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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS7481

Issued 1991-01-07

Submitted for recognition as an American National Standard

Superseding AMS 7481A

STUDS, STEEL, CORROSION AND HEAT RESISTANT 1800°F Solution Heat Treated Precipitation Heat Treated After Roll Threaded

FSC 5307

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1. SCOPE:

1.1 Type:

This procurement specification covers aircraft quality studs made from a corrosion and heat resistant age hardenable iron base alloy of the type identified under the Unified Numbering System as UNS S66286 and of 130 000 psi tensile strength at room temperature, with maximum test temperature of parts at 1200°F.

1.2 Application:

Primarily for aerospace propulsion system applications where the coefficient of expansion of the stud is more compatible in light alloys, and where stress rupture and creep resistance are of primary importance at elevated temperatures.

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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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 Specifications:

AMS 2645 Fluorescent Penetrant Inspection
AMS 2750 Pyrometry
AMS 5731 Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant, 15Cr-25.5Ni-1.3Mo-2.1Ti-0.006B-0.30V, Consumable Electrode Melted, 1800°F (982°C), Solution Heat Treated

2.1.1.2 Aerospace Standards:

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 Specifications:

MIL-S-7742 Screw Threads, Standard, Optimum Selected Series: General Specification for
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 8 Tension Testing of Metallic Materials
ASTM E 10 Brinell Hardness of Metallic Materials
ASTM E 112 Determining Average Grain Size
ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Test of Metallic Materials

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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
°C	- degree Celsius
°F	- degree Fahrenheit
cm^3	- cubic centimeter
g	- gram
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 Material:

Shall be AMS 5731 steel heading stock or bar.

3.1.1 Stock: Shall be reduced 15 to 25% in cross sectional area during the final drawing or rolling at a temperature not higher than 1600°F unless stock is so reduced or is otherwise processed, during manufacture of parts, to prevent grain growth during heat treatment. Stock reduced as above shall have a hardness of 201 to 285 HB, determined in accordance with ASTM E 10.

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.

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3.2.3 Threads: Screw thread UN profile in accordance with MIL-S-7742 and UNJ profile in accordance with MIL-S-8879 shall be a part of this specification and shall be the basis for all screw thread requirements. The applicable screw thread specification shall be as specified on the part drawing. Tolerances for pitch diameter of the stud end shall be as specified on the part drawing. The special stud end thread requirements shall be in accordance with AS3062 for the following requirements:

a. Lead and half-angle variations
b. Taper
c. Out-of-roundness
d. Stud lead threads
e. Stud thread runout

3.2.3.1 The requirements for thread crest variations, locking holes in the nut end thread, incomplete lead threads and thread runout on nut end threads shall be 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: Blanks shall be machined sufficiently to remove surface defects. The small diameter or nut end of blanks for stepped studs may be reduced as necessary by extruding or machining or both, or the larger diameter or stud end may be upset. Upsetting to produce a shoulder or shoulders between the threaded ends is permissible. Heading stock to be hot upset shall not be heated to a temperature higher than 2100°F.

3.3.1.1 When a shoulder or shoulders are produced by upsetting, the metal removed from the bearing surface shall be as little as practicable to provide a clean, smooth surface.

3.3.2 Heat Treatment: Upset, extruded or machined blanks, except blanks machined from solution heat treated stock, shall, before oxide removal and rolling the threads, be solution heat treated as in 3.3.2.2, observing the following requirements:

a. Precipitation heat treatment shall follow the oxide removal and rolling the threads on upset, extruded, or machined blanks.

b. If machined from solution heat treated stock, only precipitation heat treatment is necessary.

3.3.2.1 Heating Equipment: 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. The heating medium or atmosphere shall cause no surface hardening by carburizing or nitriding.

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3.3.2.2 Solution Heat Treatment: Blanks shall be solution heat treated by uniformly heating to 1800°F ± 25, holding at heat for not less than 1 h, and cooling at a rate equivalent to oil quench or faster.

3.3.2.3 Precipitation Heat Treatment: After oxide removal and rolling the threads, parts shall be precipitation heat treated by heating to a temperature within the range 1300 to 1400°F, holding at the selected temperature within ±15°F for not less than 16 h, and cooling in air.

3.3.3 Oxide Removal: Surface oxide and oxide penetration resulting from prior solution heat treatment shall be removed from the full body diameter and bearing surfaces of shoulders, as applicable, of the solution heat treated blanks prior to rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks.

3.3.4 Thread Rolling: Threads shall be formed on the finished blanks by a single rolling process after removal of oxide as in 3.3.3 and prior to precipitation heat treatment as in 3.3.2.3.

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 marked for oversize on the stud end thread and for material code on the nut end thread as specified on the part drawing. The markings may be formed by stamping, depressed 0.010 in maximum, with rounded root form on depressed characters.

3.5 Plating:

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

3.6 Mechanical Properties:

Parts shall conform to the requirements of 3.6.1, 3.6.2, and 3.6.3. Threaded members of gripping fixtures for tensile and stress-rupture 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

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3.6 (Continued):

between the loading fixtures during the tensile and stress-rupture tests. Finished parts shall be tested in accordance with the following applicable test methods:

a. Hardness: MIL-STD-1312-6
b. Room Temperature Ultimate Tensile Strength: MIL-STD-1312-8
c. Stress-Rupture Strength at 1200°F: MIL-STD-1312-10

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 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 (smaller thread root diameter for studs with unequal size threads) or having an undercut, parts shall conform to only the ultimate tensile strength requirements of 3.6.1.2; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part.

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. Such specimens shall meet the following requirements:

a. Ultimate Tensile Strength, minimum: 130 000 psi
b. Yield Strength at 0.2% Offset, minimum: 85 000 psi
c. Elongation in 2 in or 4D, minimum: 15%
d. Reduction of Area, minimum: 20%

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 within the range 24 to 35 HRC, but hardness of the threaded section may be higher as a result of the thread rolling.

3.6.3 Stress-Rupture Strength at 1200°F:

3.6.3.1 Finished Parts: Finished parts, maintained at 1200°F ± 3 while the tensile load specified in Table 2 is applied continuously, shall not rupture in less than 23 h. If the shank diameter of the part is less than the maximum minor (root) diameter of the thread but the part can be tested satisfactorily, parts shall conform to the requirements of 3.6.3.1.1.

3.6.3.1.1 Parts having a shank diameter less than the maximum minor (root) diameter of the thread shall be tested as in 3.6.3.1 except that the load shall be as specified in 3.6.3.2. The diameter of the area on which stress is based shall be the actual measured minimum diameter of the part.

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3.6.3.2 Machined Test Specimens: If the size or shape of the part is such that a stress-rupture test cannot be made on the part, a test specimen prepared as in 4.4, maintained at 1200°F ± 3 while a load sufficient to produce an initial axial stress of 65 000 psi is applied continuously, shall not rupture in less than 23 h. Tests shall be conducted in accordance with ASTM E 139.

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 40% hydrochloric acid (sp gr 1.19), 10% of a 30% solution of hydrogen peroxide, and 50% water, or other suitable etchant, for sufficient time to reveal flow lines but not longer than 30 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 the 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: Flow lines in threads shall be continuous, shall follow the general contour and shall be of maximum density at the root of the thread (see Figure 1). Below the thread roots, flow lines not affected by forming shall be parallel to the axis, except that on the nut end of parts formed by extruding, the flow lines may be oblique to the axis for a distance from the end of the larger diameter to the smaller diameter equal to 1.5 times the "B" dimension of Table 2 of AS3062.

3.7.1.2 Internal Defects: Examination of longitudinal sections of the parts 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.

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 2).

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 3 and 4).

3.7.1.3.3 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 5). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or nonpressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (see Figure 5).

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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 1) as measured from the thread crest when the thread major diameter is at minimum size (see Figure 6). 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.

3.7.2 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 3.7.1.3, 3.7.2.1, 3.7.2.2, and 3.7.2.3.

3.7.2.1 Microstructure: Parts shall have microstructure of completely recrystallized material except in the area of the threads.

3.7.2.2 Grain Size: Grain size shall be 5 or finer as determined by comparison of the specimen with the chart in ASTM E 112. Up to 25% by area of grains 3 ASTM numbers coarser than the general grain size are permitted in any specific area of 100 adjacent grains. Bands of fine or coarse grains are not permitted.

3.7.2.3 Surface Hardening: Parts shall have no change in hardness from core to surface except as produced during rolling of threads. There shall be no evidence of carburization or nitriding. In case of dispute over results of the microscopic examination, microhardness testing shall be used as a referee method; a Vickers hardness reading 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.

3.7.3 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.

3.7.3.1 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° 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° 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.

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3.7.3.2.1 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 3.7.3.2.2 through 3.7.3.2.5 provided the separation between indications in all directions is not less than 0.062 in.

3.7.3.2.2 Sides of Shoulders: There shall be not more than three indications per shoulder. 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.

3.7.3.2.3 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 3.7.1.3.

3.7.3.2.5 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 3.7.3.2.2, 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 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.

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4.3.2 Hardness Test (See 3.6.2): A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 6, Column A. 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 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 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.

4.3.4 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, 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.

4.3.5 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 Test Specimens:

Specimens for tensile and stress-rupture testing of machined test specimens shall be of standard proportions in accordance with ASTM E 8 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 nominal 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.

4.5 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, and stress-rupture requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, AS7481, lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

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4.6 Resampling and Retesting:

If any part or specimen used in the above 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, STEEL, CORROSION AND HEAT RESISTANT
AS7481
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, incustrial 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.

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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:

Studs, procurement specification

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

FIGURE 1 - Flow Lines, Rolled Thread

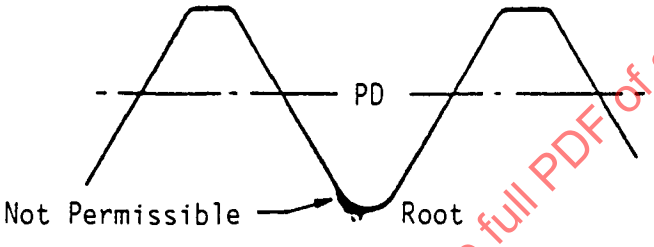

FIGURE 2 - Root Defects, Rolled Thread

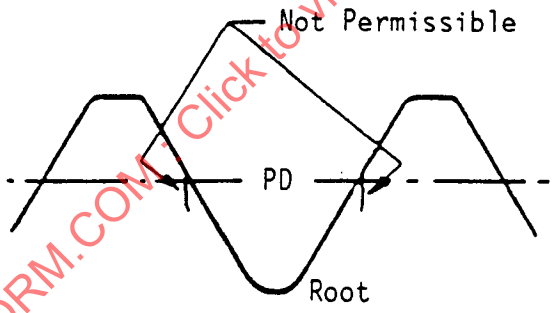

FIGURE 3 - Laps Below PD Extending Toward Root, Rolled Thread

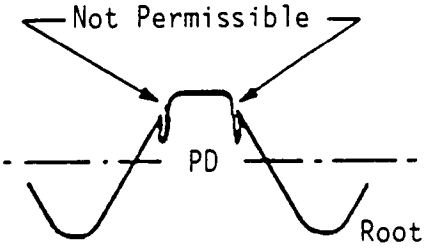

FIGURE 4 - Laps Above PD Extending Toward Root, Rolled Thread

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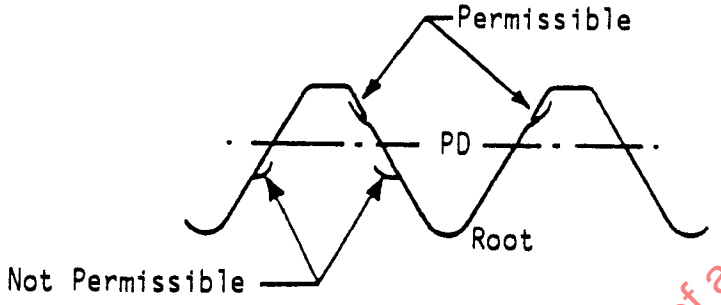
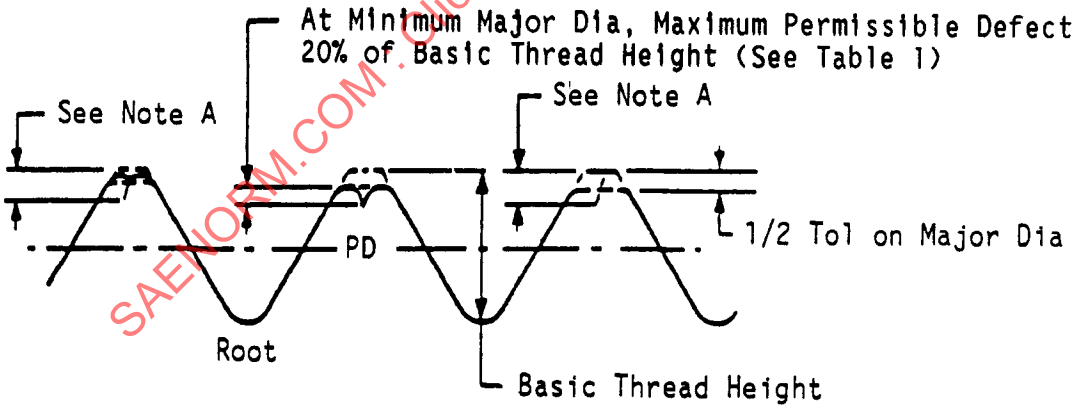


FIGURE 5 - Laps Extending Towards Crest, Rolled Thread



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 6 - Crest Craters and Crest Laps, Rolled Thread

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TABLE 1 - 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.

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TABLE 2 - Test Loads

Stepped Studs Nut End Thread Size	Ultimate Tensile Strength Test Load lbf, minimum Standard Pitch Dia UN Threads	Ultimate Tensile Strength Test Load lbf, minimum Standard Pitch Dia UNJ Threads	Ultimate Tensile Strength Test Load lbf, minimum Reduced Pitch Dia UNJ Threads	Stress-Rupture Strength Test Load lbf Standard Pitch Dia UN Threads	Stress-Rupture Strength Test Load lbf Standard Pitch Dia UNJ Threads	Stress-Rupture Strength Test Load lbf Reduced Pitch Dia UNJ Threads
0.164 -32	1 850	1 880	1 800	806	835	797
0.164 -36	1 940	1 970	1 890	862	889	849
0.190 -32	2 640	2 670	2 580	1 170	1 210	1 160
0.250 -28	4 790	4 840	4 710	2 170	2 220	2 160
0.3125-24	7 630	7 720	7 550	3 490	3 570	3 490
0.375 -24	11 500	11 600	11 400	5 360	5 460	5 360
0.4375-20	15 600	15 700	15 500	7 220	7 360	7 250
0.500 -20	21 000	21 100	20 900	9 820	9 990	9 850
0.5625-18	26 600	26 800	26 500	12 500	12 700	12 500
0.625 -18	33 500	33 700	33 400	15 800	16 100	15 900
0.750 -16	48 800	49 100	48 700	23 100	23 500	23 200

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Note 1: Requirements above apply to stepped studs nut end threads with UN or UNJ thread profiles as noted for the thread sizes shown, to Class 3A tolerances; requirements for reduced pitch diameter UNJ threaded parts are based on 0.003 in reduction below standard major, pitch, and minor diameters. The unthreaded shank area for the above stepped studs is equal to or greater than the tensile stress area for the nut end thread. The diameter of the nut end thread area upon which stress for ultimate tensile strength test load is based is equal to one-half of the sum of the maximum pitch diameter and the maximum minor (root) diameter of the thread, calculated from Equations 1 and 2:

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

$$\text{UNJ Threads:}\quad A = 0.7854[D - (0.9021/n)]^2 \qquad \text{(Eq.2)}$$

where:

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