AEROSPACE STANDARD

AS4877™ | REV. E

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Superseding AS4877D

Bolts and Screws, Nickel Alloy UNS N07718, Classification: 185 ksi/1,200 °F Procurement Specification

FSC 5306

RATIONALE

This limited scope change provides an exception for hardness requirements when tensile properties are met.

1. SCOPE

1.1 Type

This procurement specification covers bolts and screws made from a corrosion and heat resistant, age hardenable nickel base alloy of the type identified under the Unified Numbering System as UNS N07718.

1.1.1 Classification

a. Tensile strength at room temperature 185 ksi minimum

b. Maximum test temperature of parts 1,200 °F

c. Tensile strength at 1,200 °F 145 ksi minimum

d. Stress Rupture: 100 ksi stress rupture strength at 1,200 °F

1.2 Application

Primarily for use in aerospace propulsion systems as follows:

a. For use up to approximately 1,200 °F where elevated temperature tensile strength, stress-rupture strength, and resistance to relaxation are required.

b. For use up to approximately 800 °F where fatigue resistance and tensile strength are required.

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 to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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

AS1132 Bolts, Screws and Nuts - External Wrenching, Unified Thread, Inch - Design Standard

AS3062 Bolts, Screws, and Studs, Screw Thread Requirements

AS3063 Bolts, Screws, and Studs, Geometric Control Requirements

AS8879 Screw Threads - UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter

2.1.2 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

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

2.1.3 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 E8/E8M Standard Test Methods for Tension Testing of Metallic Materials

ASTM E21 Elevated Temperature Tension Tests of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

ASTM E140 Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

ASTM E1417/E1417M Standard Practice for Liquid Penetrant Examination

ASTM D3951 Commercial Packaging

2.1.4 NAS 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

NASM1312-10 Fastener Test Methods, Method 10, Stress Rupture

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

NASM1312-12 Fastener Test Methods, Method 12, Thickness of Metallic Coatings

NASM1312-13 Fastener Test Methods, Method 13, Double Shear Test

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

2.2 Definitions

BURR: A rough edge or ridge left on the metal due to a cutting, grinding, piercing, or blanking operation.

TIGHT BURR: A burr closely compacted and binding in the periphery of a part without any loose ends and is within the dimensional limits of the part.

DEFECTIVE: A unit of product which contains one or more defects.

PRODUCTION INSPECTION LOT: Shall be all finished parts of the same part number, made from a single heat of alloy, heat treated at the same time to the same specified condition, produced as one continuous run, and submitted for vendors inspection at the same time.

2.3 Unit Symbols

°C - degree Celsius

°F - degree Fahrenheit

cm^3 - cubic centimeter

g - gram, mass

% - percent (1% = 1/100)

lbf - pounds force

ksi - kip (1000 pounds) per square inch

sp gr - specific gravity

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS5662 heading stock.

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 shall apply after plating but before coating with dry 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 Lead and Runout Threads

Incomplete threads are permissible at the entering end and 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 forging or cold forging; temperature for hot forging blanks shall be within the range of 1,650 to 2,000 °F. Machined heads are not permitted, except 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 dimensions to exceed the specified limits.

3.3.2 Heat Treatment

Headed blanks, before finishing the shank and the bearing surface of the head, cold rolling the head-to-shank fillet radius, and rolling the threads, shall be solution and precipitation 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. The heat treatment atmosphere or medium shall not cause any surface contamination except as permitted by 3.3.3. On unplated bolts, discoloration from heat treatment is acceptable but no scale is permissible.

3.3.2.2 Solution Heat Treatment

Headed blanks shall be solution heat treated by heating to a temperature within the range 1,725 to 1,850 °F, holding at the selected temperature within ±25 °F for 1 hour ± 0.1 hour, and quenching in oil, water, or an inert gas.

3.3.2.3 Precipitation Heat Treatment

After solution heat treatment as in 3.3.2.2, headed blanks shall be precipitation heat treated by heating to 1,325 °F ± 15 °F in a controlled atmosphere, holding at heat for 8 hours ± 0.25 hour, furnace cooling at 100 °F ± 15 °F per hour to 1,150 °F ± 15 °F, holding at 1,150 °F ± 15 °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 1,150 °F ± 15 °F, parts may be furnace cooled at any rate provided the time at 1,150 °F ± 15 °F is adjusted to give a total precipitation heat treatment time of approximately 18 hours.

3.3.3 Oxide Removal

Surface oxide and oxide penetration resulting from prior heat treatment shall be removed from the full body diameter and bearing surface of the head of the solution and precipitation heat treated blanks prior to cold rolling the fillet radius and rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks. The metal removed from the bearing surface of the head and the full body diameter of the shank shall be as little as practicable to obtain a clean, smooth surface.

3.3.4 Cold Rolling 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 be cold rolled. Cold rolling shall be sufficient to remove all visual evidence of grinding or tool marks. 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 rolling 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 the nominal thread diameter 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 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 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.

Immediately after removal from the cleaning solution, parts shall be thoroughly rinsed in clean water at 70 to 200 °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 0.010 inch maximum, with rounded root form on depressed characters.

3.5 Plating

Where required, surfaces shall be plated as specified by the part drawing; plating thickness determined in accordance with MIL-STD-1312-12 in accordance with NASM1312-12.

3.6 Mechanical Properties

Where AS4877 is specified, parts shall conform to the requirements of 3.6.1, 3.6.2, 3.6.3, 3.6.4, and 3.6.5. Where AS4877-1 is specified, parts shall conform to the requirements of 3.6.1, 3.6.3, and 3.6.6. Threaded members of gripping fixtures for tensile, fatigue, and stress-rupture tests 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 threads from the thread runout exposed between the loading fixtures during tensile, fatigue, and stress-rupture tests.

AS4877 finished parts shall be tested in accordance with the following test methods:

a. Hardness: MIL-STD-1312-6 in accordance with NASM1312-6

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

c. Ultimate Tensile Strength at 1,200 °F: MIL-STD-1312-18 in accordance with NASM1312-18

d. Stress-Rupture Strength at 1,200 °F: MIL-STD-1312-10 in accordance with NASM1312-10

e. Fatigue Strength: MIL-STD-1312-11 in accordance with NASM1312-11

AS4877-1 finished parts shall be tested in accordance with the following test methods:

a. Hardness: MIL-STD-1312-6 in accordance with NASM1312-6

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

c. Ultimate Shear Strength at Room Temperature: MIL-STD-1312-13 in accordance with NASM1312-13

3.6.1 Ultimate Tensile Strength at Room Temperature

3.6.1.1 Finished Parts

Parts shall have an ultimate tensile load not lower than that specified in Table 1 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 thread root diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 185 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 double hexagon or hexagon-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. Specimens may be required by purchaser to perform confirmatory tests. Such specimens shall meet the following requirements:

a. Ultimate Tensile Strength, minimum: 185 ksi

b. Yield Strength at 0.2% Offset, minimum: 150 ksi

c. Elongation in 4D, minimum: 12%

d. Reduction of Area, minimum: 15%

3.6.2 Ultimate Tensile Strength at 1,200 °F

3.6.2.1 Finished Parts

Parts heated to 1,200 °F ± 5 °F, held at heat for 30 minutes minimum before testing, and tested at 1,200 °F ± 5 °F, shall have an ultimate tensile load not lower than the value specified in Table 1 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 145 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 double hexagon or hexagon 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.

3.6.2.2 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 E21 on specimens as in 4.5.7. Specimens may be required by purchaser to perform confirmatory tests. Such specimens shall meet the following requirements when heated to 1,200 °F ± 5 °F, held at heat for not less than 30 minutes minimum before testing, and tested at 1,200 °F ± 5 °F:

a. Ultimate Tensile Strength, minimum: 145 ksi

b. Yield Strength at 0.2% Offset, minimum: 125 ksi

c. Elongation in 4D, minimum: 12%

d. Reduction of Area, minimum: 15%

3.6.3 Hardness

Shall be uniform and within the range 36 to 46 HRC (see 8.1), but hardness of the threaded section and of the head-to-shank fillet area may be higher as a result of the cold working operations. Parts shall not be rejected on the basis of hardness if the tensile property requirements of 3.6.1 are met.

3.6.4 Fatigue Strength

Finished parts tested in tension-tension fatigue at room temperature with maximum load as specified in Table 1 and minimum load equal to 10% of maximum load shall have average life of not less than 65,000 cycles with no part having life less than 45,000 cycles.

Tests need not be run beyond 130,000 cycles. Life of parts which do not fail in less than 130,000 cycles shall be taken as 130,000 cycles for purposes of computing average life. If the shank diameter of the part is less than the minimum pitch diameter of thread, parts shall withstand fatigue testing as above, using loads sufficient to produce a maximum stress of 105 ksi and a minimum stress of 10.5 ksi. The above requirements apply only to parts 0.164 inch and larger in nominal thread size with round, square, hexagonal, or spline drive heads designed for tension applications and not having an undercut, and having a head-to-shank fillet radius equal to or larger than that specified in AS1132; for all parts to which the above requirements do not apply, fatigue test requirements shall be as specified on the part drawing.

3.6.5 Stress-Rupture Strength at 1,200 °F

3.6.5.1 Finished Parts

Finished parts, maintained at 1,200 °F ± 5 °F while the tensile load specified in Table 1 is applied continuously, shall not rupture in less than 23 hours. If the shank diameter of the part is less than the minimum pitch diameter of the thread but the part can be tested satisfactorily, parts shall conform to the requirements of 3.6.5.2.

3.6.5.1.1 Parts having a shank diameter less than the minimum pitch diameter of the thread shall be tested as in 3.6.5.1 except that the load shall be as specified in 3.6.5.2. The diameter of the area on which stress is based shall be the actual measured minimum diameter of the part.

3.6.5.2 Machined Test Specimens

If the size or shape of the part is such that a stress-rupture test cannot be made on the part, a test specimen prepared as in 4.5.7, maintained at 1,200 °F ± 5 °F while a load sufficient to produce an initial axial stress of 100 ksi is applied continuously, shall not rupture in less than 23 hours. Tests shall be conducted in accordance with ASTM E139. Specimens may be required by purchaser to perform confirmatory tests.

3.6.6 Ultimate Shear Strength

Finished parts having a close toleranced full shank as in AS1132 shall have an ultimate double shear load not lower than that specified in Table 1. The double shear test may be discontinued without a complete shear failure after the ultimate shear load has been reached, first measuring and recording the maximum double shear load achieved. Shear bolts having special shank diameters shall have the minimum ultimate double shear load based on 111 ksi minimum shear strength. Shear tests are not required for countersunk head fasteners having a grip less than 2.5 times the nominal diameter or protruding head fasteners having a grip less than 2 times the nominal diameter. Shear test are not required for the following conditions:

a. Bolts and screws threaded to head

b. Protruding head bolts and screws having coarse toleranced full shank

c. Protruding head bolts and screws having PD or relieved shank

3.7 Quality

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs (tight burrs may be acceptable if part performance is not affected) and foreign materials, and from imperfections detrimental to the usage of the part.

3.7.1 Macroscopic Examination

Specimens cut from headed blanks and from finished parts shall be etched in a suitable etchant and examined at a magnification of approximately 20X to determine conformance to the requirements of 3.7.1.1 and 3.7.1.2. The head and shank section shall extend not less than D/2 from the bearing surface of the head and the threaded shank 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.

3.7.1.1 Flow Lines

3.7.1.1.1 Head-to-Shank, Headed Blanks

After heading and prior to heat treatment, examination of an etched section taken longitudinally through the blank shall show flow lines in head-to-shank fillet and bearing surface which follow the contour of the blank as shown in Figure 2A. Flow lines in headed blanks having special heads, such as Dee- or Tee-shaped heads or thinner than AS1132 standard heads, shall be as agreed upon by purchaser and vendor.

3.7.1.1.2 Head-to-Shank, Finished Part

Examination of a longitudinal section through the part shall show evidence that the heads were formed by forging. This evidence shall include traces of flow lines as shown in Figure 2B.

3.7.1.1.3 Threads

Examination of a longitudinal section through the threaded portion of the shank shall show evidence that the threads were rolled. This evidence shall include traces of flow lines as shown in Figure 3.

3.7.1.2 Internal Defects

Examination of longitudinal sections of the head and shank shall reveal no cracks, laps, or porosity. Thread imperfections as in 3.7.2.4 shall be examined in accordance with 3.7.2.

3.7.2 Microscopic Examination

Specimens cut from parts shall be polished, etched in Kalling's reagent [100 cm^3 of absolute ethyl alcohol, 100 cm^3 of hydrochloric acid (sp gr 1.19), and 5 g of cupric chloride], Marble's reagent [20 cm^3 of hydrochloric acid (sp gr 1.19), 30 cm^3 of water, and 4 g of cupric sulfate pentahydrate], or other suitable etchant, and examined at not lower than 100X magnification to determine conformance to the requirements of 3.7.2.1, 3.7.2.2, 3.7.2.3, and 3.7.2.4.

3.7.2.1 Microstructure

Parts shall have microstructure of completely recrystallized material except in the area of the threads and the head-to-shank fillet radius.

3.7.2.2 Grain Size

Shall be ASTM No. 3 or finer, determined in accordance with the comparative method of ASTM E112. In case of disagreement, the intercept (Heyn) procedure shall be used.

3.7.2.3 Surface Hardening

Parts shall have no change in hardness from core to surface except as produced during cold rolling of the head-to-shank fillet radius and during rolling of threads. In case of dispute over results of the microscopic examination, microhardness testing shall be used as a referee method; a Vickers hardness reading of an unrolled surface which exceeds the reading in the core by more than 20 points shall be evidence of nonconformance to this requirement.

3.7.2.4 Threads

3.7.2.4.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (see Figure 4).

3.7.2.4.2 Multiple laps on the flanks of threads are not permissible regardless of location.

3.7.2.4.3 Single Lap on Thread Profile

Shall conform to the following:

a. Rateable Lap: Shall have its length equal to or greater than three times its width. The minimum interpretable lap size is 0.0005 inch in length or depth when viewed at 200X magnification.

b. Thread Flank Above the Pitch Diameter: A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or nonpressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (see Figure 5). The lap depth shall not exceed the limit specified in Table 2 for the applicable thread pitch. A lap extending toward the root is not permissible (see Figure 6).

c. Thread Flank Below the Pitch Diameter: A lap along the thread flank below the pitch diameter, regardless of direction it extends, is not permissible (see Figure 7).

d. Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible provided that the imperfections do not extend deeper than the limit specified in Table 2 as measured from the thread crest when the thread major diameter is at minimum size (see Figure 8). The major diameter of the thread shall be measured prior to sectioning. As the major diameter of the thread approaches maximum size, values for depth of crest crater and crest lap imperfections listed in Table 2 may be increased by one-half of the difference between the minimum major diameter and actual major diameter as measured on the part.

3.7.3 Fluorescent Penetrant Inspection

Parts shall be subject to fluorescent penetrant inspection in accordance with ASTM E1417/E1417M, Type I, Sensitivity Level 2; any required plating or coating shall be removed for this inspection.

3.7.3.1 The following conditions shall be cause for rejection of parts inspected:

3.7.3.1.1 Discontinuities transverse to grain flow (i.e., at an angle of more than 10 degrees to the axis of the shank), such as grinding checks and quench cracks.

3.7.3.1.2 Longitudinal indications (i.e., at an angle of 10 degrees or less to the axis of the shank) due to imperfections other than seams, forming laps, and nonmetallic inclusions.

3.7.3.2 The following conditions shall be considered acceptable on parts inspected:

3.7.3.2.1 Parts having longitudinal indications (i.e., at an angle of 10 degrees or less to the axis of the shank) of seams and forming laps parallel to the grain flow that are within the limits specified in 3.7.3.2.2 through 3.7.3.2.5 provided the separation between indications in all directions is not less than 0.062 inch.

3.7.3.2.2 Sides of Head

There shall be not more than three indications per head. The length of each indication may be the full height of the surface but no indication shall break over either edge to a depth greater than 0.031 inch or the equivalent of the 2H/3 thread depth (see Table 2), whichever is less.

3.7.3.2.3 Shank or Stem

There shall be not more than five indications. The length of any indication may be the full length of the surface but the total length of all indications shall not exceed twice the length of the surface. No indication shall break into a fillet or over an edge.

3.7.3.2.4 Threads

There shall be no indications, except as permitted in 3.7.2.4. Rateable lap indications shall conform to 3.7.2.4.3.a.

3.7.3.2.5 Top of Head and End of Stem

The number of indications is not restricted but the depth of any individual indication shall not exceed 0.010 inch as shown by sectioning representative samples. No indication, except those of 3.7.3.2.2 shall break over an edge.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of parts shall supply all samples and shall be responsible for performing all required tests. Purchaser reserves the right to perform such confirmatory testing as deemed necessary to ensure that the parts conform to the requirements of this specification.

4.2 Responsibility for Compliance

The manufacturer's system for parts production shall be based on preventing product defects, rather than detecting the defects at final inspection and then requiring corrective action to be invoked. An effective manufacturing in-process control system shall be established, subject to the approval of the purchaser, and used during production of parts.

4.3 Production Acceptance Tests

The purpose of production acceptance tests is to check, as simply as possible, using a method which is inexpensive and representative of the part usage, with the uncertainty inherent in random sampling, that the parts comprising a production inspection lot satisfy the requirements of this specification.

4.4 Classification of Tests

a. Acceptance tests which are to be performed on each production inspection lot. A summary of acceptance tests is specified in Table 3.

b. Periodic tests which are to be performed periodically on production lots at the discretion of the vendor or purchaser. Ultimate tensile strength test at 1200 °F as in 3.6.2 is classified as a periodic test and shall be performed when requested by the purchaser.

4.5 Acceptance Test Sampling

4.5.1 Material

Sampling for material composition on each heat shall be in accordance with AMS5662.

4.5.2 Nondestructive Tests - Visual and Dimensional

A random sample of parts shall be taken from each production inspection lot; the size of the sample to be as specified in Table 4. The classification of dimensional characteristics shall be as specified in Table 5. All dimensional characteristics are considered defective when out of tolerance.

4.5.3 Fluorescent Penetrant Inspection

A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 4 and classified as in Table 5. The sample units may be selected from those that have been subjected to and passed the visual and dimensional inspection, with additional units selected at random from the production inspection lot as necessary.

4.5.4 Stress-Rupture Test

A random sample of a minimum of one part (or one test specimen where required) shall be selected from each production inspection lot.

4.5.5 Destructive Tests

A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 6. The sample units may be selected from those that have been subjected to and passed the nondestructive tests and fluorescent penetrant inspection with additional units selected at random from the production inspection lot as necessary.

4.5.6 Acceptance Quality

Of random samples tested, acceptance quality shall be based on zero defectives.

4.5.7 Test Specimens

Specimens for tensile and stress-rupture testing of machined test specimens shall be of standard proportions in accordance with ASTM E8/E8M with either 0.250 inch diameter at the reduced parallel gage section or smaller specimens proportional to the standard when required. Specimens shall be machined from finished parts or coupons of the same lot of alloy and be processed together with the parts they represent. Specimens shall be machined from the center of parts 0.750 inch and under in nominal diameter, from the center of coupons 0.800 inch and under in nominal diameter or distance between parallel sides, and from mid-radius of larger size parts or coupons.

4.6 Periodic Test Sampling

As agreed upon by purchaser and vendor.

4.7 Reports

The vendor of parts shall furnish with each shipment a report stating that the chemical composition of the parts conforms to the applicable material specification, showing the results of tests to determine conformance to the room temperature ultimate tensile property, ultimate shear property where applicable, hardness, fatigue, and stress-rupture requirements, and stating that the parts conform to the other technical requirements. This report shall include the purchase order number, AS4877 (or AS4877-1 if applicable), lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.8 Rejected Lots

If a production inspection lot is rejected, the vendor of parts may perform corrective action to screen out or rework the defective parts, and resubmit for acceptance tests inspection as in Table 3. Resubmitted lots shall be clearly identified as re-inspected lots.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Identification

5.1.1 Parts having different part numbers shall be packed in separate containers.

5.1.2 Each container of parts shall be marked to show not less than the following information:

BOLTS (SCREWS), NICKEL ALLOY UNS N07718, CLASSIFICATION 185 ksi/1,200 °F
AS4877
PART NUMBER
LOT NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

5.1.3 Threaded fasteners shall be suitably protected from abrasion and chafing during handling, transportation, and storage.

5.1.4 Packaging shall be in accordance with ASTM D3951.

6. ACKNOWLEDGMENT

A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES

8.1 Hardness Conversion Tables

Hardness conversion tables for metals are presented in ASTM E140.

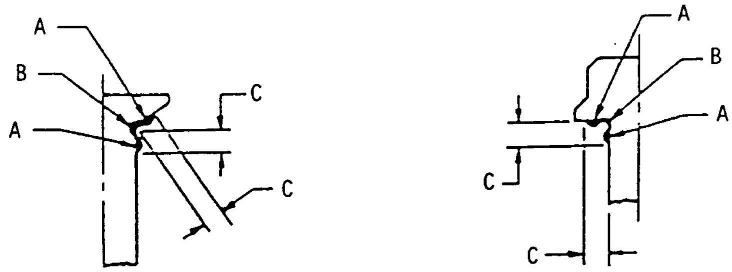
8.2 Direct U.S. Military Procurement

Purchase documents should specify not less than the following:

Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired

8.3 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications nor in documents that contain editorial changes only.



Nominal Bolt Diameter inch	C, maximum inch
Up to 0.3125, excl	0.062
0.3125 and 0.375	0.094
0.4375 to 0.625, incl	0.125
0.750 to 1.000, incl	0.156
Over 1.000	0.188

Figure 1 - Permissible distortion from fillet working

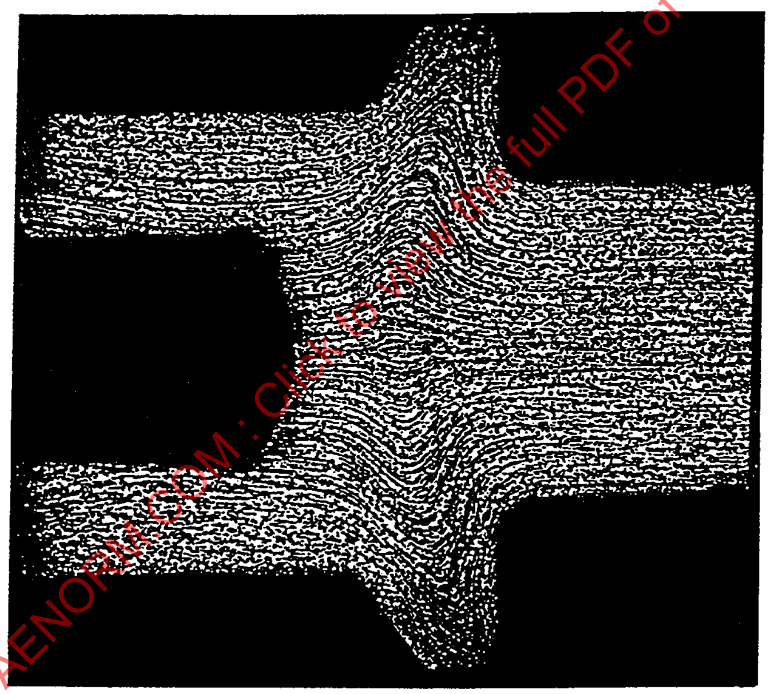


Figure 2A - Satisfactory grain flow, headed blank, before heat treatment
(showing a smooth, well-formed grain flow following the contour of the under head fillet radius)

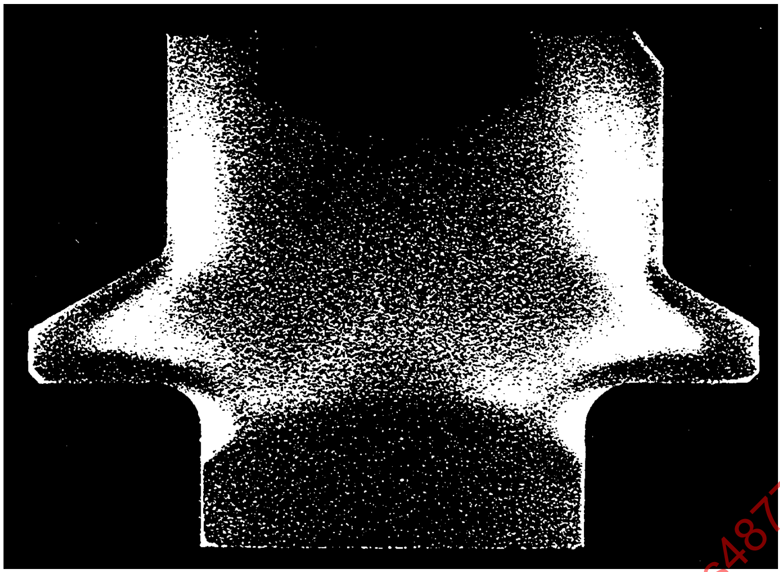


Figure 2B - Head-to-shank section through finished part (shows evidence that head was formed by forging)

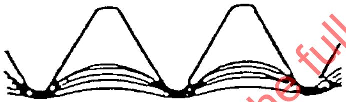


Figure 3 - Flow lines, rolled thread

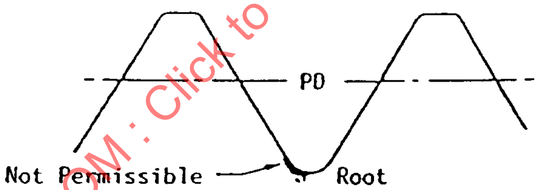


Figure 4 - Root defects, rolled thread

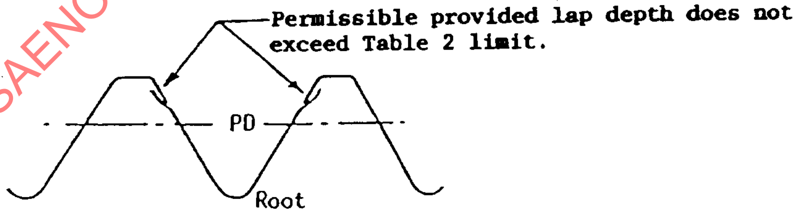


Figure 5 - Laps above pitch diameter extending towards crest, rolled thread

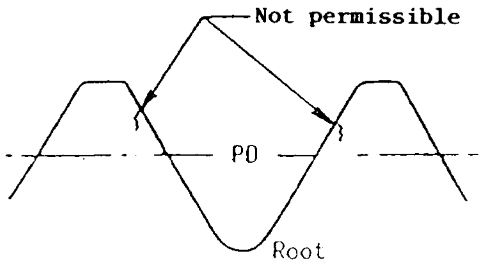


Figure 6 - Laps above PD extending toward root, rolled thread

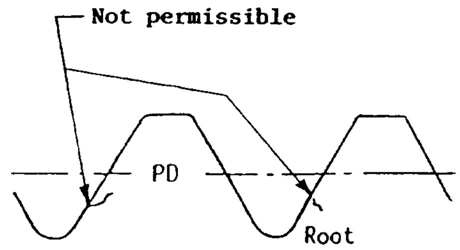
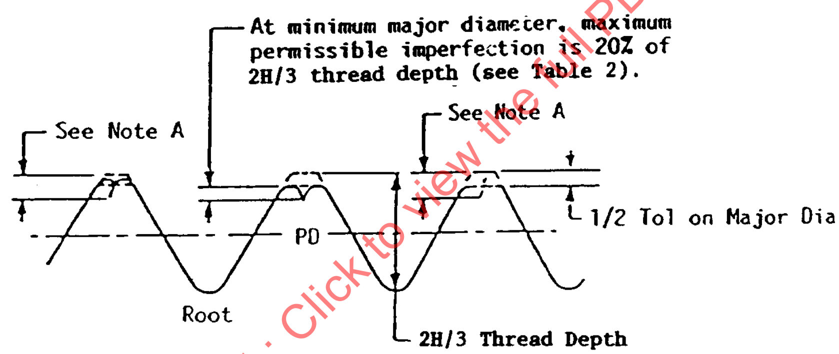


Figure 7 - Laps below PD extending in any direction, rolled thread



Note A: Maximum depth of imperfection equals 20% of 2H/3 thread depth plus 1/2 the difference of the actual major diameter and minimum major diameter.

Figure 8 - Crest craters and crest laps, rolled thread

Table 1 - Test loads

Thread Size	Ultimate Tensile Strength Test Load, lbf min Room Temp.	Ultimate Tensile Strength Test Load, lbf min At 1200 °F	Fatigue Test Load lbf max	Stress-Rupture Test Load lbf	Ultimate Double Shear Test Load lbf min
0.112 -40	1 253	982	---	544	2 187
0.112 -48	1 352	1 060	---	608	2 187
0.138 -32	1 887	1 479	---	816	3 320
0.138 -40	2 073	1 624	---	937	3 320
0.164 -32	2 871	2 250	1 349	1 285	4 690
0.164 -36	2 994	2 347	1 437	1 368	4 690
0.190 -32	4 052	3 176	1 953	1 860	6 294
0.250 -28	7 300	5 722	3 595	3 424	10 900
0.3125-24	11 600	9 090	5 765	5 491	17 030
0.375 -24	17 340	13 590	8 807	8 388	24 520
0.4375-20	23 480	18 410	11 890	11 320	33 370
0.500 -20	31 400	24 610	16 130	15 360	43 590
0.5625-18	38 830	31 220	20 480	19 500	55 170
0.625 -18	49 950	39 150	25 940	24 700	68 110
0.750 -16	72 570	56 880	37 890	36 080	98 080
0.875 -14	99 030	77 620	51 790	49 330	133 500
1.000 -12	129 000	101 100	67 360	64 160	174 400

Note 1: Requirements above apply to parts with UNJ profile threads, to Class 3A tolerances. The area upon which stress for ultimate tensile strength is based is derived from Equation 1 for threads rolled after heat treatment.

$$A_1 = 0.7854(d_3)^2(2 - (d_3/d_2)^2) \quad \text{(Eq.1)}$$

where:

A_1 = Area for ultimate tensile stress
d_2 = Maximum pitch diameter of external thread ($d_2 = d - .649519/n$)
d_3 = Maximum minor (root) diameter of external thread ($d_3 = d - 1.1547/n$)
d = Maximum major diameter of external thread
n = Number of thread pitches per inch

The area upon which stress for maximum fatigue test load and stress-rupture test load is based is derived from Equation 2.

$$A_2 = 0.7854(d_3)^2 \quad \text{(Eq.2)}$$

where:

A_2 = Area for fatigue and stress-rupture stress