AEROSPACE STANDARD	AS7459™	REV. C
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Bolts and Screws, Steel UNS K14675 Tensile Strength 195 ksi Fatigue and Stress-Rupture Rated Procurement Specification

FSC 5306

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

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NOTICE

This document references a part which contains cadmium as a plating material. Consult local officials if you have questions concerning cadmium's use.

1. SCOPE

1.1 Type

This procurement specification covers bolts and screws made from a low alloy, heat resistant steel of the type identified under the Unified Numbering System as UNS K14675, having UNJ profile threads. The following specification designations and their properties are covered

AS7459	195 ksi minimum ultimate tensile strength at room temperature 145 ksi minimum ultimate tensile strength at 900 °F 105 ksi stress rupture strength at 900 °F for 100 hours 100 ksi tension to 10 ksi tension fatigue at room temperature Protective treatment to be specified on part drawing
AS7459-1	AS7459 part plated per AMS2416, nickel-cadmium diffused plating
AS7459-2	195 ksi minimum ultimate tensile strength at room temperature 117 ksi minimum ultimate shear strength at room temperature Protective treatment to be specified on part drawing
AS7459-3	AS7459-2 part plated per AMS2416, nickel-cadmium diffused plating

1.2 Application

Primarily for aerospace propulsion system applications where high strength at temperatures up to approximately 900 °F is required and the part is protected against corrosion.

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 the 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 724-776-4970 (outside USA), www.sae.org

AMS2416 Plating, Nickel-Cadmium, Diffused

AMS2750 Pyrometry

AMS6304 Low Alloy Steel, Heat Resistant, Bars, Forgings, and Tubing 0.95Cr-0.55Mo-0.30V (0.40-0.50C)

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

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

2.1.2 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 973-358-1000, www.aia-aerospace.org.

NASM1312-6 Fastener Test Methods, Method 6, Hardness

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

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

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

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

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

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 601-832-9585, www.astm.org.

ASTM E8	Tension Testing of Metallic Materials
ASTM E21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E140	Standard Hardness Tables for Metals
ASTM E1444	Magnetic Particle Examination
ASTM D3951	Commercial Packaging

2.1.4 ASME Publications

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

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.

INCLUSION: Non-metallic 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 manufacturer's inspection at the same time.

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

STRINGER: A solid non-metallic 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

°F - degree Fahrenheit

HRC - hardness Rockwell C scale

% - percent (1% = 1/100)

lbf - pounds force

ksi - kips (1000 pounds) per square inch

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS6304 steel.

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 or coating, shall conform to the requirements as specified on the part drawing. Dimensions shall 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 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; 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 working the head-to-shank fillet radius, and rolling the threads, shall be heat treated as follows

3.3.2.1 Heating Equipment

Furnaces may be of 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 neither surface hardening nor decarburization other than that permitted by 3.7.2.2 and 3.7.2.3.

3.3.2.2 Hardening

Headed blanks shall be uniformly heated to 1750 °F ± 25 °F, held at heat for 60 to 90 minutes and quenched in oil or water.

3.3.2.3 Tempering

Hardened blanks shall be tempered by heating uniformly to a temperature not lower than 1000 °F, holding at heat for not less than 6 hours, and cooling in air.

3.3.3 Oxide and Decarburization Removal

Surface oxide and oxide penetration, and decarburization except as permitted in 3.7.2.3, resulting from 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 and rolling the threads. The 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 and decarburization 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 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 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. 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.

3.3.5 Thread Rolling

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

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 AS7459 and AS7459-2 is specified, any protective treatment shall be as specified on the part drawing. Where AS7459-1 is specified, parts in accordance with AS7459 shall be nickel-cadmium diffused plated in accordance with AMS2416. Where AS7459-3 is specified, parts in accordance with AS7459-2 shall be nickel-cadmium diffused plated in accordance with AMS2416. Plating thickness determined in accordance with plating specification.

3.6 Mechanical Properties

Where AS7459 and AS7459-1 are specified, parts shall conform to the requirements of 3.6.1, 3.6.2, 3.6.4, and 3.6.5, and 3.6.6. Where AS7459-2 and AS7459-3 are specified, parts shall conform to the requirements of 3.6.1, 3.6.3, and 3.6.4. 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.

AS7459 and AS7459-1 finished parts shall be tested in accordance with the following applicable test methods:

a. HardnessMIL-STD-1312-6 in accordance with NASM1312-6.

b. Ultimate Tensile Strength at Room TemperatureMIL-STD-1312-8 in accordance with NASM1312-8.

c. Stress-Rupture Strength at 900 °FMIL-STD-1312-10 in accordance with NASM1312-10.

d. Fatigue Strength at Room TemperatureMIL-STD-1312-11 in accordance with NASM1312-11.

e. Ultimate Tensile Strength at 900 °FMIL-STD-1312-18 in accordance with NASM1312-18.

AS7459-2 and AS7459-3 finished parts shall be tested in accordance with the following applicable test methods:

a. HardnessMIL-STD-1312-6 in accordance with NASM1312-6.

b. Ultimate Tensile Strength at Room TemperatureMIL-STD-1312-8 in accordance with NASM1312-8.

c. Ultimate Double Shear Strength at Room TemperatureMIL-STD-1312-13 in accordance with NASM1312-13.

3.6.1 Ultimate Tensile Strength at Room Temperature

3.6.1.1 Finished 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 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 thread root diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 195 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 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 on specimens prepared as in 4.5.7. Such specimens shall meet the following requirements:

a. Ultimate Tensile Strength, minimum195 ksi

b. Elongation in 4D, minimum 10%

c. Reduction of Area, minimum 30%

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

3.6.2 Ultimate Tensile Strength at 900 °F

3.6.2.1 Finished Parts

Tension bolts heated to 900 °F ± 3 °F, held at heat for 30 minutes before testing, and tested at 900 °F ± 3 °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 thread root 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 hexagon, double hexagon or spline drive 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.

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 prepared as in 4.5.7. Such specimens shall meet the following requirements when heated to 900 °F ± 3 °F, held at heat for not less than 30 minutes before testing, and tested at 900 °F ± 3 °F:

a. Ultimate Tensile Strength, minimum145 ksi

b. Elongation in 4D, minimum 10%

c. Reduction of Area, minimum 30%

3.6.3 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 minimum 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 117 ksi minimum shear strength. Shear tests are not required for screws, such as 100 degree 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 test is 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.

3.6.4 Hardness

Shall be uniform and within the range 42 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 strength properties in 3.6.1, fatigue strength in 3.6.5, and stress-rupture strength in 3.6.6 are met.

3.6.5 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 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 the thread, parts shall withstand fatigue testing as above using loads sufficient to produce a maximum stress of 100 ksi and a minimum stress of 10 ksi. The above requirements apply only to tension bolts, such as hexagon, double hexagon, and spline drive heads per design parameters specified in AS1132, 0.138 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.

3.6.6 Stress-Rupture Strength at 900 °F

3.6.6.1 Finished Parts

Finished tension bolts, maintained at 900 °F ± 3 °F while the tension load specified in Table 2A is applied continuously, shall not rupture in less than 100 hours. If the shank diameter of the bolt is less than the maximum minor (root) diameter of the thread but the part can be tested satisfactorily, bolts shall conform to the requirements of 3.6.6.1.1. Screws, such as 100 degree flush head, pan head, and fillister head, are not required to be tested for stress-rupture strength at 900 °F.

3.6.6.1.1 Bolts having a shank diameter less than the maximum minor (root) diameter of the thread shall be tested as in 3.6.6.1 except that the load shall be as specified in 3.6.6.2. The diameter of the area on which stress is based shall be the actual measured minimum diameter of the part.

3.6.6.2 Machined Test Specimens

If the size or shape of the bolt is such that a stress-rupture test cannot be made on the part, a test specimen prepared as in 4.5.7, maintained at 900 °F ± 3 °F while a load sufficient to produce an initial axial stress of 105 ksi is applied continuously, shall not rupture in less than 100 hours. Tests shall be conducted in accordance with ASTM E139.

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, Headed Blank

A 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 shall show flow lines in the shank, head-to-shank fillet, and bearing surface which follow the contour of the blank as shown in Figure 1. 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.

3.7.1.2 Internal Defects

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

3.7.2 Microscopic Examination

Specimens cut from parts shall be polished, etched in 2% Nital, and examined at 100X magnification 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

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 tempered martensite.

3.7.2.4 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. There shall be no evidence of carburization or nitriding. 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.

3.7.2.5 Decarburization

3.7.2.5.1 The bearing surface of the head, the head-to-shank fillet radius, the shank, and the threads shall be free from decarburization.

3.7.2.5.2 Depth of decarburization on those surfaces of the head which are the original surfaces of the bar shall be not greater than that permitted by the applicable material specification for the size of stock used to make the part.

3.7.2.5.3 Depth of decarburization on the OD of the head of cylindrical head parts is not restricted.

3.7.2.5.4 Depth of decarburization at any point on the surface not covered by 3.7.2.5.1, 3.7.2.5.2, or 3.7.2.5.3 shall not exceed 0.002 inch.

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 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 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 diameter, 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 Magnetic Particle Inspection

Prior to any required plating or coating, parts shall be subject to magnetic particle inspection in accordance with ASTM E1444; any method may be used but resolution of disputed rejections shall be based upon the wet, continuous, fluorescent suspension method.

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 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 is not less than 0.062 inch in all directions.

3.7.3.2.2 Sides of Head

There shall be not more than six indications or subsurface 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 2H/3 thread depth (see Table 1), whichever is less.

3.7.3.2.3 Shank or Stem

There shall be not more than 10 subsurface and hairline surface 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 manufacturer 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 manufacturer or purchaser. Ultimate tensile strength test at 900 °F in 3.6.2, fatigue strength test in 3.6.5, and stress-rupture test in 3.6.6 are classified as periodic test and shall be performed at a frequency selected by the manufacturer unless frequency of testing is specified by purchaser.

4.5 Acceptance Test Sampling

4.5.1 Material

Sampling for material composition on each heat shall be in accordance with AMS6304.

4.5.2 Non-Destructive 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 Magnetic Particle 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 non-destructive tests and the magnetic particle 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 testing of machined test specimens shall be of standard proportions in accordance with ASTM E8. 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 manufacturer.

4.7 Reports

The manufacturer 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, and stating that the parts conform to the other technical requirements. This report shall include the purchase order number, AS7459B, 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 re-inspected lots.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Identification

5.1.1 Packaging shall be in accordance with ASTM D3951.

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

BOLTS (SCREWS), STEEL, LOW ALLOY, CLASSIFICATION 195 ksi/900 °F
AS7459B (or AS7459-1B, -2B, -3B, as applicable)
PART NUMBER
LOT NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

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

6. ACKNOWLEDGMENT

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

7. REJECTIONS

Parts not conforming to this specification shall be subject to rejection.

8. NOTES

8.1 Hardness Conversion Tables

Hardness conversion tables for metals are presented in ASTM E140.

8.2 A 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, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only

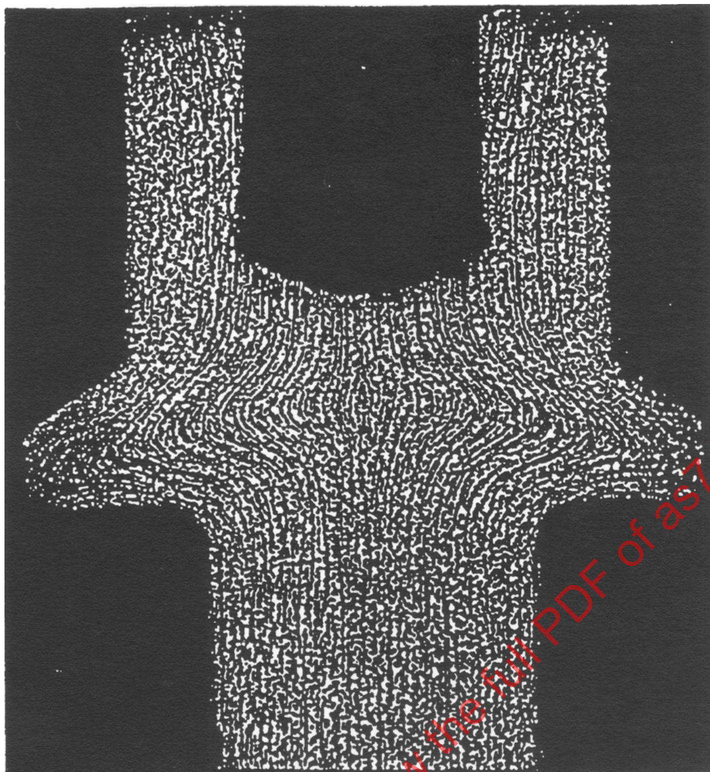
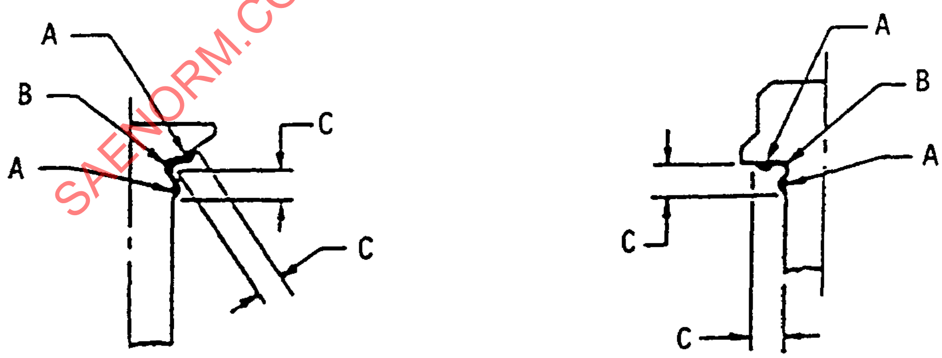


FIGURE 1 - SATISFACTORY GRAIN FLOW, HEADED BLANK, BEFORE HEAT TREATMENT

SHOWING A SMOOTH, WELL FORMED GRAIN FLOW FOLLOWING THE CONTOUR OF THE HEAD-TO-SHANK FILLET RADIUS.



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 2 - PERMISSIBLE DISTORTION FROM FILLET WORKING

FIGURE 3 - FLOW LINES, ROLLED THREAD

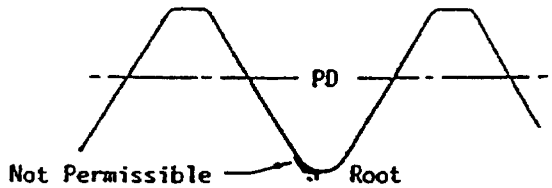


FIGURE 4 - ROOT DEFECTS, ROLLED THREAD

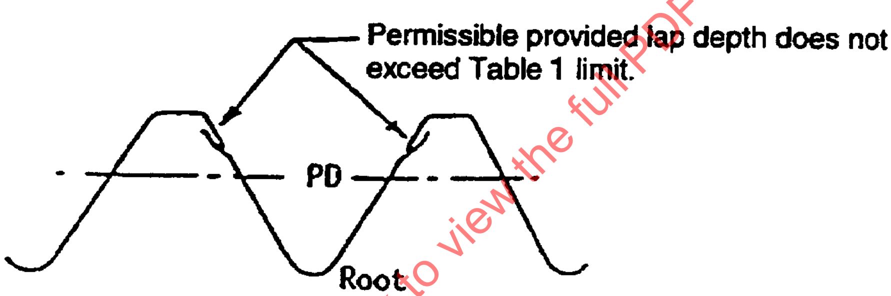


FIGURE 5 - LAPS ABOVE PITCH DIAMETER EXTENDING TOWARDS CREST, ROLLED THREAD

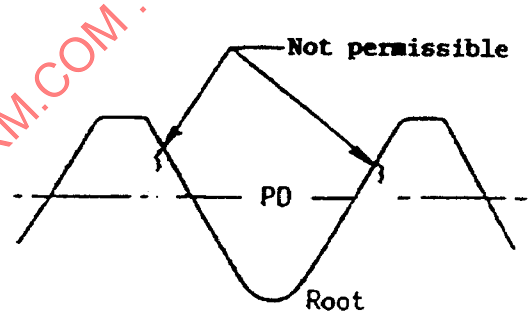


FIGURE 6 - LAPS ABOVE PD EXTENDING TOWARD ROOT, ROLLED THREAD

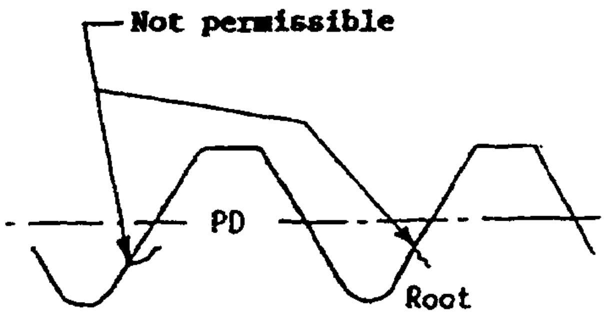
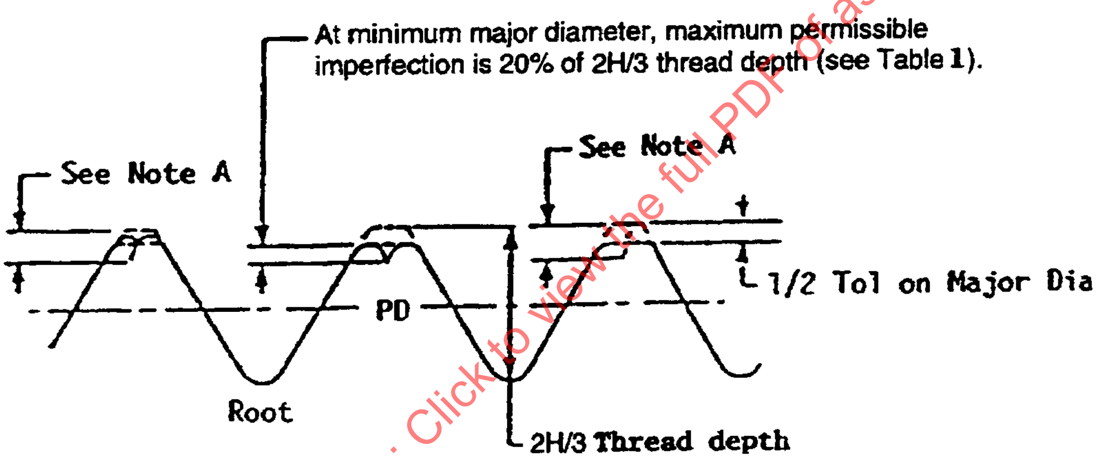


FIGURE 7 - LAPS BELOW PD EXTENDING IN ANY DIRECTION, ROLLED THREAD



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

FIGURE 8 - CREST CRATERS & CREST LAPS, ROLLED THREAD

TABLE 1 – UNJ EXTERNAL THREAD DEPTH AT 2H/3 AND ALLOWABLE THREAD LAP DEPTH

Thread Pitches Per Inch n	UNJ External 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: Allowable lap depth is based upon 20% of UNJ external thread depth at 2H/3 in accordance with AS8879, and is calculated as follows:

2H/3 external thread depth = (2/3) (cosine 30°)/n = 0.57735/n
Lap Depth = 0.2(2H/3) = 0.2(2/3)(cosine 30°)/n = 0.11547/n

TABLE 2A – TEST LOADS FOR BOLTS

Thread Size	Ultimate Tensile Strength Test Load, lbf min Room Temp.	Ultimate Tensile Strength Test Load, lbf min At 900 °F	Fatigue Test Load lbf max Room Temp.	Stress-Rupture Test Load lbf At 900 °F	Ultimate Double Shear Test Load lbf min
0.112 -40	1180	875	--	570	2300
0.112 -48	1290	958	--	638	2300
0.138 -32	1770	1320	816	857	3500
0.138 -40	1980	1470	935	982	3500
0.164 -32	2730	2030	1290	1350	4940
0.164 -36	2870	2140	1370	1440	4940
0.190 -32	3900	2900	1860	1950	6640
0.250 -28	7090	5270	3420	3590	11 500
0.3125-24	11 300	8420	5490	5760	17 900
0.375 -24	17 100	12 700	8390	8810	25 800
0.4375-20	23 100	17 200	11 300	11 900	35 200
0.500 -20	31 200	23 200	15 400	16 100	45 900
0.5625 -18	39 600	29 400	19 500	20 500	58 200
0.625 -18	49 900	37 100	24 700	25 900	71 800
0.750 -16	72 700	54 100	36 100	37 900	103 400
0.875 -14	99 300	73 900	49 300	51 800	140 700
1.000 -12	129 000	96 100	64 200	67 400	183 800

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 on which stress for room temperature and 900 °F ultimate tensile strength test load requirements is based is the UNJ basic minor diameter at 0.5625H thread depth, where H is the height of sharp V-thread, and its area is calculated from Equation 1:

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

where:

A_1 = area for ultimate tensile stress

D = maximum major diameter of external thread

H = height of sharp V-thread = (cos 30°)/n

N = number of thread pitches per inch

TABLE 2A (CONTINUED)

NOTE 1 (Continued):

The diameter of the area on which stress for maximum fatigue test load and stress-rupture test load is based is the maximum minor (root) diameter for UNJ profile at 2H/3 thread depth and its area is calculated from Equation 2:

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

where:

A_2 – area for fatigue and stress-rupture stress
H = height of sharp V-thread = (cos 30°)/n
D = maximum major diameter
N = number of thread pitches per inch

The diameter of the area upon which stress for ultimate double shear test load requirements is based is the nominal diameter of the close tolerance full shank bolt, calculated from Equation 3:

$$A_3 = 0.7854(d)^2 \quad \text{(Eq.3)}$$

where:

A_3 = area for ultimate shear stress
d = nominal diameter of close tolerance full shank

Load requirements are based on:

195 ksi for bolt ultimate tensile strength test load, minimum, room temperature
145 ksi for bolt ultimate tensile strength test load, minimum, at 900 °F
100 ksi for fatigue strength test load, maximum; minimum test load equals 10% of maximum test load
105 ksi for stress-rupture strength test load, at 900 °F
117 ksi for ultimate double shear test load, minimum, at room temperature

Test loads in lbf are computed as follows:

$(195000)A_1$ = ultimate tensile strength test load, room temperature
$(145000)A_1$ = ultimate tensile strength test load, at 900 °F
$(100000)A_2$ = fatigue strength test load, maximum
$(105000)A_2$ = stress-rupture test load
$(117000)2A_3$ = ultimate double shear test load

NOTE 2: For UNJ sizes not shown, and for parts other than Class 3A tolerances, test loads for parts tested as parts, not as speciments machined from parts or from coupons of the stock, shall be based upon the respective areas and stresses given in Note 1. The area of the unthreaded shank shall be used for computing test loads for ultimate tensile, fatigue and stress-rupture where the shank area is less than the stress areas of the thread as given in Note 1, Equation 1 or Equation 2.