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Superseding AS7460	

**Bolts and Screws, Titanium Alloy
6.0Al – 4.0V
Procurement Specification For**

FSC 5306

RATIONALE

Updated para 3.5 by adding “two to” three threads in agreement with NASM1312-8 test methodology. Added additional definitions to para 2.2. General updating for SAE requirements for obsolete specifications and standards.

1. SCOPE

1.1 Type

This procurement specification covers aircraft-quality bolts and screws made of 6.0Al-4.0V titanium alloy and of 160 ksi tensile strength at room temperature.

1.2 Application

Primarily for aerospace propulsion system applications where high strength, light weight fasteners are required for use up to approximately 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.

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.

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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.

AMS2750	Pyrometry
AMS4967	Titanium Alloy, Bars, Wire, Forgings, and Rings 6.0Al 4.0V Annealed, Heat Treatable
AS1132	Bolts, Screws and Nuts - External Wrenching UNJ Thread, Inch - Design Standard
AS1814	Terminology for Titanium Microstructures
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 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>

MIL-STD-2073-1 DoD Materiel, Procedures for Development and Application of Packaging Requirements

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 E8	Tension Testing of Metallic Materials
ASTM B600	Descaling and Cleaning Titanium and Titanium Alloy Surfaces
ASTM E1417	Standard Practice for Liquid Penetrant Testing

2.1.4 ASME Publications

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

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

2.1.5 AIA Publications

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

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

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.

Refer to AS1814 for titanium microstructure terms and definitions.

Unit Symbols° Baume'hydrometer scale unit for measuring specific gravity of liquids

°F degree Fahrenheit

% percent (1% = 1/100)

h hour

in inch

lbf pound-force

ksi kips (1000 pounds) per square inch

min minute of time

sp gr specific gravity

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be AMS4967 titanium alloy.

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, shall conform to the part drawing. Dimensions apply before any required coating with dry film lubricants.

3.2.2 Surface Texture

Surface texture of finished parts, prior to any required 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 forming or machining.

3.3.1.1 Cleaning

Blanks shall be cleaned prior to heat treatment in accordance with ASTM B600, or other methods approved by the purchaser. Blank surfaces shall be free of halogen compounds, such as residue from halogenated solvents and coolants, and salt from sweaty hands. Surfaces of parts, fixtures, racks, etc. shall be clean and free of dirt, water, oil, grease, paint, ink, crayon markings, dye pickup, finger prints, and other foreign material. After cleaning and prior to heat treatment, personnel handling blanks shall wear clean white cotton gloves or equivalent.

3.3.2 Heat Treatment

Headed and machined blanks after cleaning as in 3.3.1.1 shall, before finishing the shank and the bearing surface of the head, cold working the head-to-shank fillet radius when specified, and rolling the threads, be heat treated as follows:

3.3.2.1 Heating Equipment

Furnaces may be any type ensuring uniform temperature throughout the blanks 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 embrittlement unless blanks are machined after heat treatment, to remove surface hardening.

3.3.2.2 Solution Heat Treatment

Blanks shall be uniformly heated to a temperature within the range 1650 to 1750 °F, held at the selected temperature within ± 15 °F for 30 to 60 min, and quenched in water.

3.3.2.3 Precipitation Heat Treatment

Solution heat treated blanks shall be heated to a temperature within the range 900 to 1100 °F, held at the selected temperature within ± 10 °F for 4 to 8 h, and cooled in air.

3.3.3 Contamination Removal

The solution and precipitation heat treated blanks, before cold working the fillet radius when specified and rolling the threads, shall have the full body, head-to-shank fillet, and bearing surface of the head free from surface contamination and contamination penetration caused by prior heat treatment. The removal process shall produce no intergranular attack or corrosion, or changes of structure 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 of upset headed blanks than shown in Figure 1B.

3.3.4 Cold Working of Fillet Radius

After removal of contamination as in 3.3.3, 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 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 associated with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for degrees 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.

3.3.5 Thread Rolling

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

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

3.5 Mechanical Properties

Parts shall conform to the requirements of 3.5.1. Threaded members of gripping fixtures for 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 two to three full thread turns from the thread runout exposed between the loading fixtures during the tensile test. Finished parts shall be tested for ultimate tensile strength per MIL-STD-1312-8 in accordance with NASM1312-8.

3.5.1 Ultimate Tensile Strength at Room Temperature

3.5.1.1 Finished Parts

Parts shall have an ultimate tensile load not lower than that specified in Table 2 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 conform to only the ultimate tensile strength requirements of 3.5.1.2; 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 drive 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.

3.5.1.2 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 4.5.6. Tests on such specimens shall be conducted at a strain rate of 0.003 to 0.007 in/in/min through the 0.2% offset after which the rate shall be increased so as to produce failure in approximately one additional minute. Specimens shall meet the following requirements:

- a. Ultimate tensile strength, minimum: 160 ksi
- b. Elongation in 2 in or 4D, minimum: 8%
- c. Reduction of area, minimum: 20%

3.6 Quality

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

3.6.1 Macroscopic Examination

Parts or sections of parts as applicable, shall be etched in a solution consisting of:

- a. 15% \pm 2% by volume, technical grade nitric acid, 42° Baume'
- b. 10% \pm 1.5% by volume, hydrofluoric acid (48%)
- c. Balance water

(or other suitable etchant) for sufficient time to reveal flow lines but not longer than 5 min and then be examined at a magnification of approximately 20X to determine conformance to the following requirements.

3.6.1.1 Flow Lines

3.6.1.1.1 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 contamination 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 above requirements. Flow lines in 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 manufacturer.

3.6.1.1.2 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).

3.6.1.2 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 3.6.2.3.3 and 3.6.2.3.4. 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.

3.6.2 Microscopic Examination

Specimens cut from parts shall be polished, etched with Kroll's reagent [5% hydrofluoric acid (sp gr 1.15), 12% nitric acid (sp gr 1.42), 83% water] and then be examined at a magnification not lower than 100X to determine conformance to the requirements of 3.6.2.1, 3.6.2.2, and 3.6.2.3.

3.6.2.1 Microstructure

Parts shall have microstructure free from indications of overheating resulting from heating above the beta transus without subsequent working in the alpha-beta temperature range. Alpha case or evidence of slight overheating on non-bearing surfaces of the head is permissible if the depth of overheating or case is not greater than 0.003 in. Measurements shall be made normal to the surface. A structure showing outlines of equiaxed beta grains and no primary alpha grains will be cause for rejection.

3.6.2.2 Surface Hardening

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 during rolling of threads. In case of dispute over results of the microscopic examination, micro-hardness testing per MIL-STD-1312-6 in accordance with NASM1312-6 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.

3.6.2.3 Threads

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

3.6.2.3.2 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).

3.6.2.3.3 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).

3.6.2.3.4 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 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 the actual major diameter as measured on the part.

3.6.3 Fluorescent Penetrant Inspection

Parts shall be subject to fluorescent penetrant inspection in accordance with ASTM E1417; use of higher sensitivity penetrant is permissible. Any required coating shall be removed for this inspection.

3.6.3.1 The following conditions shall be cause for rejection of parts inspected:

3.6.3.1.1 Discontinuities transverse to grain flow (i.e., at an angle of more than 1 degrees to the axis of the shank), such as grinding checks and quench cracks.

3.6.3.1.2 Longitudinal indications (i.e., at an angle of 1 degrees or less to the axis of the shank) due to imperfections other than seams, forming laps, and nonmetallic inclusions.

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

3.6.3.2.1 Parts having longitudinal indications (i.e., at an angle of 1 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 3.6.3.2.2 through 3.6.3.2.5 provided the separation between indications in all directions is not less than 0.062 in.

3.6.3.2.2 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 in or the equivalent of the basic thread height (see Table 1), whichever is less.

3.6.3.2.3 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.

3.6.3.2.4 Threads

There shall be no indications, except as permitted in 3.6.2.3.

3.6.3.2.5 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 in, as shown by sectioning representative samples. No indication, except those of 3.6.3.2.2, 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 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.

4.5 Acceptance Tests Sampling

4.5.1 Material

In accordance with AMS4967.

4.5.2 Nondestructive Tests - Visual and Dimensional

A random sample of parts shall be taken from each production inspection lot, the size of the sample to be as specified in Table 4. The classification of dimensional characteristics shall be as specified in Table 5. All dimensional characteristics are considered defective when out of tolerance.

4.5.3 Fluorescent Penetrant Inspection

A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 4 and classified as in Table 5. The sample units may be selected from those that have been subjected to and passed the visual and dimensional inspection, with additional units selected at random from the production inspection lot as necessary.

4.5.4 Destructive Tests

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

4.5.5 Acceptance Quality

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

4.5.6 Test Specimens

Specimens for tensile testing of machined test specimens shall be of standard proportions in accordance with ASTM E8 with either 0.250 in 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 in and under in diameter, from the center of coupons 0.800 in and under in nominal diameter or distance between parallel sides, and from mid-radius of larger parts or coupons.

4.6 Reports

The manufacturer of parts shall furnish with each shipment a report stating that the chemical composition of the parts conform to the applicable material specification, showing the results of tests to determine conformance to the room temperature ultimate tensile strength requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, AS7460A, lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.7 Rejected Lots

If a production inspection lot is rejected, the manufacturer of parts may perform corrective action to screen out or rework the defective parts, and resubmit for acceptance tests inspection as in 4.4. Resubmitted lots shall be clearly identified as reinspected lots.

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:

- a. FASTENERS, TITANIUM ALLOY, 6.0Al - 4.0V
- b. AS7460A
- c. PART NUMBER
- d. LOT NUMBER
- e. PURCHASE ORDER NUMBER
- f. QUANTITY
- g. 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 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 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 Direct U.S. Military Procurement

Purchase documents should specify the following:

- a. Title, number, and date of this specification
- b. Part number of parts desired
- c. Quantity of parts desired
- d. Level A packaging, if required (see 5.1.5)

8.2 Equipment

8.2.1 The tank for the solution of 3.6.1 must be lined with polyvinyl chloride or comparable lining material.

8.2.2 Adequate ventilation is necessary because of the production of gaseous fumes due to vigorous reaction.

8.2.3 Fixtures, racks, and baskets shall be coated with acid resistant material that will not react with the nitric-hydrofluoric acid solution.

8.3 A change bar (I) 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.

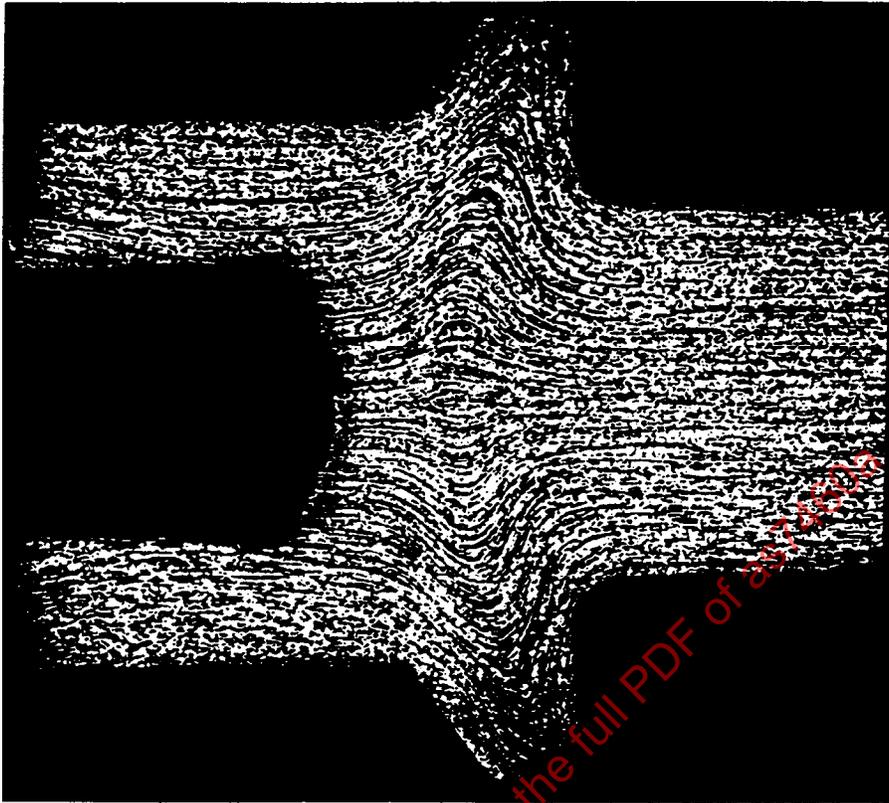


FIGURE 1A - SATISFACTORY GRAIN FLOW
SHOWING A SMOOTH, WELL FORMED GRAIN FLOW FOLLOWING
THE CONTOUR OF THE UNDER HEAD FILLET RADIUS.

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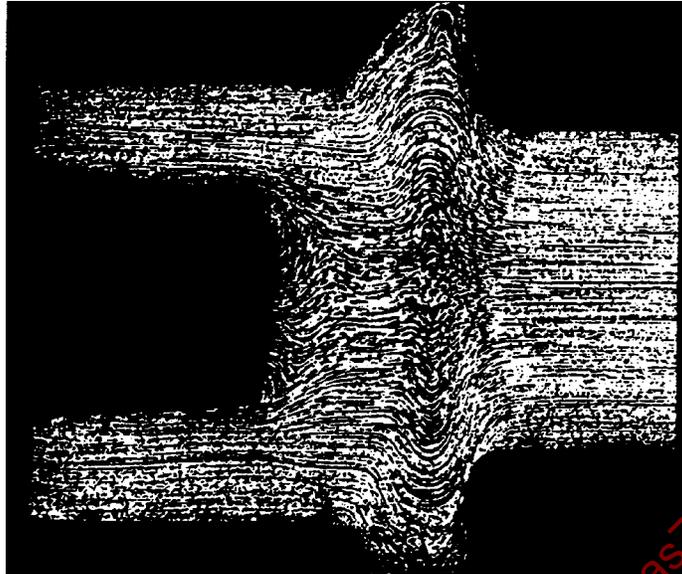


FIGURE 1B - MINIMUM ACCEPTABLE STANDARD
SHOWING MAXIMUM PERMISSIBLE CUTTING OF GRAIN FLOW
AFTER MACHINING TO REMOVE CONTAMINATION OXIDE.

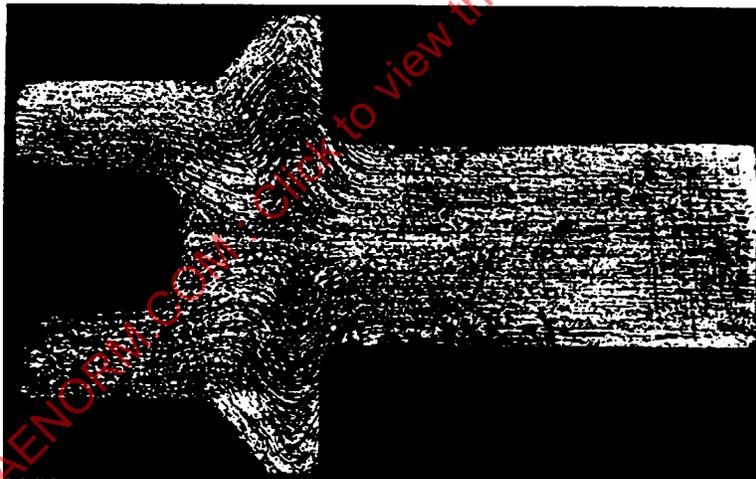
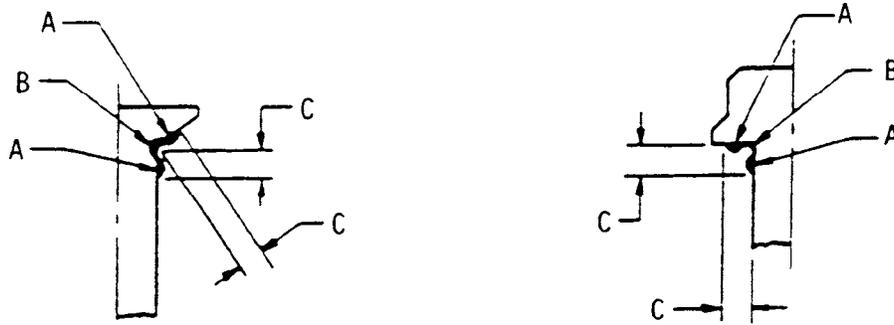


FIGURE 1C - UNACCEPTABLE GRAIN FLOW
SHOWING EXCESSIVE CUTTING OF GRAIN FLOW IN THE SHANK,
FILLET AND BEARING SURFACE WHICH IS NOT PERMISSIBLE.



Nominal Bolt Diameter, inch	C max 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

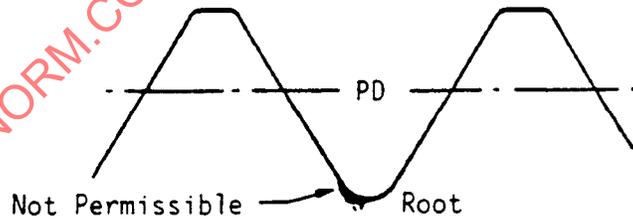


FIGURE 4 - ROOT DEFECTS, ROLLED THREAD

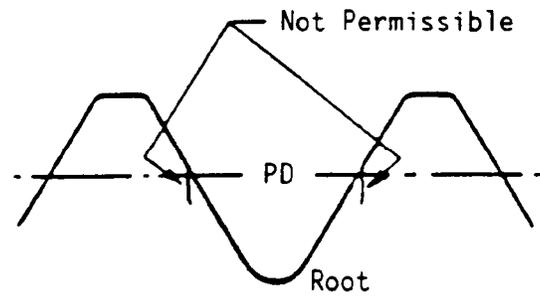


FIGURE 5 - LAPS BELOW PD EXTENDING TOWARD ROOT, ROLLED THREAD

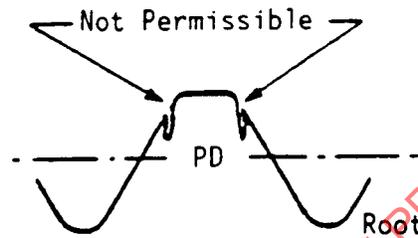


FIGURE 6 - LAPS ABOVE PD EXTENDING TOWARD ROOT, ROLLED THREAD

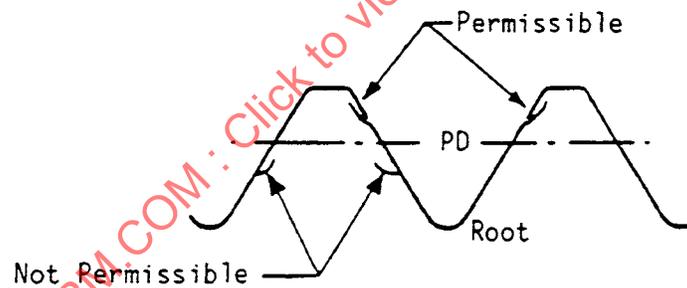
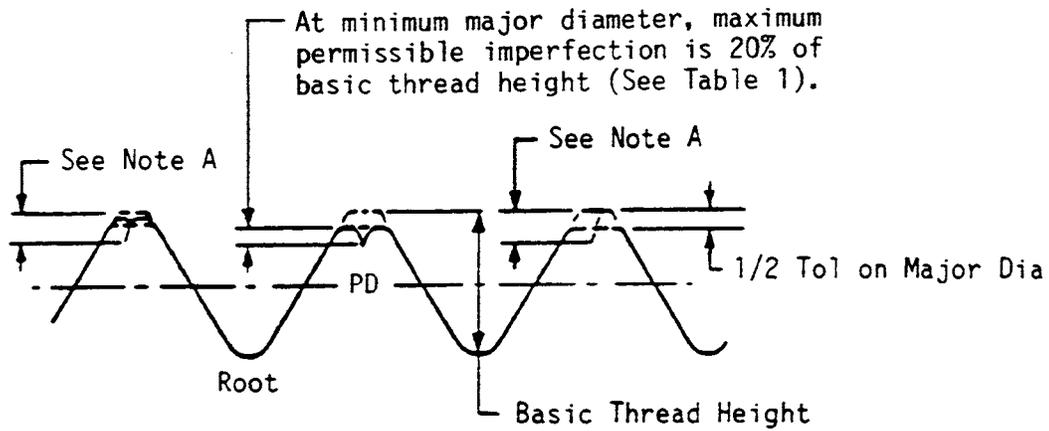


FIGURE 7 - LAPS EXTENDING TOWARDS CREST, ROLLED THREAD



Note A: Maximum depth of imperfection 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

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