SAE The Engineering Society For Advancing Mobility Land Sea Air and Space® INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS7466

REV. A

Issued 1991-01
Revised 1997-03
Reaffirmed 2001-10

Superseding AS7466

Bolts and Screws, Nickel Alloy, UNS N07718
Tensile Strength 185 ksi
Fatigue Rated
Procurement Specification

FSC 5306

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. The following specification designations and their properties are covered:

AS7466	185 ksi minimum ultimate tensile strength at room temperature
	155 ksi minimum ultimate tensile strength at 800 °F
	105 ksi tension to 10.5 ksi tension fatigue at room temperature
AS7466-1	185 ksi minimum ultimate tensile strength at room temperature
	111 ksi minimum ultimate shear strength at room temperature

1.2 Application:

Primarily for aerospace propulsion systems applications where a good combination of tensile strength and fatigue resistance are required; also, where a good combination of tensile strength, and shear 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 take necessary precautionary measures to ensure the health and safety of all personnel involved.

TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790 SAE WEB ADDRESS: http://www.sae.org

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2750	Pyrometry
AMS 5662	Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant, 52.5Ni 19Cr 3.0Mo 5.1(Cb+Ta) 0.90Ti 0.50Al 18Fe, Consumable Electrode or Vacuum Induction Melted, 1775°F (970°C) Solution Heat Treated
AS1132	Design Parameters for Bolts, and Screws - External Wrenching, Unified Threads Inch Series
AS3062	Bolts, Screws, and Studs, Screw Thread Requirements
AS3063	Bolts, Screws, and Studs, Geometric Control Requirements

2.1.2 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 112	Determining Average Grain Size
ASTM E 140	Standard Hardness Conversion Tables for Metals
ASTM E 1417	Liquid Penetrant Examination
ASTM D 3951	Commercial Packaging

2.1.3 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter; General Specification For
MIL-STD-1312-6	Fastener Test Methods, Method 6, Hardness
MIL-STD-1312-8	Fastener Test Methods, Method 8, Tensile Strength
MIL-STD-1312-11	Fastener Test Methods, Method 11, Tension Fatigue
MIL-STD-1312-13	Fastener Test Methods, Method 13, Double Shear Test
MIL-STD-1312-18	Fastener Test Methods, Method 18, Elevated Temperature Tensile Strength

2.1.4 ASME Publication: Available from ASME, 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900.

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

2.2 Definitions:

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

COLD ROLLING: Forming material below the recrystallation temperature.

CRACK: Rupture in the material which may extend in any direction and which may be intercrystalline or transcrystalline in character.

DEFECT: Any nonconformance of the unit of product with specified requirements.

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

DISCONTINUITY: An interruption in the normal physical structure or configuration of a part; such as a lap, seam, inclusion, crack, machining tear, or stringer.

HEAT PATTERN: A discernible difference in etched appearance between the head and shank caused by the plastic forming of the head.

INCLUSION: Nonmetallic particles originating from the material making process. They may exist as discrete particles or strings of particles extending longitudinally.

LAP: Surface imperfection caused by folding over metal fins or sharp corners and then rolling or forging them into the surface. The allowable lap depth shall not exceed the limit specified herein. The minimum condition that shall be rated as a lap is a fold having its length equal to or greater than three times its width with a depth of 0.0005 inch when viewed at 200X magnification.

MACHINING TEAR: A pattern of short, jagged individual cracks, generally at right angles to the direction of machining, frequently the result of improperly set cutting tools, or dull cutting tools.

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 vendor's inspection at the same time.

SEAM: Longitudinal surface imperfection in the form of an unwelded, open fold in the material.

STRINGER: A solid nonmetallic impurity in the metal bar, often the result of inclusions that have been extended during the rolling process.

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.

2.3 Unit Symbols and Abbreviations:

° - 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 AMS 5662 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 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 ANSI/ASME B46.1.

3.2.3 Threads: Screw thread UNJ profile and dimensions shall be in accordance with MIL-S-8879, 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 or cold forging; temperature for hot forging blanks shall be within the range of 1650 to 2000 °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, shall be solution heat treated 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 AMS 2750. The heating medium or atmosphere shall cause no surface hardening by carburizing or nitriding.

3.3.2.2 Solution Heat Treatment: Headed blanks shall be solution heat treated by heating to a temperature within the range 1725 to 1850 °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, blanks shall be precipitation heat treated by heating to 1325 °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 1150 °F ± 15 °F, holding at 1150 °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 1150 °F ± 15 °F, blanks may be furnace cooled at any rate provided the time at 1150 °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 working the underhead 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 headed parts having the radius complete throughout the circumference of the part shall be cold rolled sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold rolling shall conform to Figure 2, 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 2; distorted areas shall not extend beyond “C” as shown in Figure 2. In configurations having an undercut connected with the fillet radius, the cold rolling will be required only for 90° 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° of fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank.

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 not more than 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 plating specification.

3.6 Mechanical Properties:

Where AS7466 is specified, parts shall conform to the requirements of 3.6.1, 3.6.2, 3.6.3, and 3.6.4. Where AS7466-1 is specified, parts shall conform to the requirements of 3.6.1, 3.6.3, and 3.6.5. Threaded members of gripping fixtures for tensile and stress-rupture tests shall be of sufficient size and strength to develop the full strength of the part without stripping the thread.

AS7466 finished parts shall be tested in accordance with the following applicable test methods:

a. Hardness:	MIL-STD-1312-6
b. Ultimate Tensile Strength at Room Temperature:	MIL-STD-1312-8
c. Ultimate Tensile Strength at 800 °F:	MIL-STD-1312-18
d. Fatigue Strength at Room Temperature:	MIL-STD-1312-11

AS7466-1 finished parts shall be tested in accordance with the following test methods:

a. Hardness:	MIL-STD-1312-6
b. Ultimate Tensile Strength at Room Temperature:	MIL-STD-1312-8
c. Ultimate Shear Strength at Room Temperature:	MIL-STD-1312-13

3.6.1 Ultimate Tensile Strength at Room Temperature: 3.6.1.1Finished Parts: Tension bolts, such as hexagon, double hexagon, and spline drive head, 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° 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 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 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 Machine 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 E 8 on specimens as in 4.5.7. 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 800 °F:

3.6.2.1 Finished Parts: Tension bolts heated to 800 °F ± 5 °F, held at heat for 20 minutes before testing, and tested at 800 °F ± 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 155 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° flush head, pan head, and fillister head, are not required to be tested for tensile strength at 800 °F.

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 E 21 on specimens as in 4.5.7. Such specimens shall meet the following requirements when heated to 800 °F ± 5 °F, held at heat for not less than 20 minutes before testing, and tested at 800 °F ± 5 °F:

a. Ultimate Tensile Strength, minimum:	155 ksi
b. Yield Strength at 0.2% Offset, minimum:	130 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 rolling 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 tension bolts tested in tension-tension fatigue at room temperature with maximum load as specified in Table 2A and minimum load equal to 10% of maximum load shall have an 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 bolt is less than the minimum pitch diameter of thread, bolts 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 to tension bolts, such as hexagon, double hexagon, and spline drive heads per design parameters specified in AS1132, 0.164 inch and larger in nominal thread size, and having a head-to-shank fillet radius equal to or larger than that specified in AS1132, and not having an undercut; 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 Ultimate Shear Strength: Finished bolts having a close toleranced full shank as in AS1132 shall have an ultimate double shear load not lower than that specified in Table 2A. 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 screws, such as 100° flush head, having a grip less than 2.5 times the nominal diameter or protruding head screws, such as pan head and fillister head, having a grip less than 2 times the nominal diameter. Shear tests 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, free from burrs (tight burrs may be acceptable if part performance is not affected), from foreign materials, and from imperfections detrimental to the usage of the part.

3.7.1 Macroscopic Examination, Headed Blank: A longitudinal specimen cut from a headed blank shall be etched in a suitable etchant and examined at a magnification of 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, where “D” is the nominal diameter of the shank after heading.

3.7.1.1 Flow Lines: After heading and prior to heat treatment, examination of an etched section taken longitudinally through the blank as in 3.7.1 shall show flow lines or heat pattern in the shank, head-to-shank fillet, and bearing surface which follow the contour of the blank as shown in Figure 1 or Figure 1A. Flow lines or heat pattern 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.

3.7.1.2 Internal Defects: Examination of longitudinal sections of the head and shank shall reveal no cracks, laps, or porosity.

3.7.2 Microscopic Examination, Finished Parts: Specimens cut from finished parts shall be polished, etched in Kalling's reagent, Marble's reagent, or other suitable etchant, and examined at a magnification not lower than 100X to determine conformance to the requirements of 3.7.2.1, 3.7.2.2, 3.7.2.3, 3.7.2.4, 3.7.2.5, and 3.7.2.6.

3.7.2.1 Flow Lines, Threads: Examination of a longitudinal section through the threaded portion of the shank shall show evidence that the threads were rolled (see Figure 3).

3.7.2.2 Internal Defects: Examination of longitudinal sections of the head and shank shall reveal no cracks, laps, or porosity. Thread imperfections shall conform to the requirements of 3.7.2.6.

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

3.7.2.4 Grain Size: The grain size shall be ASTM No. 3 or finer, determined in accordance with the comparative method of ASTM E 112. In case of disagreement, the intercept (Heyn) procedure shall be used.

3.7.2.5 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 30 points shall be evidence of nonconformance to this requirement.

3.7.2.6 Threads:

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

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

3.7.2.6.3 Single Lap on Thread Profile: Shall conform to the following:

a. Thread Flank Above the Pitch Diameter: A single lap is permissible along the flank of the thread above the pitch line 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 1 for the applicable thread pitch. A lap extending toward the root is not permissible (see Figure 6).

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

c. 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 1 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 1 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: Prior to any required plating or coating, parts shall be subject to fluorescent penetrant inspection in accordance with ASTM E 1417, Type I, Sensitivity Level 2 minimum.

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° to the axis of the shank), such as grinding checks and cracks.

3.7.3.1.2 Longitudinal indications (i.e., at an angle of 10° 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° 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 is not less than 0.062 inch in all directions.

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 1), 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 3.7.2.6.

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 800 °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 AMS 5662.

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 Macroscopic Examination: A random sample of one part 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 the 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 E 8. 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.

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, hardness, ultimate shear property where applicable, and fatigue strength requirements, and stating that the parts conform to the other technical requirements. This report shall include the purchase order number, AS7466, 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 shall perform corrective action to screen out or rework the defective parts, resubmit for acceptance tests inspection as in Table 3, or scrap the entire lot. Resubmitted lots shall be clearly identified as reinspected lots.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Packaging shall be in accordance with ASTM D 3951.

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

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

FASTENERS, NICKEL BASE ALLOY, UNS N07718, FATIGUE RATED
AS7466 (or AS7466-1, as applicable)
PART NUMBER
LOT NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

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

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:

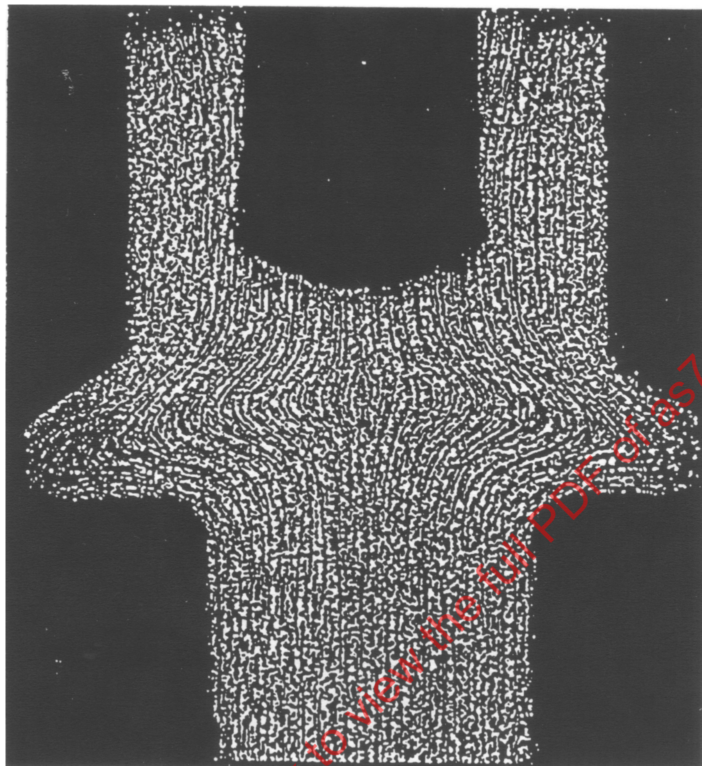
8.1 Hardness conversion tables for metals are presented in ASTM E 140.

8.2 Key Words:

Bolts, Procurement Specification

8.3 The change bar (|) 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.

PREPARED BY SAE COMMITTEE E-25,
GENERAL STANDARDS FOR AEROSPACE PROPULSION SYSTEMS



Showing a smooth, well formed grain flow following the contour of the head-to-shank fillet radius.

FIGURE 1 - Satisfactory Grain Flow, Headed Blank, Before Heat Treatment

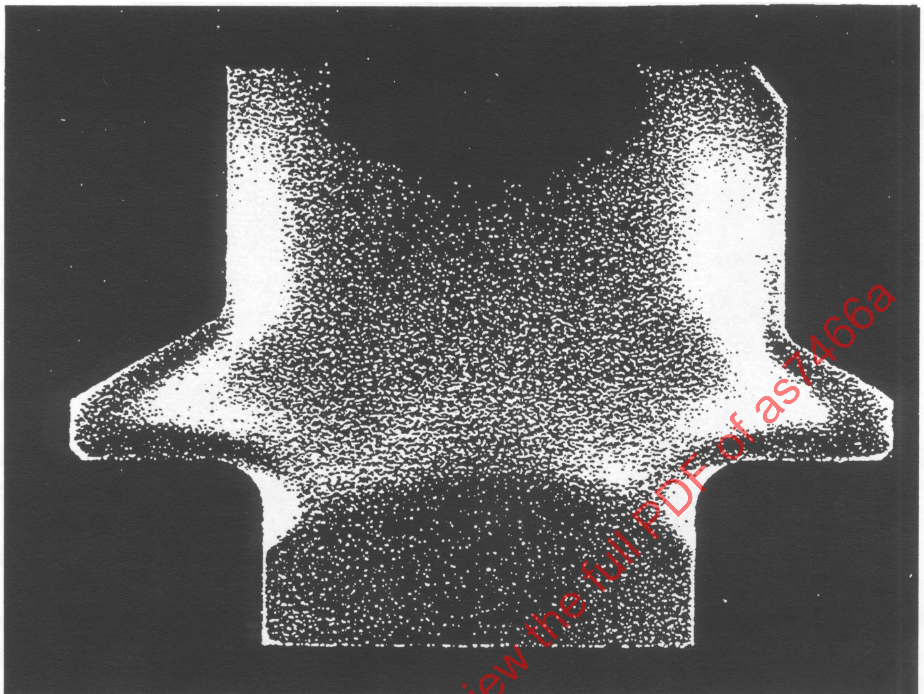
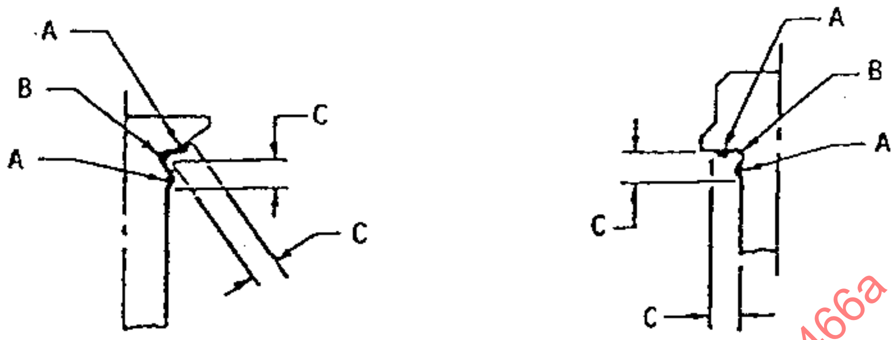


FIGURE 1A - Satisfactory Heat Pattern,
Headed Blank, Before Heat Treatment



Nominal Bolt Diameter, inch	C, max inch
Up to 0.3125, excl	0.062
0.3125 & 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 2 - Permissible Distortion From Fillet Working

FIGURE 3 - Flow Lines, Rolled Thread

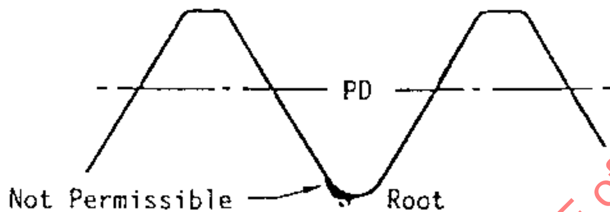


FIGURE 4 - Root Defects, Rolled Thread

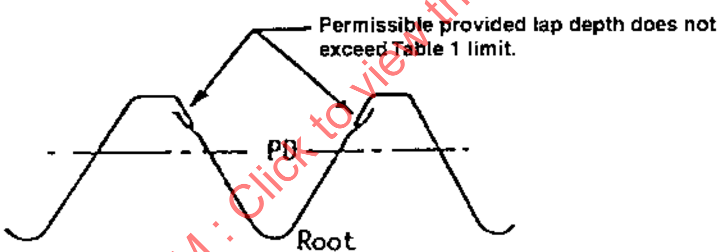


FIGURE 5 - Laps Above Pitch Diameter Extending Towards Crest, Rolled Thread

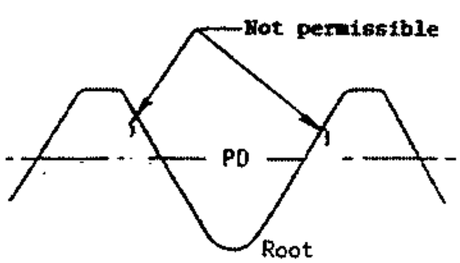


FIGURE 6 - Laps Above PD Extending Toward Root, Rolled Thread

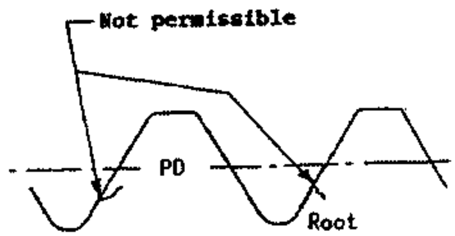


FIGURE 7 - Laps Below PD Extending in Any Direction, Rolled Thread

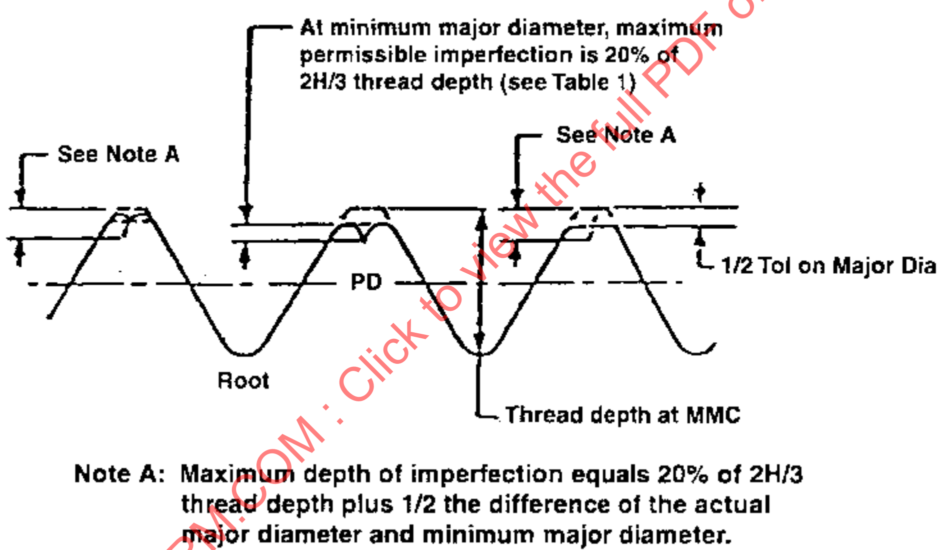


FIGURE 8 - Crest Craters and Crest Laps, Rolled Thread

TABLE 1 - UNJ Ext Thread Depth at 2H/3 and Allowable Thread Lap Depth

Thread Pitches Per Inch n	UNJ Ext Thread Depth at 2H/3 inch	Allowable Thread Lap Depth inch
40	0.0144	0.0029
36	0.0160	0.0032
32	0.0180	0.0036
28	0.0206	0.0041
24	0.0241	0.0048
20	0.0289	0.0058
18	0.0321	0.0064
16	0.0361	0.0072
14	0.0412	0.0082
13	0.0444	0.0089
12	0.0481	0.0096
11	0.0525	0.0105
10	0.0577	0.0115
9	0.0642	0.0128
8	0.0722	0.0144

NOTE 1: Allowable lap depth is based upon 20% of UNJ external thread depth at 2H/3 in accordance with MIL-S-8879, and is calculated as follows:

Ext thd depth = 2H/3 = (2/3) (cos 30°)/n = 0.57735/n
Lap depth = 0.2(2H/3) = 0.2(2/3)(cos 30°)/n = 0.11547/n

TABLE 2A - Test Loads for Bolts

Thread Size UNJC, UNJF Class 3A	Ultimate Tensile Strength Test Load, lbf min Room Temp.	Ultimate Tensile Strength Test Load, lbf min at 800 °F	Fatigue Strength Test Load lbf max at Room Temp.	Ultimate Double Shear Test Load lbf min Room Temp.
0.112 -40	1116	935	---	2187
0.112 -48	1222	1024	---	2187
0.138 -32	1681	1408	---	3320
0.138 -40	1876	1572	---	3320
0.164 -32	2592	2171	1349	4690
0.164 -36	2725	2283	1435	4690
0.190 -32	3699	3099	1954	6294
0.250 -28	6729	5638	3594	10900
0.3125-24	10742	9000	5765	17030
0.375 -24	16248	13610	8812	24520
0.4375-24	21960	18400	11890	33370
0.500 -20	29590	24790	16130	43590
0.5625-18	37550	31460	20480	55170
0.625 -18	47350	39670	25940	68110
0.750 -16	69000	57810	37890	98080
0.875 -14	94250	78970	51800	133500
1.000 -12	122700	102800	67360	174400

NOTE 1: Requirements above apply to parts with UNJC or UNJF threads as applicable for thread sizes shown, to Class 3A tolerances. The diameter of the area upon which stress for ultimate tensile strength test load is based is the UNJ basic minor diameter at 0.5625H thread depth, where H is the height of sharp V-thread, calculated from Equation 1:

$$A_1 = .7854(d - 1.125H)^2 = 0.7854[d - (0.9743/n)]^2 \qquad \text{(Eq.1)}$$

where, A_1 = area at UNJ basic minor diameter at 0.5625H thread depth
d = maximum major diameter
H = height of sharp V-thread = (cos 30°)/n
n = number of thread pitches per inch

The diameter of the area upon which stress for fatigue strength test load requirements is based is the area at the maximum minor (root) diameter for UNJ thread at 2H/3 thread depth, calculated from Equation 2:

$$A_2 = 0.7854[d - (4H/3)]^2 = 0.7854[d - (1.1547/n)]^2 \qquad \text{(Eq.2)}$$

where, A_2 = area at maximum minor (root) diameter of UNJ thread at 2H/3 thread depth
d = maximum major diameter
H = height of sharp V-thread = (cos 30°)/n
n = number of thread pitches per inch