SAE INTERNATIONAL

AEROSPACE STANDARD

AS7452™ REV. C

Issued 1991-02
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Superseding AS7452B

(R) Bolts and Screws, Steel, Low Alloy Heat Treated, Roll Threaded
FSC 5306

RATIONALE

AS6416 added, many paragraphs updated or deleted, specs updated, photo of bolt head deleted, figures redrawn, notes updated, usage note added.

1. SCOPE

1.1 Type

This procurement specification covers aircraft quality bolts and screws made from a low alloy steel of the type identified under the Unified Numbering System as UNS G87400, and of a series of room temperature tensile strengths ranging from 125000 to 185000 psi.

1.2 Application

Primarily for aerospace propulsion system bolt applications where good strength is required and the part is protected against corrosion.

1.2.1 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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For more information on this standard, visit
https://www.sae.org/standards/content/AS7452C/

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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2750 Pyrometry

AMS6322 Steel Bars, Forgings, and Rings, 0.50Cr - 0.55Ni - 0.25Mo (0.38 - 0.43C) (SAE 8740)

AMS6327 Steel Bars and Forgings, 0.50Cr - 0.55Ni - 0.25Mo (0.38 - 0.43C) (SAE 8740) Heat Treated, 125 ksi (862 MPa) Tensile Strength

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

AS3062 Bolts, Screws and Studs, Screw Thread Requirements

AS3063 Bolts, Screws, and Studs, Geometric Control Requirements

AS6416 Bolts, Screws, Studs, and Nuts, Definitions for Design, Testing and Procurement

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

2.1.2 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 D3951 Standard Practice for Commercial Packaging

ASTM E8/E8M Standard Test Method for Tension Testing of Metallic Materials

ASTM E140 Standard Hardness Conversion Tables for Metals

ASTM E1444/E1444M Standard Practice for Magnetic Particle Testing

2.1.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

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

2.1.4 AIA Publications

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

NASM1312-6 Fastener Test Methods, Method 6, Hardness

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

NASM1312-12 Fastener Test Methods, Method 12, Plating Thickness

2.2 Definitions

Refer to AS6416.

2.3 Unit Symbols

A ampere

°F degree Fahrenheit

% 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 AMS6322, or AMS6327 steel, unless otherwise specified on the part drawing.

3.2 Design

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

3.2.1 Dimensions

The dimensions shall conform to the part drawing, unless otherwise stated Dimensions apply after plating but before lubrication.

3.2.2 Surface Texture

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

3.2.3 Threads

Threads shall be in accordance with AS8879, unless otherwise specified on the part drawing.

3.2.3.1 Incomplete Threads

Incomplete runout and lead threads are permissible as specified in AS3062.

3.2.3.2 Chamfer

Bolts shall be chamfered as specified on the part drawing.

3.2.4 Geometric Tolerances

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

3.3 Fabrication

3.3.1 Blanks

Heads shall be formed by hot or cold forging 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 Heat Treatment

Headed blanks 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 parts 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 no surface hardening by carburizing or nitriding nor decarburization other than that permitted by 3.6.2.2 and 3.6.2.3.

3.3.2.2 Hardening

Blanks of AMS6322 shall be uniformly heated to a temperature within the range 1500 to 1550 °F, held at heat for not less than 15 minutes, and quenched in oil. For other steels, when specified, the temperature shall be as agreed by purchaser and vendor.

3.3.2.3 Tempering

Hardened blanks shall be tempered by heating uniformly to a temperature necessary to produce the specified hardness and microstructure, holding at heat for not less than 1 hour and cooling.

3.3.3 Oxide and Decarburization Removal

Surface oxide and decarburization except as permitted in 3.6.2.3, resulting from prior heat treatment, shall be removed from the full body diameter and bearing surface of the head of the heat treated blanks prior to cold working the under head fillet radius when specified and rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks. The metal removed from the bearing surface of the head and the full body diameter of the shank shall be as little as practicable to obtain a clean, smooth surface. and, in no case, shall be so great as to produce more cutting of flow lines in the head-to-shank junction of forged headed parts than shown in Figure 1B.

3.3.4 Cold Working of Fillet Radius

After removal of oxide and decarburization as in 3.3.3, shall be cold worked. Distortion due to cold working shall conform to Figure 1, unless otherwise specified on the part drawing. It shall not raise metal more than 0.002 inches above the contour at “A” or depress metal more than 0.002 inches below the contour at “B” as shown in Figure 1.

3.3.4.1 Thread Rolling

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

3.3.4.2 Undercut Bolt Heads

In configurations having an undercut connected with the fillet radius, the cold working will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head.

3.3.4.3 Shouldered Bolts

For shouldered bolts, having an unthreaded shank diameter larger than the thread major diameter and having an undercut connected with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for 90 degrees of the fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank.

3.3.4.4 Close Tolerance Bolts

The shank diameter on full shank close tolerance bolts shall not exceed its maximum diameter limit after cold rolling the head to shank fillet radius.

3.3.5 Thread Rolling

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

3.4 Plating

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

3.5 Mechanical Properties

Bolts for tensile test shall be of sufficient size and strength to develop the full strength of the bolt 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 in accordance with the following applicable test methods:

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

Ultimate Tensile Strength at Room Temperature: 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 having hardness not lower than 26 HRC 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 conform to only the tensile 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 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 the 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/E8M on specimens prepared as in 4.4. Such specimens shall meet requirements in Table 1:

Table 1 - Tensile properties of test specimens

Minimum Hardness of Specified Range HRC	Ultimate Tensile Strength psi, Minimum	Elongation in 2 Inches or 4D %, Minimum	Reduction of Area %, Minimum
26	125000	15	52
32	145000	13	50
36	165000	12	47
40	185000	10	43

3.5.2 Hardness

Hardness shall conform to the part drawing but not be less than 26 HRC.

3.6 Quality

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs (light burrs may be acceptable if part performance is not affected) and foreign materials, and from imperfections detrimental to their performance.

3.6.1 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), 50% water for sufficient time to reveal flow lines but not longer than 15 minutes, and then examined at a magnification of approximately 20X or greater to determine conformance to the requirements of 3.6.1.1, 3.6.1.2, and 3.6.1.3, except that examination for thread imperfections as specified in 3.6.1.3 should be made by microscopic examination of specimens polished and etched as in 3.6.2.

3.6.1.1 Flow Lines

3.6.1.1.1 Head-to-Shank

After heading, examination of an etched section taken longitudinally through the blank shall show flow lines or heat pattern in the shank, head-to-shank fillet, and the bearing surface which are representative of a forging process and shall follow the head contour.

3.6.1.1.2 Threads

3.6.1.2 Internal Imperfections

Examination of a longitudinal section through the threaded portion of the shank shall show evidence that the threads were rolled. 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 2).

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 3.6.1.3.3 and 3.6.1.3.4. 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.

3.6.1.3 Threads

3.6.1.3.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (see Figure 3).

3.6.1.3.2 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 4, 5, and 6).

3.6.1.3.3 Single lap on thread profile shall conform to the following, A rateable lap shall have its length equal to or greater than three times its width. The minimum interpretable lap size is 0.0005 inch length or depth when viewed at 200X magnification.

3.6.1.3.4 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 4). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or non-pressure flank (one lap at any cross-section through the thread) provided it extends towards the crest and generally parallel to the flank (see Figure 4).

3.6.1.3.5 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 7). 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 1/2 of the difference between the minimum major diameter and the actual major diameter as measured on the part.

3.6.2 Microscopic Examination

Specimens cut from the parts shall be polished, etched in 2% Nital, and examined at a magnification not lower than 100X to determine conformance to the requirements of 3.6.1.3, 3.6.2.1, and 3.6.2.2

3.6.2.1 Microstructure

Parts shall have microstructure of tempered martensite.

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. There shall be no evidence of carburization, recarburization, or nitriding. In case of dispute over results of the microscopic examination, microhardness testing in accordance with NASM1312-6 shall be used as a referee method; a Vickers hardness reading within 0.003 inch 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 Decarburization

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

3.6.2.3.2 The 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 for the size of stock used to make the part.

3.6.2.3.3 The depth of decarburization on the OD of the head of cylindrical head parts is not restricted.

3.6.2.3.4 The depth of decarburization at any point on the surface not covered by 3.6.2.3.1, 3.6.2.3.2, or 3.6.2.3.3 shall not exceed 0.002 inch.

3.6.3 Magnetic Particle Inspection

Parts shall be subject to magnetic particle inspection in accordance with ASTM E1444/E1444M; any method may be used but resolution of disputed rejections shall be based upon wet, continuous, fluorescent suspension method using amperages shown in 3.6.3.1.

3.6.3.1 Procedures

3.6.3.1.1 Circular Magnetization

A current of 800 to 1000 A per square inch of contact area passed through the part longitudinally.

3.6.3.1.2 Longitudinal Magnetization

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

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

3.6.3.2.1 Discontinuities transverse to grain flow (i.e., at an angle of more than 10 degrees to the axis of the shank), such as grinding checks and quench cracks.

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

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

3.6.3.3.1 Parts having longitudinal indications (i.e., at an angle of 10 degrees or less to the axis of the shank) of seams, forming laps, and nonmetallic inclusions parallel to the grain flow that are within the limits specified in 3.7.3.2.2 through 3.7.3.2.5 provided the separation between indications in all directions is not less than 0.062 inch.

3.6.3.3.2 Sides of Head

There shall be not more than six indications 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 inch or the equivalent of the basic thread height (see Table 2), whichever is less.

3.6.3.3.3 Shank

There shall be no 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.

3.6.3.3.4 Threads

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

3.6.3.3.5 Top of Head and End of Stem

The number of indications is not restricted, but the depth of any individual indication shall not exceed 0.010 inch, as shown by sectioning representative samples. No indication, except those of 3.3.6.2.2, 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 Classification of 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 Material

Sampling for material composition on each heat shall be in accordance with AMS6322 or AMS6327.

4.3.2 Nondestructive Test - Visual and Dimensional

A random sample shall be selected from each production inspection lot; the size of the sample to be as specified in Table 5. The classification of dimensional characteristics shall be as specified in Table 6. All dimensional characteristics are considered defective when out of tolerance.

4.3.3 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 7. 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 Magnetic Particle Inspection

A random sample shall be as selected from each production inspection lot; the size of the sample shall be as specified in Table 5 and classified as 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.

4.3.5 Destructive Tests

A random sample shall be selected from each production inspection lot; the size of the sample shall be as specified in Table 7. The sample units may be selected from those that have been subjected to and passed the nondestructive tests and the magnetic particle inspection, with additional units selected at random from the production inspection lot as necessary.

4.3.6 Acceptance Quality

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

4.4 Test Specimens

Specimens for tensile testing of machined test specimens shall be of standard proportions in accordance with ASTM E8/E8M with either 0.250 inch diameter at the reduced parallel gage section or smaller specimens proportional to the standard when required. Specimens shall be machined from finished parts or coupons of the same lot of alloy and be processed together with the parts they represent. Specimens shall be machined from the center of parts 0.750 inch and under in nominal diameter, from the center of coupons 0.800 inch and under in nominal diameter or distance between parallel sides, and from mid-radius of larger parts or coupons.

4.5 Reports

The vendor of parts shall furnish with each shipment a report for all tests. This report shall include the purchase order number, AS7452C, lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.6 Rejected Lots

Failure of a nondestructive test requirement, the vendor of parts shall perform corrective action to screen out or rework the defective parts, resubmit for acceptance tests inspection as in Table 3, or scrap the entire lot. Resubmitted lots shall be clearly identified as reinspected lots.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Identification

5.1.1 Packaging shall be in accordance with ASTM D3951.

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

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

FASTENERS, STEEL, LOW ALLOY
AS7452C
PART NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

5.1.4 Threaded fasteners shall be suitably protected from damage during handling, transportation, and storage.

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.

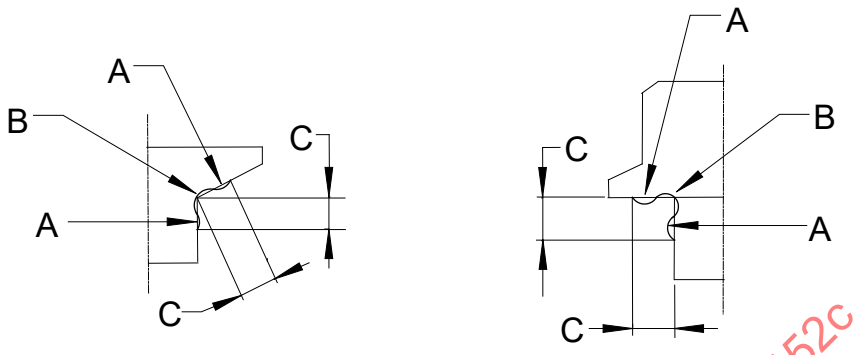
8. NOTES

8.1 Hardness conversion tables for metals are presented in ASTM E140.

8.2 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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



Nominal Bolt Diameter	C Max Inch
Up to 0.3125	0.062
0.3125 and 0.375	0.094
0.4375 to 0.625	0.125
0.750 to 1.000	0.156
Over 1.000	0.188

Figure 1 - Permissible distortion from fillet working

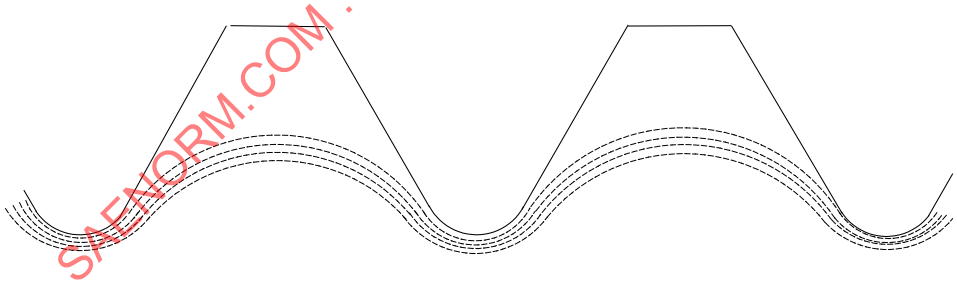


Figure 2 - Flow lines, rolled thread

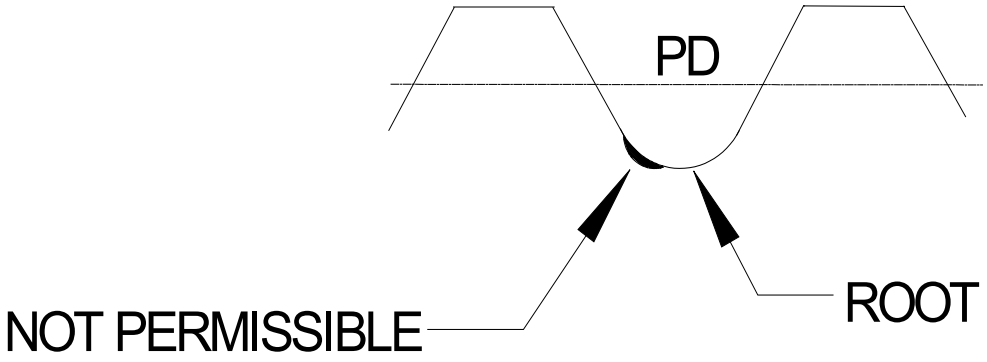


Figure 3 - Root defects, rolled thread

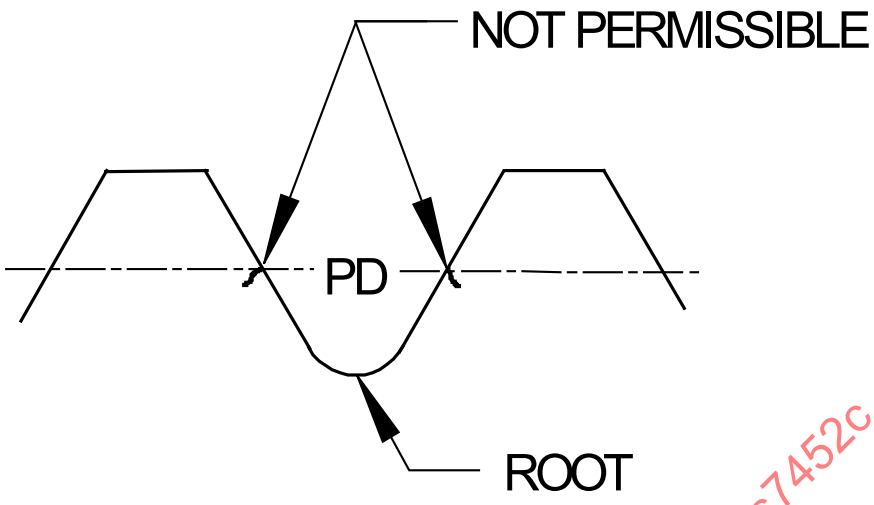


Figure 4 - Laps below pd extending toward root, rolled thread

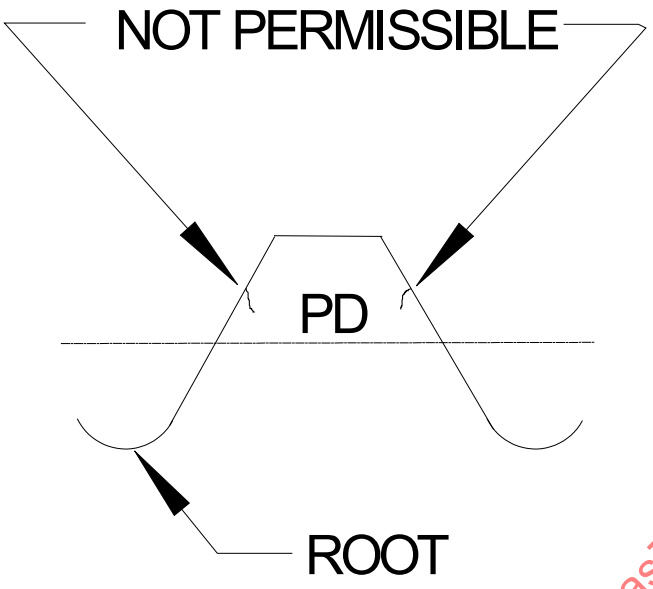


Figure 5 - Laps above pd extending toward root, rolled thread

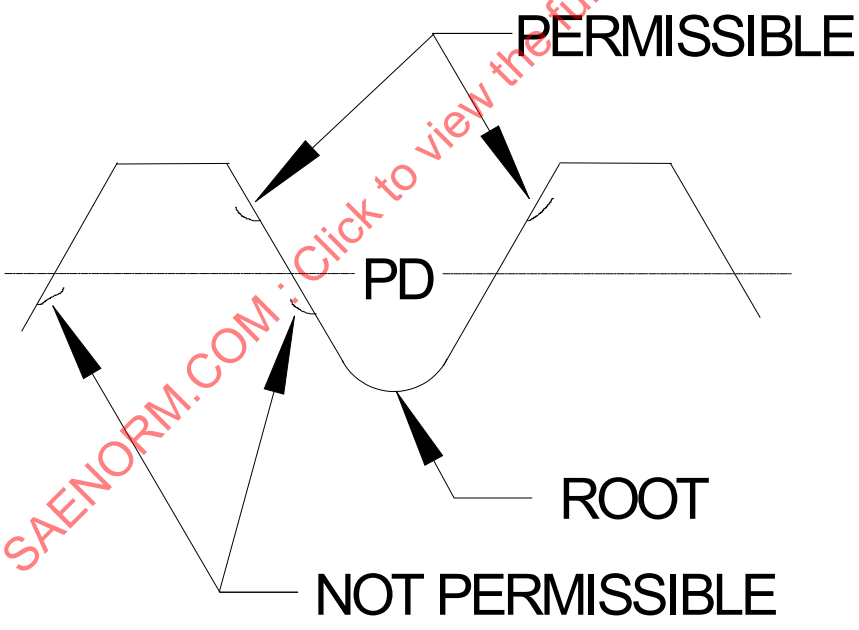
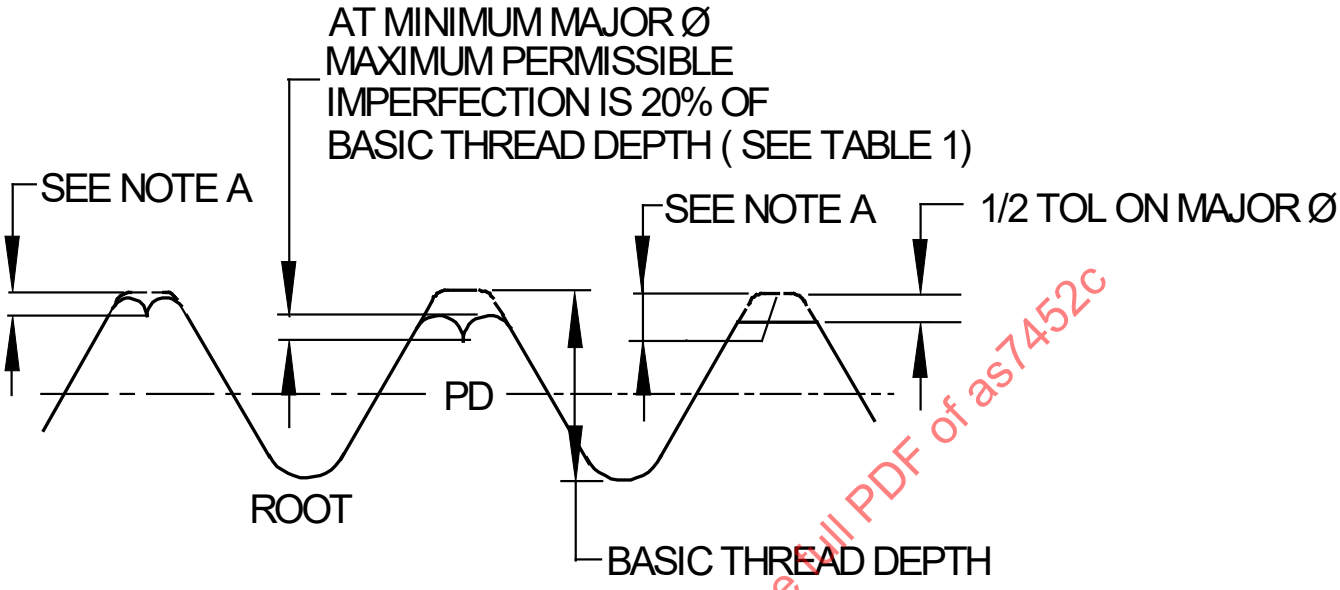


Figure 6 - Laps extending towards crest, rolled thread



NOTE A
MAXIMUM DEPTH OF IMPERFECTION EQUALS 20% OF 2H/3 BASIC THREAD DEPTH PLUS 1/2 THE DIFFERENCE OF THE ACTUAL MAJOR DIAMETER AND MINIMUM MAJOR DIAMETER

Figure 7 - 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	Ultimate Tensile Strength Load lbf, minimum
0.112 -40	865
0.112 -48	914
0.138 -32	1 310
0.138 -40	1 400
0.164 -32	1 950
0.164 -36	2 010
0.190 -32	2 720
0.250 -28	4 850
0.3125-24	7 680
0.375 -24	11 900
0.4375-20	16 100
0.500 -20	21 500
0.5625-18	27 200
0.625 -18	34 000
0.750 -16	49 400
0.875 -14	67 400
1.000 -12	87 800

Note 1: Requirements above apply to parts with UNC, UNF, UNJC, or UNJF threads, as applicable to the sizes shown, and having hardness within the range 26 to 32 HRC. For nominal thread diameter 0.3125 in and smaller, area upon which stress is based is 98% of the maximum pitch diameter, calculated from Equation 1:

$$A = 0.7854[0.98(D - (0.6495/n))]^2 \quad \text{(Eq.1)}$$

where:

A = area at 98% of PD maximum
D = maximum major diameter
n = number of thread pitches per inch

For nominal thread major diameter larger than 0.3125 in, area upon which stress is based is the maximum pitch diameter, calculated from Equation 2:

$$A = 0.7854[D - (0.6495/n)]^2 \quad \text{(Eq.2)}$$

Load requirements are based on 125 000 psi for ultimate tensile strength test load at room temperature.