SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS7472

Issued 1991-01
Reaffirmed 2006-05

Superseding AMS 7472H

Bolts and Screws, Steel, Corrosion Resistant 125 000 psi Tensile Strength Roll Threaded

FSC 5306

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

1.1 Type:

This procurement specification covers aircraft quality bolts and screws made from a corrosion resistant austenitic iron base alloy of the type identified under the Unified Numbering System as UNS S30200 and of 125 000 psi tensile strength at room temperature.

1.2 Application:

Primarily for aerospace propulsion system applications where a good corrosion resistance and moderate strength is required.

1.3 Safety - Hazardous Materials:

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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1.1 Aerospace Material Specification:

AMS 2248	Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys.
AMS 2645	Fluorescent Penetrant Inspection
AMS 2750	Pyrometry
AMS 5637	Steel Bars, Corrosion Resistant, 18Cr-9Ni, Solution Heat Treated and Cold Drawn - 125,000 psi (860 MPa) Tensile Strength

2.1.1.2 Aerospace Standards:

AS1132	Design Parameters for Bolts and Screws, External Wrenching, Unified Thread Inch Series
AS3062	Bolts, Screws, and Studs, Screw Thread Requirements
AS3063	Bolts, Screws, and Studs, Geometric Control Requirements

2.1.2 U. S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2.1 Military Specification:

MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter; General Specification For

2.1.2.2 Military Standards:

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1312	Fasteners, Test Methods
MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

2.1.3 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 353	Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.1.4 ANSI Publication: Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

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

2.2 Definitions:

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:

°	- degree, angle
°F	- degree Fahrenheit
h	- hour
in	- inch
min	- minute of time
%	- percent (1% = 1/100)
lbf	- pounds force
psi	- pounds force per square inch
sp gr	- specific gravity

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the following percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 353, by spectrochemical methods, or by other methods acceptable to purchaser:

TABLE 1 - Composition

Element	% by Weight min	max
Carbon	---	0.15
Manganese	---	2.00
Silicon	---	1.00
Phosphorus	---	0.040
Sulfur	---	0.030
Chromium	17.00	20.00
Nickel	7.00	12.00

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Material:

Heading stock shall have composition specified in 3.1. Stock for machining shall be AMS 5637.

3.3 Design:

Finished (completely manufactured) parts shall conform to the following requirements:

3.3.1 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.

3.3.2 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.

3.3.3 Threads: Screw thread UNJ profile and dimensions shall be in accordance with MIL-S-8879, unless otherwise specified on the part drawing.

3.3.3.1 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.

3.3.3.2 Chamfer: The entering end of the thread shall be chamfered as specified on the part drawing.

3.3.4 Geometric Tolerances: Part features shall be within the geometric tolerances specified on the part drawing and, where applicable, controlled in accordance with AS3063.

3.4 Fabrication:

3.4.1 Blanks: Heads shall be formed by cold forging or machining. When heads are machined, AMS 5637 steel shall be used. Lightening holes on forged or machined heads 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.

3.4.2 Oxide Removal: The blanks, before cold working the fillet radius when specified and rolling the threads, shall have surface oxide and oxide penetration removed from the full body diameter and bearing surface of the head. 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 and, in no case shall be so great as to produce more cutting of flow lines in the head-to-shank junction than shown in Figure 1B.

3.4.3 Cold Working of Fillet Radius: After removal of oxide as in 3.4.2, the head-to-shank fillet radius of parts having the radius complete throughout the circumference of the part shall, when specified, be cold worked sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold working shall conform to Figure 2, unless otherwise specified on the part drawing. It shall not raise metal more than 0.002 in above the contour at "A" or depress metal more than 0.002 in 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 associated with the fillet radius, the cold working 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 associated 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. For parts with compound fillet radii between head and shank, cold work only the radius that blends with the head.

3.4.4 Thread Rolling: Threads shall be formed on the finished blanks by a single rolling process after removal of oxide as in 3.4.2.

3.4.5 Stress Relieving: Parts, after thread rolling, shall be stress relieved by heating to 700°F ± 10, holding at heat for 3 h, and cooling, except that parts make of AMS 5637 steel need not be so treated. 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.

3.4.6 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 min at room temperature.

b. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 30 to 40 min at room temperature.

c. One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 10 to 15 min at 140 to 160°F.

3.5 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 in maximum, with rounded root form on depressed characters.

3.6 Plating:

Where required, surfaces shall be plated as specified by the part drawing.

3.7 Mechanical Properties:

Parts shall conform to the requirements of 3.7.1 and 3.7.2. Threaded members of gripping fixtures for proof load and tensile 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 three full thread turns from the thread runout exposed between the loading fixtures during the proof load and tensile tests. Finished parts shall be tested in accordance with MIL-STD-1312-8 at room temperature for the proof load and tensile tests.

3.7.1 Proof Load: Parts shall be subjected to the load specified in Table 3 for not less than 1 min. After removing the load, the length shall have increased not more than 0.001 in. If the size or shape of the part is such that this elongation requirement would not be met but the part can be tested satisfactorily, such as parts having a shank diameter equal to or less than the thread minor (root) diameter or having an undercut, parts shall be subjected to a stress of 70 000 psi for not less than 1 min; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part. After removing the load, parts shall have increased in length not more than 0.002 in.

3.7.2 Ultimate Tensile Strength at Room Temperature: Parts shall have an ultimate tensile load not lower than that specified in Table 3 and shall be tested to failure, 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 125 000 psi with reduction of area not less than 20%; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part. When specified, heads formed by forging and head-to-shank fillet is cold worked, 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 associated with an undercut or with a shank diameter less than the minimum pitch diameter of the thread.

3.8 Quality:

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials, and from imperfections detrimental to their performance.

3.8.1 Macroscopic Examination: Parts or sections of parts, as applicable, shall be etched in a solution consisting of approximately 50% hydrochloric acid (sp gr 1.19), and 50% water, or other suitable etchant, for sufficient time to reveal flow lines but not longer than 15 min, and then be examined at a magnification of approximately 20X to determine conformance to the requirements of 3.8.1.1, 3.8.1.2, and 3.8.1.3 except that examination for thread imperfections as specified in 3.8.1.3 should be made by microscopic examination of specimens polished and etched.

3.8.1.1 Flow Lines:

3.8.1.1.1 Head-to-Shank: If parts have forged heads, examination of a longitudinal section through the part shall show flow lines in the shank, head-to-shank fillet, and bearing surface which follow the contour of the part as shown in Figure 1A, except that slight cutting of flow lines by the oxide removal process of 3.4.2 is permissible, as shown in Figure 1B; excessive cutting of flow lines in the shank, head-to-shank fillet, and bearing surface, as shown in Figure 1C, is not permissible except when an undercut is associated with the fillet radius. The head style shown in Figures 1A through 1C is for illustrative purposes only but other symmetrical head styles shall conform to the above requirements. Flow lines in upset heads on parts 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.

3.8.1.1.2 Threads: Flow lines in threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at root of thread (see Figure 3).

3.8.1.2 Internal Defects: Examination of longitudinal sections of the head and shank and of the threads shall reveal no cracks, laps, or porosity except laps in threads as permitted in 3.8.1.3.3 and 3.8.1.3.4. The head and shank section shall extend not less than D/2 from the bearing surface of the head and the threaded section shall extend not less than D/2 beyond the thread runout where "D" is the nominal diameter of the shank after heading. If the two sections would overlap, the entire length of the part shall be sectioned and examined as a whole.

3.8.1.3 Threads:

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

3.8.1.3.2 Multiple laps on the flanks of threads are not permissible regardless of location. Single laps on the flank of threads that extend toward the root are not permissible (see Figures 5 and 6).

3.8.1.3.3 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 7). 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 7).

3.8.1.3.4 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 20% of the basic thread height (see 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 the actual major diameter as measured on the part.

3.8.2 Fluorescent Penetrant Inspection: Parts shall be subject to fluorescent penetrant inspection in accordance with AMS 2645; any required plating or coating shall be removed for this inspection.

3.8.2.1 The following conditions shall be cause for rejection of parts inspected.

3.8.2.1.1 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 quench cracks.

3.8.2.1.2 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.

3.8.2.2 The following conditions shall be considered acceptable on parts inspected.

3.8.2.2.1 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 3.8.2.2.2 through 3.8.2.2.5 provided the separation between indications in all directions is not less than 0.062 in.

3.8.2.2.2 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 in or the equivalent of the basic thread height (see Table 2), whichever is less.

3.8.2.2.3 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.

3.8.2.2.4 Threads: There shall be no indications, except as permitted in 3.8.1.3.

3.8.2.2.5 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 in, as shown by sectioning representative samples. No indication, except those of 3.8.2.2.2, 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 Acceptance Tests:

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 4.

4.3 Acceptance Test Sampling:

4.3.1 Nondestructive Test - Visual and Dimensional: A random sample will be selected from each production inspection lot; the size of the sample to be as specified in Table 5. The classification of defects for parts shall be as specified in Table 6. Defects not classified in Table 6 shall be classified as Minor B defects. All dimensional characteristics are considered defective when out of tolerance.

4.3.2 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 5 and the acceptance quality level (AQL) shall be as specified in Table 6. 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.

4.3.3 Destructive Tests: A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 7, Column B. 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.

4.3.4 Acceptance Quality: The AQL and acceptance number of defectives for the acceptance tests shall be as specified in Tables 5 and 7.

4.4 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 proof load and ultimate tensile strength, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, AS7472, lot number, contractor or other direct supplier of material, part number, nominal size, and quality.

4.5 Resampling and Retesting:

If any part or specimen used in the tests fails to meet the specified requirements for design as in 3.3, mechanical properties and quality as in 3.7 and 3.8, disposition of parts may be based on the results of testing three additional parts or specimens for each original nonconforming part or specimen. Failure of any retest part or specimen to meet the specified requirement shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

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

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

FASTENERS, STEEL, CORROSION RESISTANT
AS7472
PART NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

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

5.1.4 Containers of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.1.5 For direct U. S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, industrial packaging, unless Level A is specified in the request for procurement.

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 Direct U. S. Military Procurement:

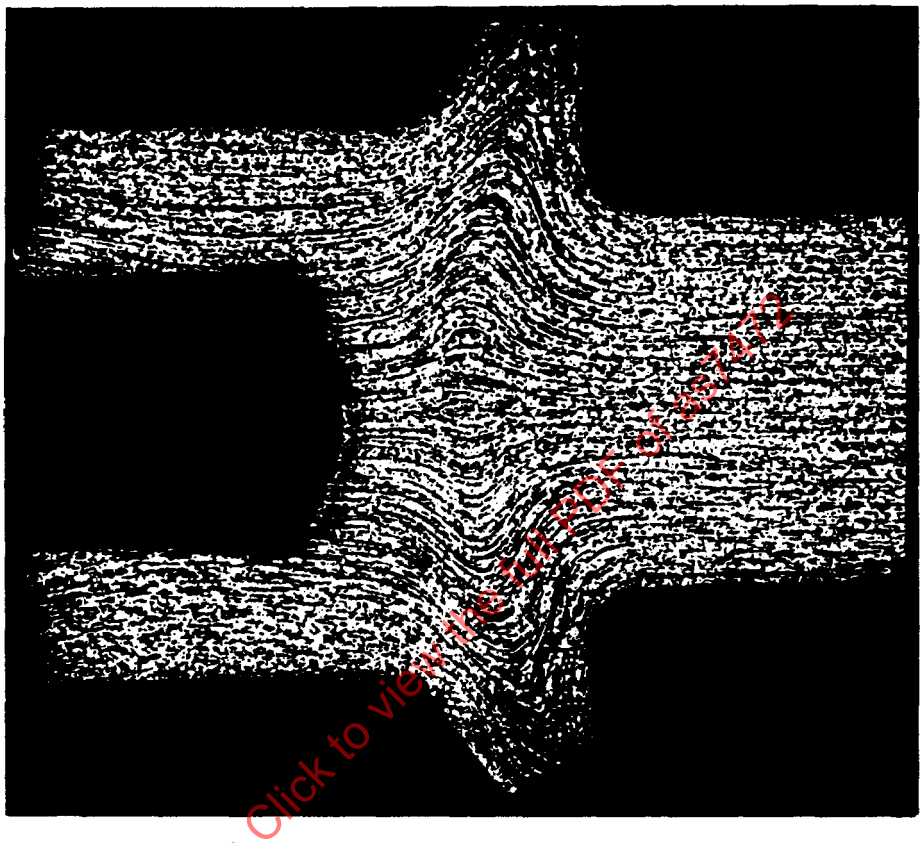
Purchase documents should specify the following:

Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired
Level A packaging, if required (see 5.1.5)

8.2 Key Words:

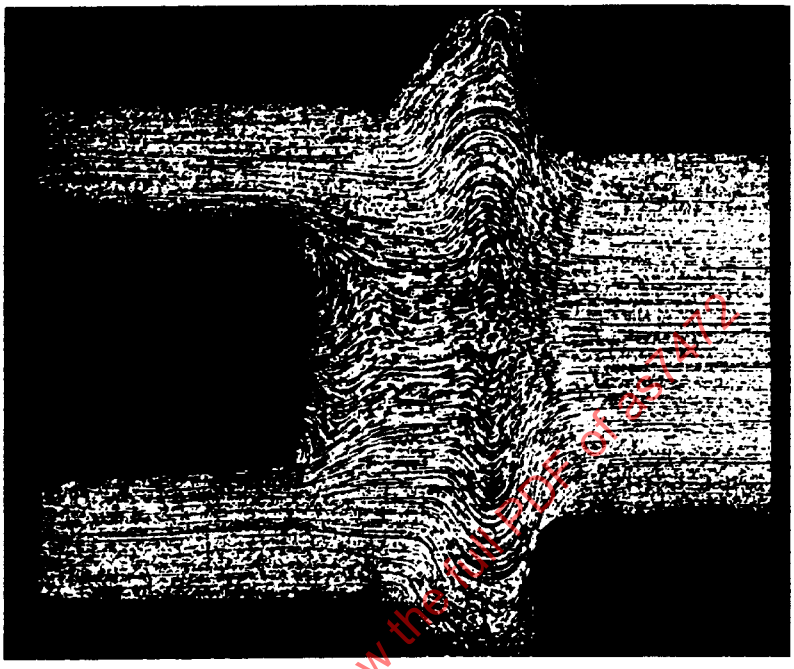
Bolts, screws, procurement specification

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



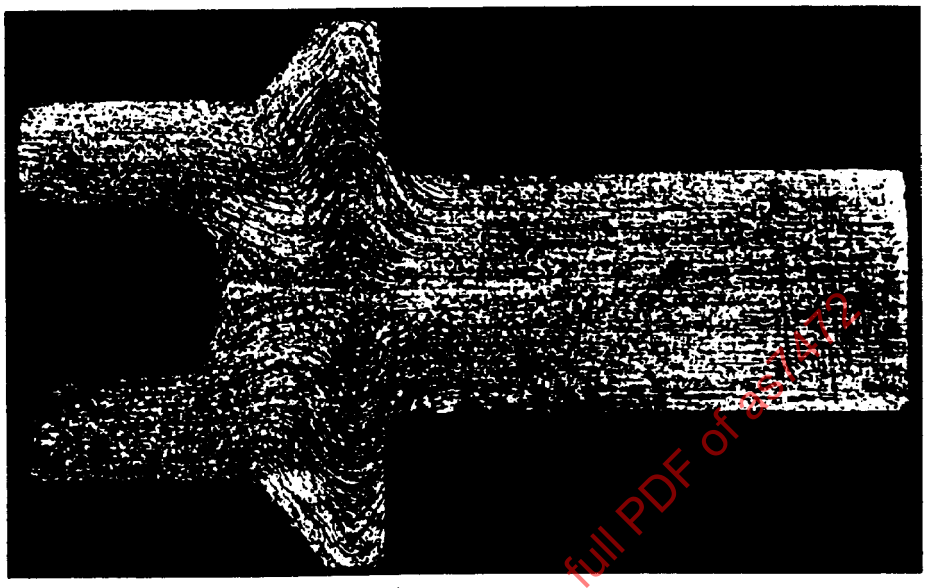
NOTE: Showing a smooth, well formed grain flow following the contour of the under head fillet radius.

FIGURE 1A - Satisfactory Grain Flow



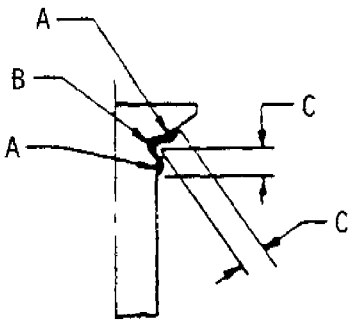
NOTE: Showing maximum permissible cutting of grain flow after machining to remove contamination oxide.

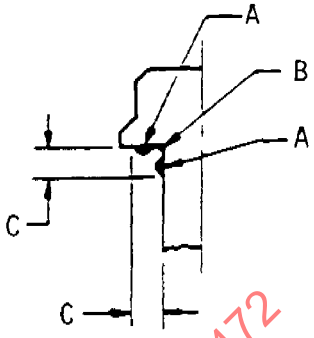
FIGURE 1B – Minimum Acceptable Standard



NOTE: Showing excessive cutting of grain flow in the shank, fillet, and bearing surface which is not permissible.

FIGURE 1C - Unacceptable Grain Flow





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

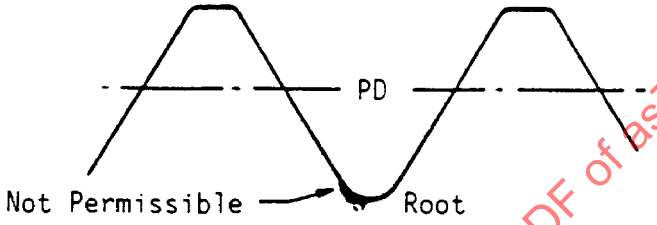


FIGURE 4 - Root Defects, Rolled Thread

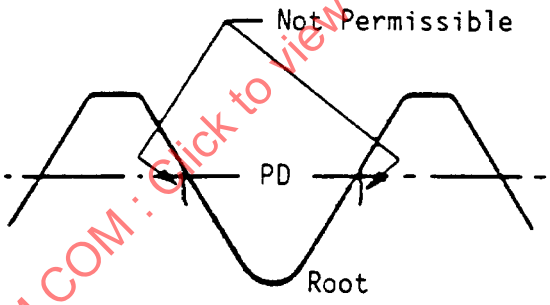


FIGURE 5 - Laps Below PD Extending Toward Root, Rolled Thread

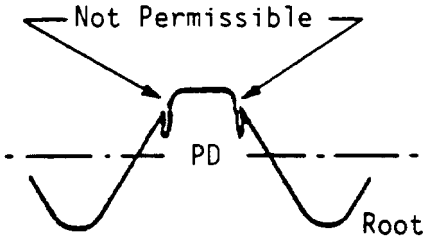


FIGURE 6 - Laps Above PD Extending Toward Root, Rolled Thread

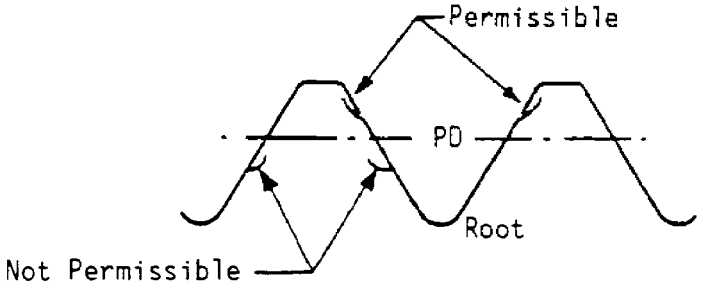
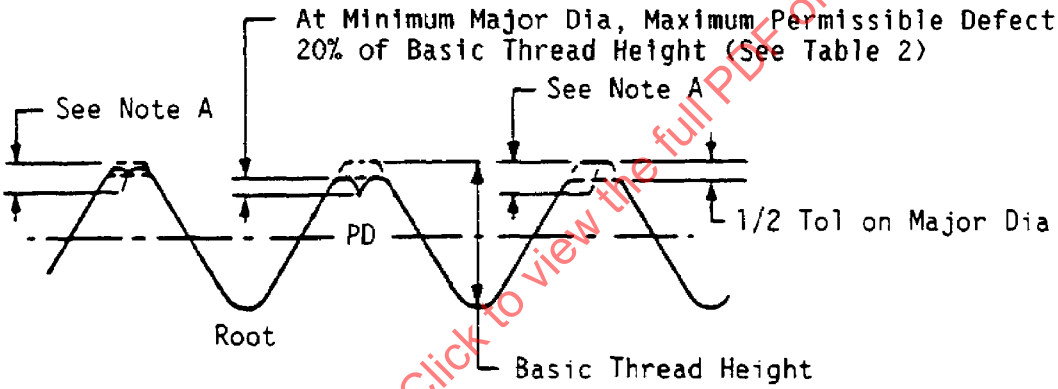


FIGURE 7 - Laps Extending Towards Crest, Rolled Thread



Note A: Depth of defect equals 20% of basic thread height plus 1/2 the difference of the actual major diameter and minimum major diameter.

FIGURE 8 - Crest Craters and Crest Laps, Rolled Thread

TABLE 2 - Thread Height

Thread Pitches Per Inch n	Basic Thread Height Ref (See Note 1) inch	20% Basic Thread Height inch
80	0.0081	0.0016
72	0.0090	0.0018
64	0.0102	0.0020
56	0.0116	0.0023
48	0.0135	0.0027
44	0.0148	0.0030
40	0.0163	0.0033
36	0.0181	0.0036
32	0.0203	0.0041
28	0.0232	0.0046
24	0.0271	0.0054
20	0.0325	0.0065
18	0.0361	0.0072
16	0.0406	0.0081
14	0.0464	0.0093
13	0.0500	0.0100
12	0.0542	0.0108
11	0.0591	0.0118
10	0.0650	0.0130
9	0.0722	0.0144
8	0.0813	0.0163

Note 1: Basic thread height is defined as being equivalent to 0.650 times the pitch, where pitch equals 1/n.

TABLE 3 - Test Loads

Thread Size	Proof Test Load lbf Standard Pitch Dia UN and UNJ Threads	Proof Test Load lbf Reduced Pitch Dia UN Threads Only	Ultimate Tensile Strength Test Load lbf, minimum Standard Pitch Dia UN and UNJ Threads	Ultimate Tensile Strength Test Load lbf, minimum Reduced Pitch Dia UN Threads Only
0.112 -40	431	402	770	718
0.112 -48	470	440	839	786
0.138 -32	649	614	1 160	1 100
0.138 -40	721	684	1 290	1 220
0.164 -32	997	953	1 780	1 700
0.164 -36	1 050	1 000	1 870	1 790
0.190 -32	1 420	1 370	2 530	2 440
0.250 -28	2 580	2 510	4 600	4 470
0.3125-24	4 110	4 020	7 340	7 180
0.375 -24	6 200	6 090	11 100	10 900
0.4375-20	8 390	8 260	15 000	14 700
0.500 -20	11 300	11 100	20 200	19 900
0.5625-18	14 300	14 200	25 600	25 300
0.625 -18	18 000	17 900	32 200	31 900
0.750 -16	26 300	26 100	46 900	46 500
0.875 -14	35 900	35 600	64 100	63 600
1.000 -12	46 700	46 400	83 400	82 900

Note 1: Requirements above apply to parts with UNC, UNF, UNJC, or UNJF threads, as applicable to the sizes shown, to Class 3A tolerances; requirements for reduced pitch diameter threads are based on 0.003 in reduction below standard major, pitch and minor (root) diameters. Area upon which stress for proof load and ultimate tensile strength test load requirements is 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:

$$A = 0.7854[D - (0.9382/n)]^2 \qquad \text{(Eq.1)}$$

where:

A = area at [PD maximum + minor (root) diameter maximum]/2
D = maximum major diameter
n = number of thread pitches per inch