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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS7473

Issued 1991-02-25

Submitted for recognition as an American National Standard

Superseding AMS 7473D

BOLTS AND SCREWS
Roll Threaded

FSC 5306

1. SCOPE:

1.1 Type:

This procurement specification covers aircraft quality bolts and screws made from carbon steels, high expansion steels, or corrosion and heat resistant steels of the type identified under the Unified Numbering System as follows:

a. UNS K00802 - carbon steel (AMS 5061)
b. UNS K91505 - high expansion steel (AMS 5624)
c. UNS K91456 - high expansion steel (AMS 5625)
d. UNS S32100 - corrosion and heat resistant steel (AMS 5645)

1.2 Application:

Primarily for parts of carbon and low alloy steels, corrosion and heat resistant steel and alloys, and high expansion steels not subjected to heat treatment during manufacture. Parts of steels such as AMS 5061 are generally for use where stresses are low at moderate temperatures. Parts of corrosion and heat resistant steels and alloys such as AMS 5645 are generally for use at elevated temperatures where stresses are low. Parts of high expansion steels such as AMS 5624 or AMS 5625 are generally for use at lower temperatures where expansion approaching that of aluminum and magnesium alloys is required.

1.2.1 This specification may also be used to control the manufacture, characteristics, and quality of parts subjected to heat treatment during manufacture but the stage of manufacture at which heat treatment shall be performed, the actual heat treatment, and the mechanical properties of such parts are to be specified, where required, on the part drawing.

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 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.

AMS 2640	Magnetic Particle Inspection
AMS 2645	Fluorescent Penetrant Inspection
AMS 5061	Steel Bars and Wire, Low Carbon
AMS 5624	Steel Bars, High Expansion, 12.5Ni-4.5Mn-4.0Cr (0.50-0.60C)
AMS 5625	Steel Bars, High Expansion, 5.5Mn-9.5Ni (0.55-0.65C), Cold Finished
AMS 5645	Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant 18Cr-10Ni-0.40Ti
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.

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

A - ampere
° - degree, angle
°F - degree Fahrenheit
cm^3 - cubic centimeter
g - gram
in - inch
in^2 - square inch
min - minute of time
% - percent (1% = 1/100)
psi - pounds force per square inch
sp gr - specific gravity
HRC - hardness, Rockwell C scale

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Unless otherwise specified on the part drawing, the material shall be as in Table 1 for the specified procurement specification dash number:

TABLE 1

Procurement Specification Designation	Fastener Material	Material Type
AS7473-1	AMS 5061	Carbon Steel
AS7473-2	AMS 5624	Alloy Steel, High Expansion
AS7473-3	AMS 5625	Alloy Steel, High Expansion
AS7473-4	AMS 5645	Corrosion and Heat Resistant 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, shall conform to the part drawing. Dimensions apply after plating but before coating with dry film lubricants.

3.2.2 Surface Texture: Surface texture of finished parts, prior to plating or coating, shall conform to the requirements as specified on the part drawing, determined in accordance with ANSI/ASME B46.1.

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

3.2.3.1 Incomplete 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: AS7473-1 and AS7473-4 heads shall be formed by hot forging, cold forging, or machining. AS7473-2 and AS7473-3 heads shall be formed by hot forging or machining. 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 Oxide and Decarburization Removal: Surface oxide, oxide penetration, and decarburization resulting from prior heat treatment, shall be removed from the full body diameter and bearing surface of the head prior to cold working the fillet radius when specified and rolling the threads. The oxide and decarburization 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.

3.3.3 Cold Working of Fillet Radius: After removal of oxide and decarburization as in 3.3.2, 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. In addition to cold working the head-to-shank fillet radius, 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.

3.3.4 Thread Rolling: Threads shall be formed on the finished blanks by a single rolling process after removal of oxide and decarburization as in 3.3.2.

3.3.5 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.

3.4 Product Marking:

Each part shall be identification marked as specified on 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.

3.5 Plating:

Where required, any protective treatment shall be as specified on the part drawing.

3.6 Mechanical Properties:

Parts shall conform, as applicable, to the requirements of 3.6.1, 3.6.2, and 3.6.3. Threaded members of gripping fixtures for tests requiring tensile loads 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 test wherein tensile loading is applied. Finished parts shall be tested for the following requirements in accordance with the following applicable test methods:

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

3.6.1 For AS7473-1 and AS7473-4, mechanical properties shall be as specified on the part drawing.

3.6.2 Ultimate Tensile Strength at Room Temperature: AS7473-3 finished parts shall have an ultimate tensile strength not lower than 125 000 psi and shall be tested to failure, first measuring and recording the maximum tensile load achieved. The diameter of the area upon which tensile stress is based shall be one-half of the sum of the maximum pitch diameter and maximum minor (root) diameter of the thread or the unthreaded shank diameter, whichever is smaller.

3.6.3 Hardness: Hardness at mid-radius of unthreaded shank cross-section for AS7473-2 and AS7473-3 parts shall be as follows:

a. AS7473-2: 27 to 38 HRC
b. AS7473-3
   (1) Nominal diameter up to 1.0 in, incl: 25 to 36 HRC
   (2) Nominal diameter over 1.0 in: 24 to 36 HRC

3.7 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.

3.7.1 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 3.7.1.1, 3.7.1.2, and 3.7.1.3, except that examination for thread imperfections as specified in 3.7.1.3 should be made by microscopic examination of specimens polished and etched as in 3.7.2.

3.7.1.1 Flow Lines:

3.7.1.1.1 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 and decarburization removal process of 3.3.3 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 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.

3.7.1.1.2 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).

3.7.1.2 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 3.7.1.3.3 and 3.7.1.3.4. 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.

3.7.1.3 Threads:

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

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

3.7.1.3.3 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).

3.7.1.3.4 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.

3.7.2 Microscopic Examination: Specimens cut from parts shall be polished, etched, and examined at a magnification not lower than 100X to determine conformance to the requirements of 3.7.1.3, 3.7.2.1, and 3.7.2.2; the etchant shall be 2% Nital for parts made of carbon or low alloy steels, and 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 for parts made of corrosion and heat resistant steels and alloys.

3.7.2.1 Surface Hardening: Except for parts whose strength is obtained only by cold working, parts shall have no change in hardness from core to surface except as produced during cold working of the head-to-shank fillet radius when specified 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 in accordance with MIL-STD-1312-6 shall be used as a referee method; a Vickers hardness reading within 0.003 in of an unrolled surface which exceeds the reading in the core by more than 30 points shall be evidence of nonconformance to this requirement.

3.7.2.2 Decarburization: Parts made of carbon or low alloy steels shall not be decarburized more than the following:

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

3.7.2.2.2 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.

3.7.2.2.3 Depth of decarburization on the OD of the head of cylindrical head parts made by upsetting is not restricted.

3.7.2.2.4 Depth of decarburization at any point on the surface not covered by 3.7.2.2.1, 3.7.2.2.2, or 3.7.2.2.3 shall not exceed 0.002 in.

3.7.3 Nondestructive Inspection:

3.7.3.1 Parts shall be subject to nondestructive inspection in accordance with the following procedures, as applicable:

3.7.3.1.1 Magnetic Particle Inspection: Parts of magnetic material shall be inspected in accordance with AMS 2640; any method may be used but resolution of disputed rejections shall be based upon the wet, continuous, fluorescent suspension method using amperages specified in 3.7.3.1.1.1 and 3.7.3.1.1.2.

3.7.3.1.1.1 Circular Magnetization: 800 to 1000 A per in^2 of contact area passed through the part longitudinally.

3.7.3.1.1.2 Longitudinal Magnetization: Sufficient to produce 5000 A-turns per inch of shank diameter with the part placed in a standard solenoid of appropriate size.

3.7.3.1.2 Fluorescent Penetrant Inspection: Parts of nonmagnetic material shall be fluorescent penetrant inspected in accordance with AMS 2645; any required plating shall be removed for this inspection.

3.7.4 Nondestructive Inspection Criteria:

3.7.4.1 Nonacceptable Conditions: The following conditions shall be cause for rejection of parts inspected by either magnetic particle or fluorescent penetrant inspection procedures:

3.7.4.1.1 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.

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

3.7.4.2 Magnetic Particle Inspection Criteria: Parts inspected by magnetic particle inspection shall be considered acceptable if longitudinal indications (i.e., at an angle of 10° or less to the axis of the shank) of seams, forming laps, and nonmetallic inclusions parallel to the grain flow that are within the following limits, provided that the separation between indications in all directions is not less than 0.062 in.

3.7.4.2.1 Sides of Head: There shall be not more than six surface 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 in or the equivalent of the basic thread height (see Table 2), whichever is less.

3.7.4.2.2 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.

3.7.4.2.3 Threads: There shall be no indications, except as permitted in 3.7.1.3.

3.7.4.2.4 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 3.7.4.2.1, shall break over an edge.

3.7.4.3 Fluorescent Penetrant Inspection Criteria: Parts inspected by fluorescent penetrant inspection shall be considered acceptable if 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 are within the following limits, provided that the separation between indications in all directions is not less than 0.062 in.

3.7.4.3.1 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.

3.7.4.3.2 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.

3.7.4.3.3 Threads: There shall be no indications, except as permitted in 3.7.1.3.

3.7.4.3.4 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 3.7.4.3.1, 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 3.

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 4. The classification of defects for parts shall be as specified in Table 5. Defects not classified in Table 5 shall be classified as Minor B defects. All dimensional characteristics are considered defective when out of tolerance.

4.3.2 Nondestructive 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 the AQL shall be as specified 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.

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

4.3.4 Acceptance Quality: The acceptance quality level (AQL) and acceptance number of defectives for the acceptance tests shall be as specified in Tables 4 and 6.

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 mechanical properties and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, AS7473, lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.6 Resampling and Retesting:

If any part or specimen used in the tests fails to meet the specified requirements for design as in 3.2, mechanical properties and quality as in 3.6 and 3.7, 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, ROLL THREADED
AS7473
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:

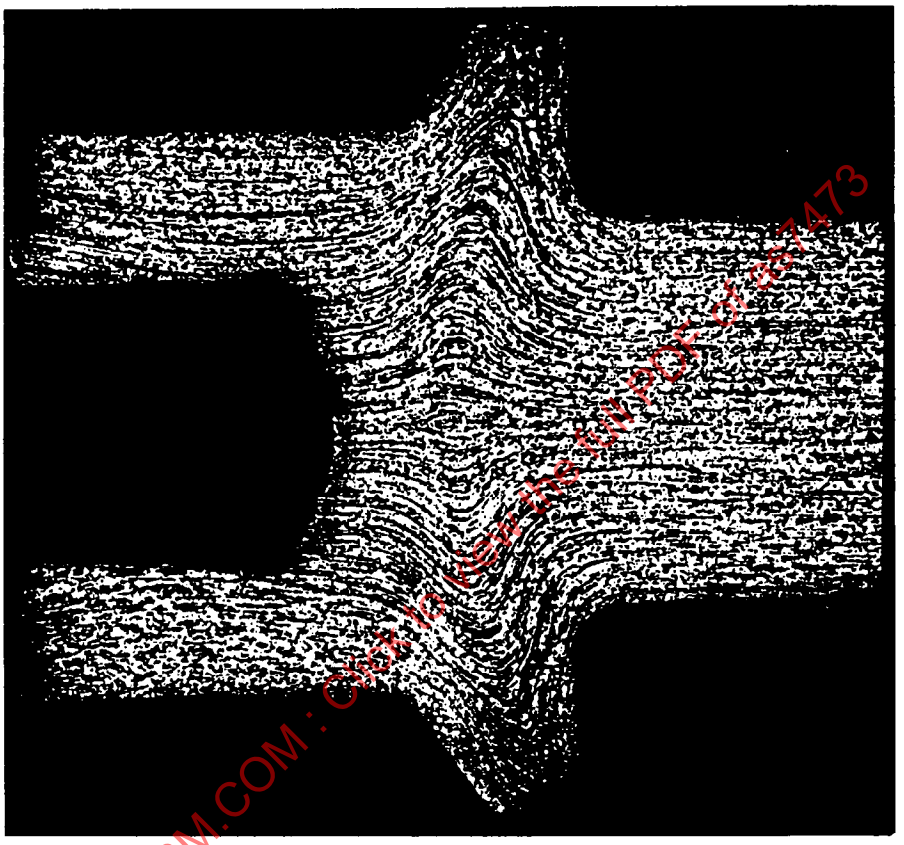
Purchase documents should specify the following:

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:

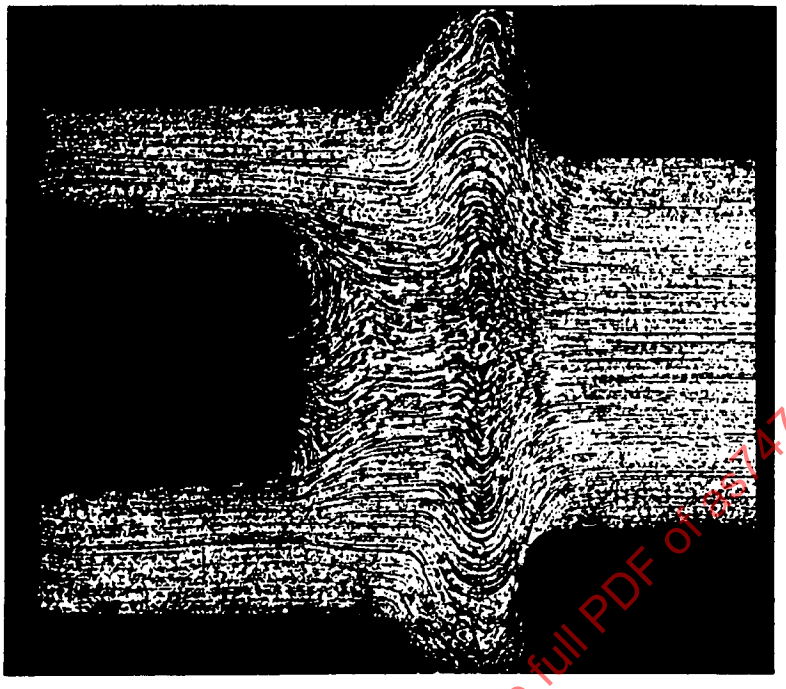
Bolts, screws, procurement specification

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



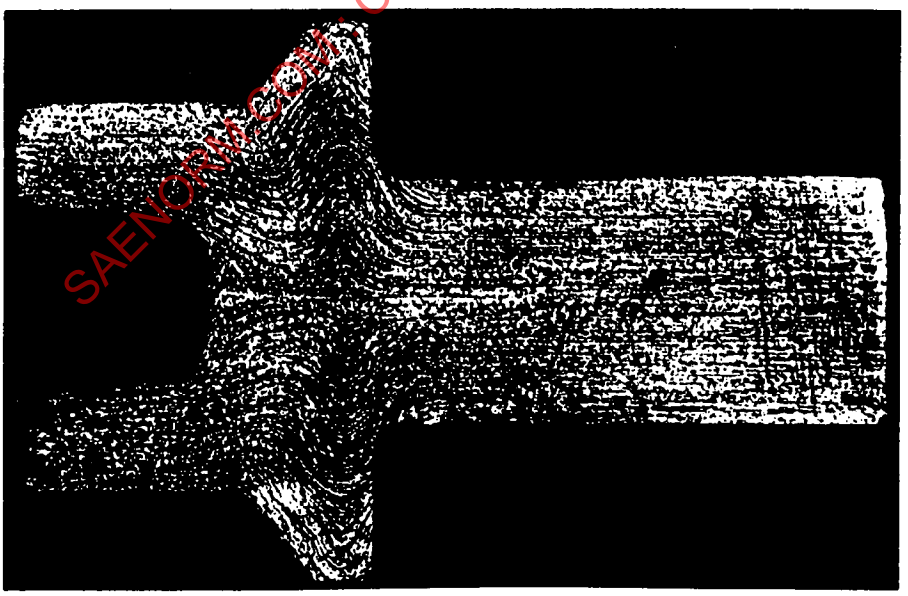
NOTE: Showing a smooth, well formed grain flow following the contour of the under head fillet radius.

FIGURE 1A - Satisfactory Grain Flow



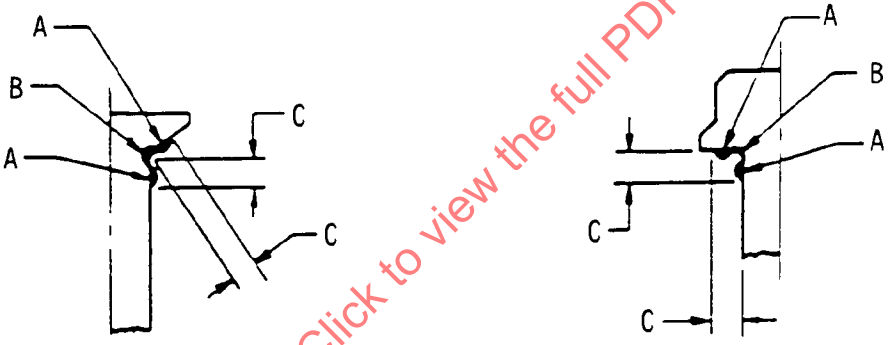
NOTE: Showing maximum permissible cutting of grain flow after machining to remove contamination oxide.

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

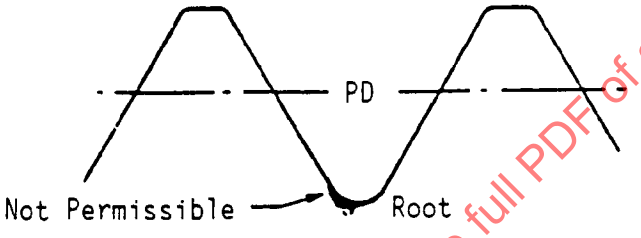


FIGURE 4 - Root Defects, Rolled Thread

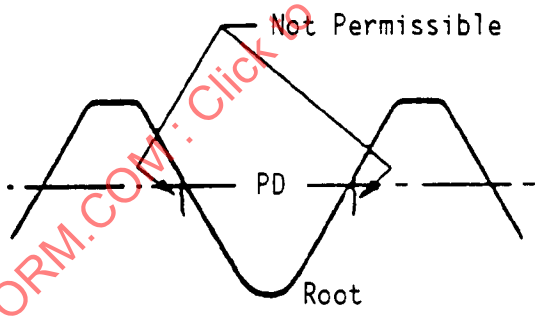


FIGURE 5 - Laps Below PD Extending Toward Root, Rolled Thread

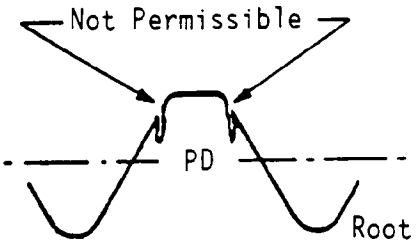


FIGURE 6 - Laps Above PD Extending Toward Root, Rolled Thread

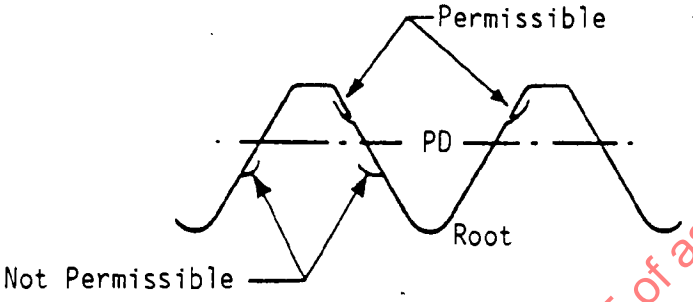
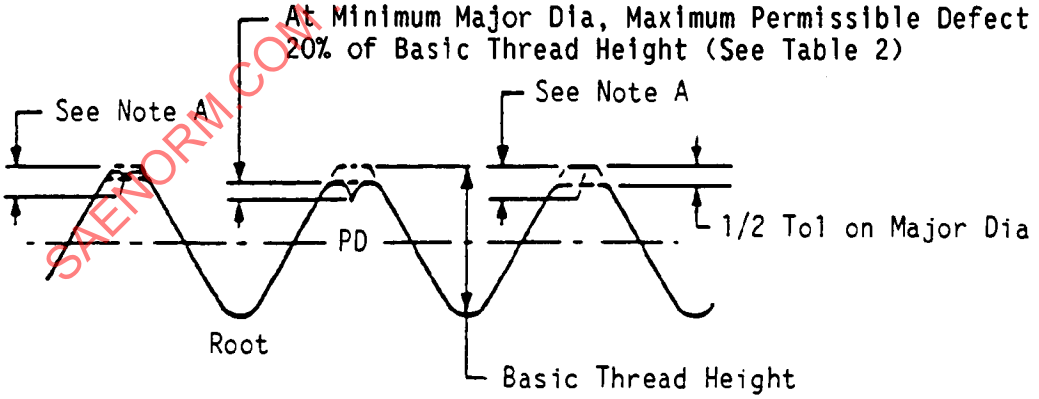


FIGURE 7 - Laps Extending Towards Crest, Rolled Thread



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