to produce the specified hardness and microstructure but not within the range of 700 to 1000 °F, holding at heat for not less than 1 hour, and cooling.

3.3.3 Oxide Removal

Surface oxide, and oxide penetration caused by prior heat treatment, shall be removed from the full body diameter and bearing surface of the head of the heat treated blanks prior to cold working the under head fillet radius when specified and rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks.

3.3.4 Cold Working of Fillet Radius

After removal of oxide as in 3.3.3, the head-to-shank fillet radius of parts having the radius complete throughout the circumference of the part shall, when specified, be cold rolled sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold working shall conform to Figure 1, unless otherwise specified on the part drawing. It shall not raise metal more than 0.002 inch above the contour at "A" or depress metal more than 0.002 inch below the contour at "B," as shown in Figure 1; distorted areas shall not extend beyond "C," as shown in Figure 1. In configurations having an undercut associated with the fillet radius, the cold working will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head. In addition to cold working the head-to-shank fillet radius, shouldered bolts having an unthreaded shank diameter larger than the thread major diameter and having an undercut associated with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank. For parts with compound fillet radii between head and shank, cold work only the radius that blends with the head.

3.3.5 Thread Rolling

Threads shall be formed on the heat treated and finished blanks by a single rolling process after removal of oxide as in 3.3.3.

3.3.6 Cleaning

Parts, after finishing, shall be degreased and immersed in one of the following solutions for the time and temperature shown:

- a. One volume of nitric acid (sp gr 1.42) and nine volumes of water for not less than 20 minutes at room temperature.
- b. One volume of nitric acid (sp gr 1.42) and four volumes of water for 30 to 40 minutes at room temperature.
- c. One volume of nitric acid (sp gr 1.42) and four volumes of water for 10 to 15 minutes at 140 to 160 °F.
- d. Citric acid solution containing 4 to 10 weight percent of citric acid, for a minimum of 20 minutes at a temperature in the range of 70 to 120 °F.

3.4 Product Marking

Each part shall be identification marked as specified by the part drawing. The markings may be formed by forging or stamping, raised or depressed not more than 0.010 inch maximum, with rounded root form or depressed characters.

3.5 Plating

Where required, any protective treatment shall be as specified by the part drawing. Thickness determined in accordance with MIL-STD-1312-12 in accordance with NASM1312-12.

3.6 Mechanical Properties

Parts shall conform to the requirements of 3.6.1 and 3.6.2. Threaded members of gripping fixtures for tensile test shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The loaded portion of the shank shall have two to three full thread turns from the thread runout exposed between the loading fixtures during the tensile test. Finished parts shall be tested in accordance with the following applicable test methods:

- a. Hardness: MIL-STD-1312-6 in accordance with NASM1312-6.
- b. Room Temperature Ultimate Tensile Strength: MIL-STD-1312-8 in accordance with NASM1312-8.

3.6.1 Ultimate Tensile Strength at Room Temperature

3.6.1.1 Finished Parts

Parts having hardness not lower than 30 HRC shall have an ultimate tensile load not lower than that specified in Table 3 and shall be tested to failure, first measuring and recording the maximum tensile load achieved. Parts requiring minimum hardness not lower than 35 HRC shall have an ultimate tensile load not lower than the minimum ultimate tensile load specified in Table 3 multiplied by 1.08. If the size or shape of the part is such that failure would occur outside the threaded section but the part can be tested satisfactorily, such as parts having a shank diameter equal to or less than the thread root diameter or having an undercut, parts shall conform to only the ultimate tensile strength requirements of 3.6.1.2; for such parts, the diameter of the area on which stress is based shall be actual measured minimum diameter of the part. Tension fasteners with either standard double hexagon or hexagon-type head having a minimum metal condition in the head equal to the design parameters specified in AS1132 shall not fracture in the head-to-shank fillet radius, except when this radius is associated with an undercut or with a shank diameter less than the minimum pitch diameter of the thread, or where cold working of the fillet radius is not required and the heads are machined.

3.6.1.2 Machined Test Specimens

If the size or shape of the part is such that a tensile test can not be made on the part, tensile tests shall be conducted in accordance with ASTM E8/E8M on specimens prepared as in 4.4. Such specimens shall meet the requirements in Table 1:

Table 1 - Tensile properties of test specimens

Minimum Hardness of Specified Range HRC	Ultimate Tensile Strength psi Minimum	Elongation in 2 Inches or 4D % Minimum	Reduction of Area % Minimum
30	140000	17	40
35	152000	13	35

3.6.1.2.1 When permitted by purchaser, hardness test on the end of the parts may be substituted for tensile test of machined specimens.

3.6.2 Hardness

Unless otherwise specified on the part drawing, hardness shall be uniform and within the range 30 to 38 HRC, but hardness of the threaded section and of the head-to-shank fillet area when cold working of this area is specified, may be higher as a result of the cold working operations.

3.7 Quality

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials, and from imperfections detrimental to their performance.

3.7.1 Macroscopic Examination

Parts or sections of parts, as applicable, shall be etched in a solution consisting of approximately 50% hydrochloric acid (sp gr 1.19), 50% water, or other suitable etchant for sufficient time to reveal flow lines but not longer than 15 minutes, and then examined at a magnification of approximately 20X to determine conformance to the requirements of 3.7.1.1, 3.7.1.2, and 3.7.1.3, except that examination for thread imperfections as specified in 3.7.1.3 should be made by microscopic examination of specimens polished and etched as in 3.7.2.

3.7.1.1 Flow Lines

3.7.1.1.1 Head-to-Shank

If parts have forged heads, examination of a longitudinal section through the part shall show flow lines in the shank, head-to-shank fillet, and bearing surface which are representative of a forging process and shall follow the head contour. Flow lines in upset heads on parts having special heads, such as Dee- or Tee-shaped heads, or thinner than AS1132 standard heads, shall be as agreed by purchaser and vendor.

3.7.1.1.2 Threads

Flow lines in threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at root of thread (see Figure 2).

3.7.1.2 Internal Defects

Examination of longitudinal sections of the head and shank and of the threads shall reveal no cracks, laps, or porosity, except laps in threads as permitted in 3.7.1.3.3 and 3.7.1.3.4. The head and shank section shall extend not less than D/2 from the bearing surface of the head and the threaded section shall extend not less than D/2 beyond the thread runout, where "D" is the nominal diameter of the shank after heading. If the two sections would overlap, the entire length of the part shall be sectioned and examined as a whole.