SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS7474 REV. C

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Revised 2011-10

Superseding AS7474B

Bolts and Screws, Steel, Corrosion Resistant, UNS S17400 Tensile Strength 140 ksi Procurement Specification

FSC 5306

RATIONALE

To revise paragraph 3.6 by adding "two to" three threads in agreement with NASM1312 test methodology and general updating of specifications and SAE formatting requirements also tables 1 to 7 have been redrawn.

1. SCOPE

1.1 Type

This specification covers bolts and screws made from a corrosion and heat resistant, martensitic iron base alloy of the type identified under the Unified Numbering System as UNS S17400. The following specification designations and their properties are covered:

AS7474	140 ksi minimum ultimate tensile strength at room temperature 100 ksi stress corrosion test 72 ksi to 7.2 ksi tension-tension fatigue
AS7474-1	140 ksi minimum ultimate tensile strength at room temperature 100 ksi stress corrosion test 88 ksi minimum ultimate shear strength at room temperature

1.2 Application

Primarily for aerospace propulsion system applications where corrosion resistance and high strength in tension is required in temperatures not to exceed 600 °F.

1.3 Safety - Hazardous Materials

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

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SAE values your input. To provide feedback on this Technical Report, please visit http://www.sae.org/technical/standards/AS7474C

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

AMS2700 Passivation of Corrosion Resistant Steels

AMS2759/3 Heat Treatment Precipitation-Hardening Corrosion-Resistant and Maraging Steel Parts

AMS5643 Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing, and Rings 16Cr 4.0Ni 0.30Cb 4.0Cu Solution Heat Treated, Precipitation Hardenable

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

AS3062 Bolts, Screws, and Studs, Screw Thread Requirements

AS3063 Bolts, Screws, and Studs, Geometric Control Requirements

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

2.1.2 AIA Publications

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

NASM 1312-6 Fastener Test Methods, Method 6, Hardness

NASM 1312-8 Fastener Test Methods, Method 8, Tensile Strength

NASM 1312-9 Fastener Test Methods, Method 9, Stress Corrosion

NASM 1312-11 Fastener Test Methods, Method 11, Tension Fatigue

NASM 1312-12 Fastener Test Methods, Method 12, Thickness of Metallic Coatings

NASM 1312-13 Fastener Test Methods, Method 13, Double Shear Test

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 E 8 Tension Testing of Metallic Materials

ASTM E 140 Standard Hardness Tables for Metals

ASTM E 1417 Liquid Penetrant Examination

ASTM D 3951 Commercial Packaging

2.1.4 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O.Box 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.

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 vendor's inspection at the same time.

2.3 Unit Symbols

°C degree Celsius

°F degree Fahrenheit

cm^3 cubic centimeter

g gram (mass)

HRC hardness, Rockwell C scale

% percent (1% = 1/100)

h hour

lbf pound-force

ksi kips (1000 pounds) per square inch

sp gr specific gravity

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS5643 steel 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 or coating, shall conform to the requirements as specified on 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 Threads

Incomplete threads are permissible at the chamfered 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; machined heads are not permitted, except lightening holes may be produced by any suitable method. Wrenching recesses may be forged or machined.

3.3.2 Heat Treatment

Shall conform to the technical requirements and other provisions specified in AMS2759/3 for 17-4PH, condition H 1100 treatment.

3.3.2.1 Solution Heat Treatment

Blanks shall be solution heat treated as in 3.3.2.

3.3.2.2 Aging Heat Treatment

Solution treated blanks shall be heat treated by aging as in 3.3.2. In no case shall material be re-aged between 700 °F and 1050 °F.

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 aged heat treated blanks prior to cold rolling the under head 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 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.

3.3.5 Thread Rolling

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

3.3.6 Passivation Treatment

Parts, after finishing, shall be degreased and then subjected to the passivation treatment and copper sulfate test in accordance with AMS2700.

3.4 Product Marking

Each part shall be identification marked as specified by the part drawing. Unless otherwise specified on 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 on the part drawing. Thickness determined in accordance with MIL-STD-1312-12 in accordance with NASM1312-12.

3.6 Mechanical Properties

Where AS7474 is specified, parts shall conform to the requirements of 3.6.1, 3.6.2, 3.6.3, and 3.6.4. Where AS7474-1 is specified, parts shall conform to the requirements of 3.6.1, 3.6.2, 3.6.4, and 3.6.5. Threaded members of gripping fixtures for tensile, fatigue, and stress corrosion 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 a minimum of two to three full thread turns from the thread runout exposed between the loading fixtures during tensile, fatigue, and stress corrosion tests.

AS7474 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. Stress Corrosion at Room Temperature: MIL-STD-1312-9 in accordance with NASM1312-9.

d. Fatigue Strength at Room Temperature: MIL-STD-1312-11 in accordance with NASM1312-11.

AS7474-1 finished parts shall be tested in accordance with the following test methods:

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

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

g. Stress Corrosion at Room Temperature: MIL-STD-1312-9 in accordance with NASM1312-9.

h. Ultimate Double Shear 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 140 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 E 8 on specimens prepared as in 4.4.7. Specimens may be required by the purchaser to perform confirmatory tests. Such specimens shall meet the following requirements:

a. Ultimate Tensile Strength, minimum: 140 ksi

b. Yield Strength at 0.2% Offset, minimum: 120 ksi

c. Elongation in 2 inch or 4D, minimum: 14%

d. Reduction of Area, minimum: 45%

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 Hardness

Shall be uniform and within the range 32 to 38 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.

3.6.3 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 the thread, parts shall withstand fatigue testing as above using loads sufficient to produce a maximum stress of 72 ksi and a minimum stress of 7.2 ksi. The above requirements apply only to parts 0.138 inch and larger in nominal thread size with round, square, hexagonal, or double hexagonal 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.

3.6.4 Stress Corrosion

Finished parts conforming to the fluorescent penetrant inspection standards of 3.7.3 and loaded as specified in Table 1 shall withstand, without cracking, immersion for 4 h at room temperature in a solution of not less than 50% by volume of hydrochloric acid (sp gr 1.19) and 50% by volume of a solution of distilled water to which is added 10 g selenium dioxide per 1000 cm^3 of solution.

3.6.5 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 double 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 88 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 is not required for the following conditions:

a. Bolts or screws threaded to head

b. Protruding head bolts having coarse tolerance full shank

c. Protruding head bolts having a PD or relieved shank

3.7 Quality

Parts shall be uniform in quality and condition, free from burrs and foreign materials, and free from imperfections detrimental to the usage of the parts.

3.7.1 Macroscopic Examination

Specimens cut 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.

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 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.

3.7.1.1.2 Head-To-Shank, Finished Part

Examination of a longitudinal section through the part shall show evidence that the heads were formed by forging (see Figure 1A).

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 3.7.2.3 shall be examined in accordance with 3.7.2. 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 part shall be sectioned and examined as a whole.

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), 20 cm^3 of water, and 4 g of cupric sulfate pentahydrate], 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, and 3.7.2.3.

3.7.2.1 Microstructure

Parts shall have microstructure of tempered martensite free from a continuous delta ferrite network. Delta ferrite shall not exceed 5% in the matrix.

3.7.2.2 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 rolling of threads. Parts shall show 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.

3.7.2.3 Threads

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

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

3.7.2.3.3 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 length or depth when viewed at 200X magnification.

b. Thread Flank Above the Pitch Diameter: A slight 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 towards 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

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.

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 3.7.2.3. Rateable lap indications shall conform to 3.7.2.3.3(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 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.

4.3.1 Tests for all technical requirements are acceptance tests and shall be performed on each production inspection lot. A summary of acceptance tests is specified in Table 3.

4.4 Acceptance Test Sampling

4.4.1 Material

Sampling for material composition on each heat shall be in accordance with AMS5643.

4.4.2 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.

4.4.3 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.

4.4.4 Stress Corrosion Test

A random sample of three parts shall be selected from each production inspection lot.

4.4.5 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.

4.4.6 Acceptance Quality

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

4.4.7 Test Specimens

Specimens for tensile testing of machined test specimens shall be of standard proportions in accordance with ASTM E 8 with either 0.25 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.

4.5 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, fatigue, stress corrosion, and double shear test (if required), and stating that the parts conform to the other technical requirements. This report shall include the purchase order number, AS7474C (or AS7474-1 if applicable), lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.6 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, STEEL, CORROSION RESISTANT
AS7474C or AS7474-1 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 inspection 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 E 140.

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.

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

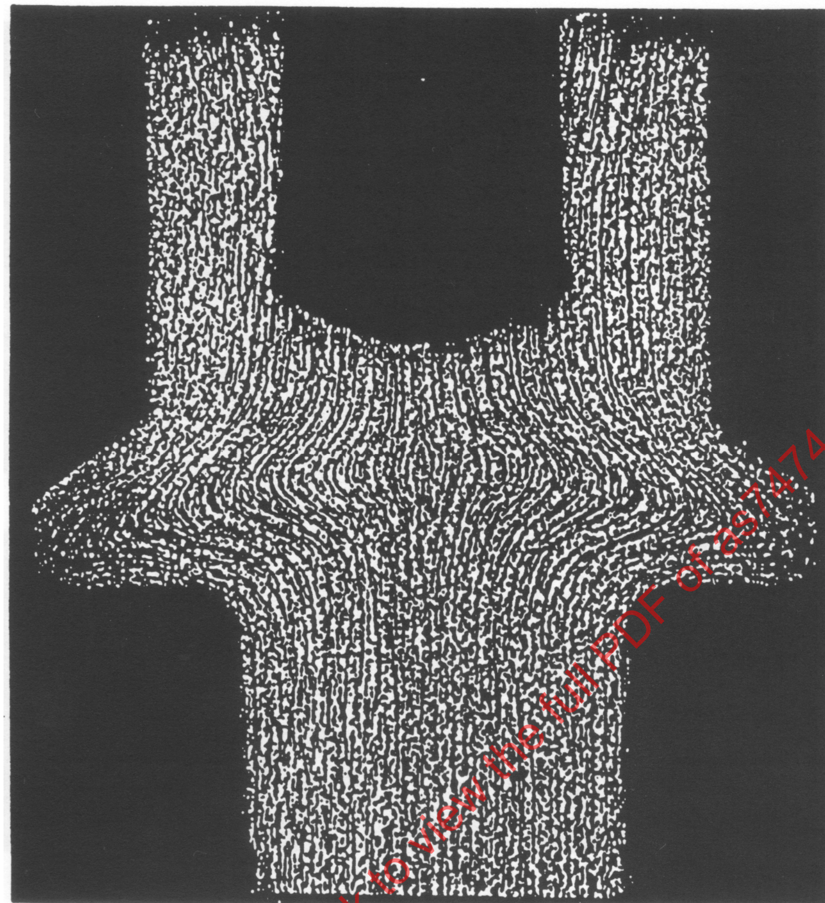


FIGURE 1 - SATISFACTORY GRAIN FLOW, HEADED BLANK, BEFORE HEAT TREATMENT

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

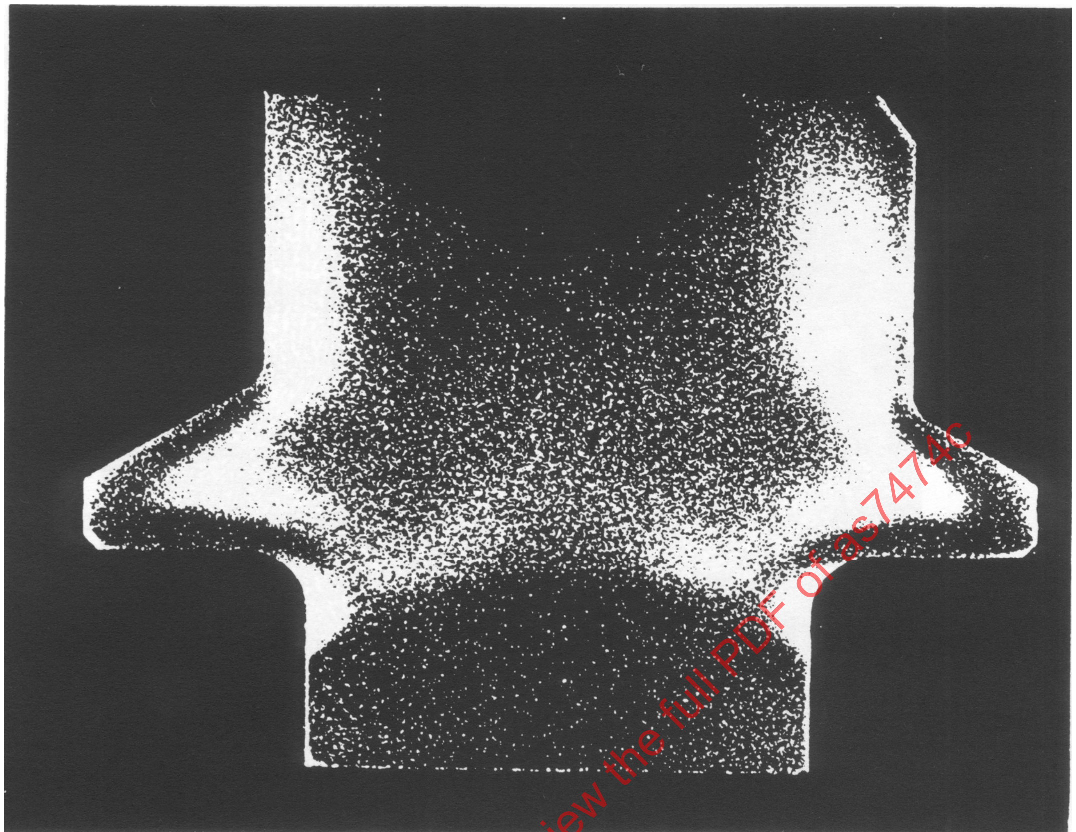
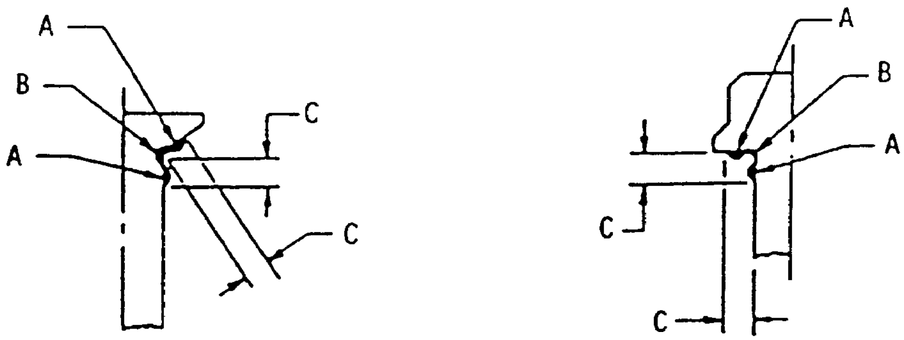


FIGURE 1A - HEAD-TO-SHANK SECTION THROUGH FINISHED PART

SHOWS EVIDENCE THAT HEAD WAS FORMED BY FORGING.



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

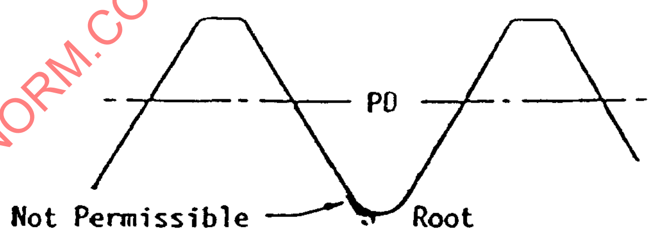


FIGURE 4 - ROOT DEFECTS, ROLLED THREAD

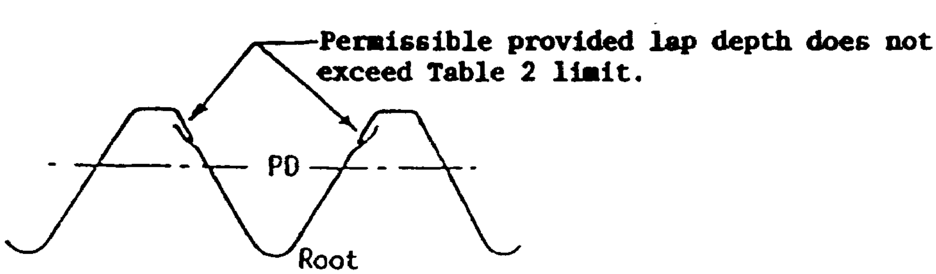


FIGURE 5 - LAPS ABOVE PITCH DIAMETER EXTENDING TOWARDS CREST, ROLLED THREAD

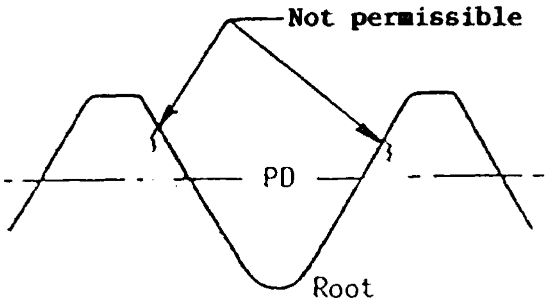


FIGURE 6 - LAPS ABOVE PD EXTENDING TOWARD ROOT, ROLLED THREAD

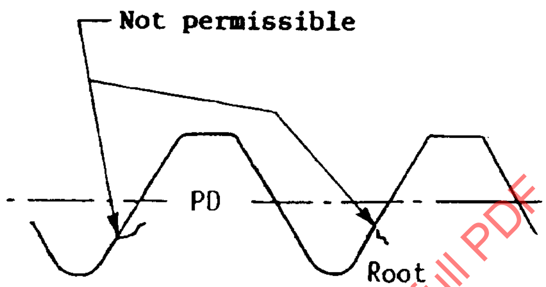
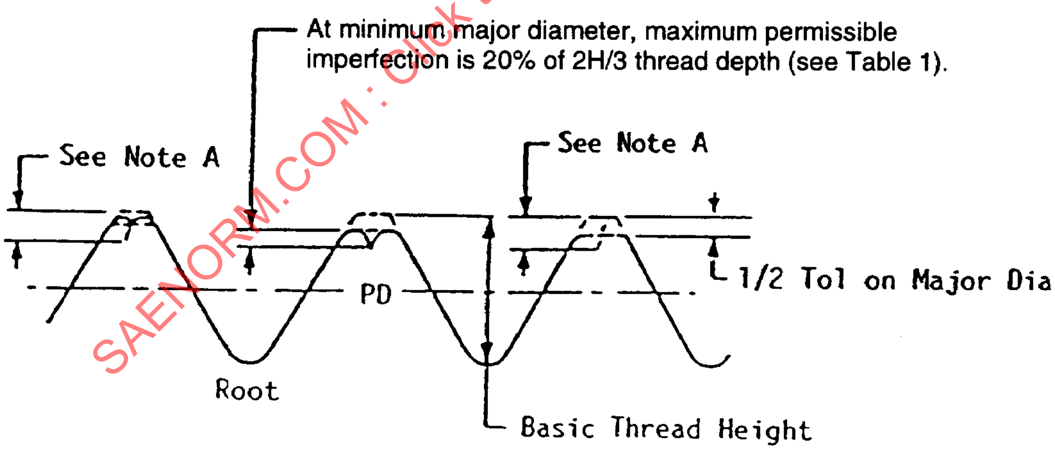


FIGURE 7 - LAPS BELOW PD EXTENDING IN ANY DIRECTION, ROLLED THREAD



Note A: Maximum depth of imperfection equals 20% of 2H/3 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 Minimum Standard PD UN and UNJ Threads	Ultimate Tensile Strength Test Load lbf Minimum Reduced PD UNJ Threads	Stress Corrosion Test Load lbf Minimum Standard PD UN and UNJ Threads	Stress Corrosion Test Load lbf Minimum Reduced PD UNJ Threads	Ultimate Double Shear Test load lbf Minimum Full Shank Close Tol	Fatigue Strength Test load lbf Maximum Standard PD UN and UNJ Threads	Fatigue Strength Test load lbf Maximum Reduced PD UNJ Threads
0.112-40	862	805	616	575	1734	--	--
0.112-48	940	880	671	628	1734	--	--
0.138-32	1299	1228	928	877	2632	562	528
0.138- 40	1443	1368	1030	977	2632	651	615
0.164-32	1994	1907	1425	1362	3718	893	851
0.164-36	2092	2002	1494	1430	3718	954	911
0.190-32	2839	2734	2028	1943	4990	1301	1250
0.250-28	5154	5012	3681	3580	8639	2404	2335
0.3125-24	8219	8040	5871	5743	13499	3863	3775
0.375-24	12407	12186	8862	8704	19439	5932	5822
0.4375-20	16775	16518	11982	11799	26458	8001	7874
0.500-20	22573	22275	16124	15911	34558	10881	10733
0.5625-18	28642	28306	20459	20219	43737	13819	13652
0.625-18	36086	35709	25776	25507	53996	17534	17346
0.750-16	52557	52102	37541	37216	77755	25637	25409
0.875-14	71784	71252	51274	50894	105833	35057	34790
1.000-12	93435	92827	66739	66305	138230	45577	45273

Note 1:

Requirements above apply to parts with UNC, UNF, UNJC, or UNF threads, as applicable to the sizes shown, to class 3A tolerances; requirements for reduced pitch diameter threads are based on 0.003 inch reduction below standard major, pitch and minor (root) diameters.
Requirements for ultimate double shear test load are based on the nominal diameter of close toleranced full shank parts.
The diameter of the area on which stresses for room temperature ultimate tensile strength test load and stress corrosion test load requirements are based is one-half of the sum of the maximum pitch diameter and the maximum minor (root) diameter for UN threads, calculated from Equation 1:

$$A_1 = 0.7854 (d - (0.9382/n))^2 \qquad \text{(Equation1)}$$

Where:

A_1 = area at (d_2 maximum + d_3 maximum) /2
d = maximum major diameter
n = number of threads pitches per inch
d_2 = pitch diameter
d_3 = minor (root) diameter

TABLE 1 – TEST LOADS (CONTINUED)

Area upon which stress for ultimate double shear test load requirements is based is twice the area at the nominal shank diameter which is equal to the basic major diameter of the thread, calculated from Equation 2:

$$A_2 = 0.7854(d)^2 \qquad \text{(Equation 2)}$$

Where:

A_2 = area of nominal full shank diameter – basic major diameter of thread
d = nominal shank diameter – basic thread diameter of thread

Area on which stress for maximum fatigue test load requirements is based is the area at the maximum minor (root) diameter for UN threads, calculated from Equation 3:

$$A_3 = 0.7854(d- (1.2269/n))^2 \qquad \text{(Equation 3)}$$

Where;

A_3 = area at maximum minor (root) diameter
d = maximum major diameter
n = number of thread pitches per inch

Load requirements are based on:

A_1 x 140000 psi for ultimate tensile strength test load
A_1 x 100000 psi for stress corrosion test load
2 x A_2 x 88000 psi for ultimate double shear test load
A_3 x 72000 psi for maximum fatigue strength test load. Minimum fatigue test load equals 10% of maximum fatigue test load

Note 2:

For sizes not shown and parts having other than class 3A tolerances, minimum ultimate tensile strength test load, stress corrosion test load, minimum ultimate double shear test load, and maximum fatigue strength test load requirements for parts tested as parts, not as specimens machined from parts or from coupons of stock, shall be based upon the respective areas and stresses given in Note1.