



AEROSPACE STANDARD	AS5270™	REV. A
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Superseding AS5270		
(R) Bolts, Screws and Studs, Nickel Alloy, UNS N07718 Work-Strengthened, Tensile Strength 220 ksi Procurement Specification		
FSC 5306		

RATIONALE

Most paragraphs have been modified, AS6416 added. Paragraphs 3.7.2.6.2 and 3.7.2.6.3 added, all figures have been redrawn for clarity.

1. SCOPE

1.1 Type

This procurement specification covers bolts, screws, and studs made from a work-strengthened corrosion and heat resistant, age hardenable nickel base alloy of the type identified under the Unified Numbering System as UNS N07718. The following properties are covered:

220 ksi minimum ultimate tensile strength at room temperature
180 ksi minimum ultimate tensile strength at 900 °F
114 ksi tension to 11.4 ksi tension fatigue at room temperature

1.2 Application

Primarily for aerospace propulsion systems applications where a good combination of tensile strength, fatigue strength, resistance to relaxation, and shear strength is required for use up to approximately 900 °F.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes 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 take necessary precautionary measures to ensure the health and safety of all personnel involved.

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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.

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
AMS5662	Nickel Alloy, Corrosion and Heat-Resistant, Bars, Forgings, and Rings, 52.5Ni - 19Cr - 3.0Mo - 5.1Cb (Nb) - 0.90Ti - 0.50Al - 18Fe, Consumable Electrode or Vacuum Induction Melted, 1775 °F (968 °C) Solution Heat Treated, Precipitation-Hardenable
AMS5962	Nickel Alloy, Corrosion and Heat-Resistant, Round Bars and Wire, 52.5Ni - 19Cr - 3.0Mo - 5.1Cb - 0.90Ti - 0.50Al - 18Fe, Consumable Electrode or Vacuum Induction Melted, 1775 °F (968 °C) Solution Treated and Work Strengthened, Precipitation Hardenable
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 E21	Standard Test Methods for Elevated Temperature Tension of Metallic Materials
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM E1417/E1417M	Standard Practice for Liquid Penetrant Examination

2.1.3 AIA Publications

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

NASM1312-8 Fastener Test Methods, Method 8, Tensile Strength

NASM1312-11 Fastener Test Methods, Method 11, Tension Fatigue

NASM1312-18 Fastener Test Methods, Method 18, Elevated Temperature Tensile Strength

2.1.4 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)

2.2 Definitions

Refer to AS6416.

2.3 Unit Symbols

°	degree, angle
°C	degree, Celsius
°F	degree, Fahrenheit
HRC	hardness Rockwell C scale
lbf	pounds force
%	percent (1% = 1/100)
sp gr	specific gravity
ksi	kips (1000 pounds) per square inch

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS5962 or AMS5662 heading stock sufficiently cold worked to meet the mechanical property requirements of this specification.

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 Screw Threads

Threads shall be in accordance with AS8879, unless otherwise specified on the part drawing.

3.2.3.1 Incomplete Lead and Runout Threads

Incomplete threads are permissible 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

3.3.1.1 Bolts and Screws

Heads shall be formed by hot or cold forging; machined heads are not permitted, except lightening holes and wrenching recess may be forged or machined. Flash or chip clearance in machined recesses shall not cause recess dimensions to exceed the specified limits.

3.3.1.2 Studs

Blanks may be machined from bar stock. The smaller diameter or nut end of blanks for stepped studs may be reduced as necessary; the larger diameter or stud end may be upset. For shoulder studs and double ended bolts, material shall be swaged so that flow lines follow approximate configuration of shoulder and transverse axis of flow lines occur at approximate center of shoulder.

3.3.2 Heat Treatment

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

3.3.2.1 Heating Equipment

Furnaces may be any type ensuring uniform temperature throughout the blanks being heated and shall be equipped with, and operated by, automatic temperature controllers. Pyrometry shall be in accordance with AMS2750. The heating medium or atmosphere shall cause no surface hardening.

3.3.2.2 Precipitation Heat Treatment

After heading (extruding, upsetting, and swaging) as applicable, the blanks shall be precipitation heat treated by heating to $1325^{\circ}\text{F} \pm 15^{\circ}\text{F}$ in a controlled atmosphere, holding at heat for 8 hours ± 0.25 hour, furnace cooling at $100^{\circ}\text{F} \pm 15^{\circ}\text{F}$ per hour to $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$, holding at $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ for 8 hours ± 0.25 hour and cooling at a rate equivalent to air cool. Instead of the 100°F per hour cooling rate to $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ the blanks maybe furnace cooled at any rate provided the time at $1150^{\circ}\text{F} \pm 15^{\circ}\text{F}$ is adjusted to give a total precipitation heat treatment time of approximately 18 hours.

3.3.3 Oxide Removal

Prior to cold working the underhead fillet radius and rolling the threads, 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. The oxide removal process shall produce no intergranular attack or corrosion of the blanks.

3.3.4 Cold Rolling of Fillet Radius

After removal of oxide as in 3.3.3, the head-to-shank fillet radius of headed parts having the radius complete throughout the circumference of the part shall be cold worked. The fillet shall be cold worked sufficiently to remove all visual evidence of grinding or tool marks. If there is no visual evidence of grinding or tool marks prior to cold working, the fillet shall still be cold worked. Distortion due to cold rolling 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 connected with the fillet radius, the cold rolling 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. For shouldered bolts, having an unthreaded shank diameter larger than the thread major diameter and having an undercut connected 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, the shank diameter on full shank close tolerance bolts shall not exceed its maximum diameter limit after cold rolling the head to shank fillet radius.

3.3.5 Thread Rolling

Threads shall be formed on the finished blanks by a single cold or warm rolling process after removal of oxide as in 3.3.3.

3.3.6 Cleaning

Parts, before finishing, shall be cleaned in one of the following solutions for the time and temperature shown and then thoroughly rinsed:

- a. One volume of nitric acid (sp gr 1.42) and 9 volumes of water for not less than 20 minutes at room temperature.
- b. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 30 to 40 minutes at room temperature.
- c. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 10 to 15 minutes at 140 to 160 °F.
- d. ASTM A967, ASTM A380, or AMS2700 for cleaning parts only, excluding any additional verification requirements (such as salt spray)

3.4 Product Marking

Unless otherwise specified, 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 on depressed characters.

3.5 Plating

Where required, surfaces shall be plated or coated as specified by the part drawing; plating or coating thickness shall determined in accordance with the requirements of the plating or coating specification.

3.6 Mechanical Properties

Parts shall conform to the requirements of 3.6.1, 3.6.2, and 3.6.3. Threaded members of gripping fixtures for tensile and fatigue tests shall be of sufficient size and strength to develop the full strength of the part without stripping the thread.

Finished parts shall be tested in accordance with the following applicable test methods:

- a. Ultimate Tensile Strength at Room Temperature MIL-STD-1312-8 in accordance with NASM1312-8
- b. Ultimate Tensile Strength at 900 °F MIL-STD-1312-18 in accordance with NASM1312-18
- c. Fatigue Strength at Room Temperature MIL-STD-1312-11 in accordance with NASM1312-11

3.6.1 Ultimate Tensile Strength at Room Temperature

3.6.1.1 Finished Parts

Tension studs and tension bolts, such as hexagon, double hexagon, and spline drive heads, shall have an ultimate tensile load not lower than that specified in Table 2A and shall be tested to failure in order to observe fracture location, first measuring and recording the maximum tensile load achieved. Screws, such as 100 degree flush head, pan head, and fillister head, shall have an ultimate tensile load not lower than that specified in Table 2B; screws need not be tested to failure, however the maximum tensile load achieved shall be measured and recorded. 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 minimum pitch diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 220 ksi; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part. Tension fasteners with either standard hexagon, double hexagon, or spline drive type heads 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 connected with an undercut or with a shank diameter less than the minimum pitch diameter of the thread.

3.6.1.2 Machined Test Specimens

If the size or shape of the part is such that a tensile test cannot be made on the part, tensile tests shall be conducted in accordance with ASTM E8/E8M on specimens as in 4.5.7. Such specimens shall meet the following requirements:

- a. Ultimate Tensile Strength 220 ksi
- b. Yield Strength at 0.2% Offset, minimum 200 ksi
- c. Elongation in 4D, minimum 8%
- d. Reduction of Area, minimum 15%

3.6.2 Ultimate Tensile Strength at 900 °F

3.6.2.1 Finished Parts

Tension bolts and studs heated to 900 °F $\pm$ 5 °F, held at heat for 30 minutes before testing, and tested at 900 °F $\pm$ 5 °F, shall have an ultimate tensile load not lower than the value specified in Table 2A and shall be tested to failure in order to observe fracture location, first measuring and recording the maximum tensile load achieved. 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 minimum pitch diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 180 ksi; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part. Tension fasteners with either standard hexagon, double hexagon, or spline drive type heads 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 connected with an undercut or with a shank diameter less than the minimum pitch diameter of the thread. Screws, such as 100 degree flush head, pan head, and fillister head, are not required to be tested for tensile strength at 900 °F.