# AEROSPACE STANDARD

**AS7471™** | **REV. K**

Issued 1991-01
Reaffirmed 1997-07
Revised 2023-02

Superseding AS7471J

Bolts and Screws, Nickel Alloy, UNS N07001
Tensile Strength 165 ksi, Corrosion- and Heat-Resistant
Procurement Specification

FSC 5306



RATIONALE

Revision to add paragraphs for undercut bolts (3.3.4.1), shouldered bolts (3.3.4.2), and close tolerance bolts (3.3.4.3).

## 1. SCOPE

### 1.1 Type

This procurement specification covers bolts and screws made from a corrosion- and heat-resistant, age hardenable nickel base alloy of the type identified under the Unified Numbering System as UNS N07001. The following specification designations and their properties are covered:

AS7471 165 ksi minimum ultimate tensile strength at room temperature.
75 ksi stress-rupture strength at 1350 °F.

AS7471-1 165 ksi minimum ultimate tensile strength at room temperature.
99 ksi minimum ultimate shear strength at room temperature.

### 1.2 Application

Primarily for aerospace propulsion systems bolt applications where a good combination of tensile strength and resistance to relaxation at elevated temperatures up to approximately 1500 °F is required.

### 1.3 Safety - Hazardous Materials

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



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https://www.sae.org/standards/content/AS7471K/

## 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 documents shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification 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.

#### 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.

AMS2700 Passivation of Corrosion-Resistant Steels

AMS2750 Pyrometry

AMS5708 Nickel Alloy, Corrosion- and Heat-Resistant, Bars, Wire, Forgings, and Rings, 58Ni - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al - 0.05Zr - 0.006B, Consumable Electrode or Vacuum Induction Melted, 1975 °F (1079 °C), Solution Heat Treated

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 AIA/NAS 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

NASM1312-10 Fastener Test Methods, Method 10, Stress-Rupture

NASM1312-13 Fastener Test Methods, Method 13, Double Shear Test

#### 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 A380 Practice for Cleaning and Descaling of Stainless Steel Parts

ASTM A967 Chemical Passivation Treatment for Stainless Steel

ASTM D3951 Standard Practice for Commercial Packaging

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

ASTM E112 Determining Average Grain Size

ASTM E139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

ASTM E140 Standard Hardness Conversion Tables for Metals

ASTM E340 Standard Test Methods for Microetching Metals and Alloys

ASTM E407 Standard Practice for Microetching Metals and Alloys

ASTM E930 Standard Test Methods for Estimating the Largest Grains Observed in a Metallographic Section (ALA Grain Size)

ASTM E1417/E1417M Standard Practice for Liquid Penetrant Testing

2.1.4 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)

2.2 Definitions

Refer to AS6416.

2.3 Unit Symbols

°C degree Celsius

°F degree Fahrenheit

$cm^3$ cubic centimeter

g gram (mass)

HRC hardness Rockwell C scale

lbf pound-force

% percent (1% = 1/100)

sp gr specific gravity

ksi kips (1000 pounds) per square inch

# 3. TECHNICAL REQUIREMENTS

## 3.1 Material

Shall be AMS5708 alloy heading stock.

## 3.2 Design

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

### 3.2.1 Dimensions

The dimensions of finished partsshall conform to the part drawing. Unless otherwise specified 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 Lead and Runout Threads

Incomplete runout and 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 forging; machined heads are not permitted, except lightening holes and 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

Before finishing the shank and the bearing surface of the head, cold rolling the head-to-shank fillet radius, and rolling the threads, headed blanks shall be solution and stabilization heat treated as follows; precipitation heat treatment shall follow cold rolling of the fillet radius and rolling the threads.

#### 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.

3.3.2.2 Solution Heat Treatment

Headed blanks shall be solution heat treated by heating to a temperature within the range 1900 to 1975 °F, holding at the selected temperature within ±25 °F for 1 to 4 hours, and cooling at a rate equivalent to air cool or faster.

3.3.2.2.1 A temperature lower than 1900 °F may be used provided the furnace control is such that during the holding period no part is below 1875 °F.

3.3.2.3 Stabilization Heat Treatment

Solution heated blanks shall be stabilization heat treated by heating to 1550 °F ± 15 °F, holding at heat for 4 hours ± 0.5 hour, and cooling in air.

3.3.2.4 Precipitation Heat Treatment

After cold rolling the fillet radius as in 3.3.4 and rolling the threads as in 3.3.5, parts shall be precipitation heat treated by heating to 1400 °F ± 15 °F in a controlled atmosphere, holding at heat for 16 hours ± 1 hour, and cooling at a rate equivalent to air cool.

3.3.3 Oxide Removal

Surface oxide resulting from prior heat treatment shall be removed from the full body diameter, thread roll diameter and bearing surface of the head of the solution and stabilization heat treated blanks prior to cold rolling the underhead fillet radius and rolling the threads. The oxide removal process shall produce no intergranular attack or corrosion of the blanks.

3.3.4 Cold Rolling of Fillet Radius

After removal of oxide as in 3.3.3, the head-to-shank fillet radius of headed parts having the radius complete throught the circumference of the part shall be cold worked. The fillet shall be cold worked sufficiently to remove all visual evidence of grinding or tool marks. If there is no visual evidence of grinding or tool marks prior to cold working, the fillet shall still 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; distorted areas shall not extend beyond “C” as shown in Figure 1. The shank diameter on close tolerance full shank parts shall not exceed its maximum diameter limit after cold rolling the head-to-shank fillet radius.

3.3.4.1 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.

3.3.4.2 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.

3.3.4.3 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 finished blanks by a single rolling process after removal of oxide as in 3.3.3.

3.3.6 Cleaning

Bolts, after finishing, shall be cleaned in one of the following solutions for the time and temperature shown and then thoroughly rinsed:

a. One volume of nitric acid (sp gr 1.42) and 9 volumes of water for not less than 20 minutes at room temperature.

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

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

d. ASTM A967, ASTM A380 or AMS2700 for cleaning parts only, excluding any additional verification requirements (such as salt spray).

3.4 Plating or Coating

Where required, bolts shall be plated or coated as specified by the part drawing.

3.5 Mechanical Properties

Bolts for tensile and stress-rupture tests shall be of sufficient size to develop the full strength of the bolt without stripping the thread.

AS7471 finished parts shall be tested in accordance with the following test methods:

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

b. Ultimate Tensile Strength at Room Temperature: MIL-STD-1312-8 in accordance with NASM1312-8

c. Stress-Rupture Strength at 1350 °F: MIL-STD-1312-10 in accordance with NASM1312-10

AS7471-1 finished parts shall be tested in accordance with the following test methods:

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

b. Ultimate Tensile Strength at Room Temperature: MIL-STD-1312-8 in accordance with NASM1312-8

c. Ultimate Shear Strength at Room Temperature: MIL-STD-1312-13 in accordance with NASM1312-13

3.5.1 Ultimate Tensile Strength at Room Temperature

3.5.1.1 Finished Parts



Tension bolts, such as hexagon, double hexagon, and spline drive head, shall have an ultimate tensile load not lower than that specified in Table 2A and shall be tested to failure in order to observe fracture location, first measuring and recording the maximum tensile load achieved. Screws, such as 100 degree flush head, pan head, and fillister head, shall have an ultimate tensile load not lower than that specified in Table 2B; screws need not be tested to failure, however the maximum tensile load achieved shall be measured and recorded. 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 minor (root) diameter or having an undercut, parts shall have an ultimate tensile strength not lower than 165 ksi; for such parts, the diameter of the area on which stress is based shall be the actual measured minimum diameter of the part at the location of the fracture. Tension fasteners with either standard hexagon, double hexagon, or spline drive 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 connected 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/E8M on specimens prepared as in 4.3.8. Specimens may be required by the purchaser to perform confirmatory tests. Such specimens shall meet the following requirements:

a. Ultimate Tensile Strength, minimum: 165 ksi

b. Yield Strength at 0.2% Offset, minimum: 105 ksi

c. Elongation in 4D, minimum: 15%

d. Reduction of Area, minimum: 18%

3.5.2 Hardness

Shall be uniform and within the range 34 to 44 HRC (see 8.1), but hardness of the threaded section and the head-to-shank fillet may be higher as a result of the cold rolling operations. Bolts shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.5.3 Stress-Rupture Strength at 1350 °F

3.5.3.1 Finished Parts

Finished tension bolts, maintained at 1350 °F ± 3 °F while the stress rupture load specified in Table 2A is applied continuously, shall not rupture in less than 23 hours. If the shank diameter of the part is less than the maximum minor (root) diameter of the thread but the parts can be tested satisfactorily, parts shall conform to the requirements of 3.5.3.1.1

3.5.3.1.1 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 3.5.3.2. The diameter of the area on which the stress is based shall be the actual measured minimum diameter of the part.3.5.3.2.

3.5.3.2 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 shall be prepared as in 4.4.8, maintained at 1350 °F ± 3 °F while a load sufficient to produce an axial stress of 75 ksi is applied continuously, shall not rupture in less than 23 hours. Tests shall be conducted in accordance with ASTM E139. Specimens may be required by purchaser to perform confirmatory tests.

3.5.4 Ultimate Shear Strength

Finished bolts having a close toleranced full shank as in AS1132 shall have an ultimate double shear load not lower than that specified in Table 2A. The double shear test may be discontinued without a complete shear failure after the ultimate shear load has been reached, first measuring and recording the maximum double shear load achieved. Shear bolts having special shank diameters shall have the minimum ultimate shear load based on 99 ksi minimum shear strength. Shear tests are not required for screws, such as 100 degree flush head, having a grip length less than 2.5 times the nominal diameter, or protruding head screws, such as pan head and fillister head, having a grip length less than 2 times the nominal diameter. Shear tests are not required for the following conditions:

a. Bolts and screws threaded to head.

b. Protruding head bolts and screws having coarse toleranced full shank.

c. Protruding head bolts and screws having PD or relieved shank.

3.6 Quality

Parts shall be uniform in quality and condition, free from burrs, foreign materials, and from imperfections, detrimental to the usage of the parts. There shall be no visual indication of discoloration, oxides or tint from final heat treatment.

3.6.1 Macroscopic Examination, Headed Blank

A longitudinal specimen cut from a headed blank shall be etched in accordance with ASTM E340 and ASTM E407, and examined at a magnification of 20X or greater to determine conformance to the requirements of 3.6.1.1 and 3.6.1.2.

3.6.1.1 Flow Lines

After heading and prior to heat treatment, examination of an etched section taken longitudinally through the blank as in 3.6.1 shall show flow lines or heat pattern in the shank, head-to-shank fillet, and bearing surface which are representative of a forging process and shall follow the head contour.

3.6.1.2 Internal Imperfections

Examination of longitudinal sections of the head and shank shall reveal no cracks, laps, or porosity, or other conditions detrimental to intended performance.

3.6.2 Microscopic Examination, Finished Parts

Specimens cut from finished parts shall be polished, etched in Kalling's reagent, Marble's reagent, or other suitable etchant, and examined at 100X magnification to determine conformance to the requirements of 3.6.2.1, 3.6.2.2, 3.6.2.3, and 3.6.2.4. Specimens cut from finished parts shall be polished, etched in Kalling's reagent, Marble's reagent, or other suitable etchant, and examined at 100X magnification to determine conformance to the requirements of 3.6.2.1, 3.6.2.2, 3.6.2.3, and 3.6.2.4.

3.6.2.1 Threads

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).

3.6.2.2 Microstructure

Parts shall have microstructure of completely recrystallized material except in the area of the threads and the head-to-shank fillet radius.

3.6.2.3 Grain Size

Grain size shall be an average ASTM No. 2 to No. 6, as determined in accordance with ASTM E112. Individual coarse grains larger than ASTM No. 2 but not as large as (ALA) ASTM No. 00, as determined by ASTM E930, may occur at an occasional (5 to 16% of structure) frequency. Coarse grains ALA ASTM No. 00 may occur at an isolated (0 to 5% of structure) frequency. Coarse grains shall be surrounded by grains which are ASTM No. 1 to No. 7 and at least two layers of grain distance away from the bearing surface and the fillet radius. Individual grains, which are as fine as ASTM No. 7, may occur at an occasional frequency. In the case of disagreement on grain size by the comparison method, the intercept (Heyn) procedure shall be used.

3.6.2.4 Threads

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

3.6.2.4.2 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 and 5).

3.6.2.4.3 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.

3.6.2.4.4 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).

3.6.2.4.5 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 1) 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.

3.6.3 Fluorescent Penetrant Inspection

Prior to any required plating or coating, parts shall be subject to fluorescent penetrant inspection in accordance with ASTM E1417/E1417M, Type 1, Sensitivity Level 2 minimum.

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 10 degrees to the axis of the shank), such as grinding checks and cracks.

3.6.3.1.2 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.

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

3.6.3.3 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 inch or the equivalent of the 2H/3 thread depth (see Table 1), whichever is less.

3.6.3.4 Shank

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.

3.6.3.5 Threads

There shall be no indications, except as permitted in 3.6.2.4. Rateable lap indications shall conform to 3.6.2.4.3.

3.6.3.6 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 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 Test Sampling

### 4.2.1 Material

Sampling for material composition on each heat shall be in accordance with AMS5708.

### 4.2.2 Nondestructive Test - Visual and Dimensional

A random sample of parts shall be taken from each production inspection lot; the size of the sample shall 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.

### 4.2.3 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.

### 4.2.4 Stress-Rupture Test

A random sample of a minimum of one part (or one test specimen where required) shall be selected from each production inspection lot.

### 4.2.5 Macroscopic Examination

4.2.6 A random sample of one part shall be selected from each production inspection lot. The size of the sample shall be as specified in Table 6.

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.



### 4.2.7 Acceptance Quality

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

### 4.2.8 Test Specimens

Specimens for tensile and stress-rupture testing of machined test specimens shall be of standard proportions in accordance with ASTM E8/E8M. 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.

## 4.3 Reports

The vendor of parts shall furnish with each shipment a report for all tests. This report shall include the purchase order number, AS7471H (or AS7471-1H, as applicable), lot number, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.4 Rejected Lots

Failure of a non-destructive test requirement as specified in Table 3 will require vendor of parts to perform corrective action to screen out or rework the non-conforming parts and resubmit for acceptance tests inspection as in Table 3. 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:

BOLTS (SCREWS), NICKEL ALLOY, CORROSION- AND HEAT-RESISTANT
AS7471 (OR AS7471-1, as applicable)
PART NUMBER
LOT 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

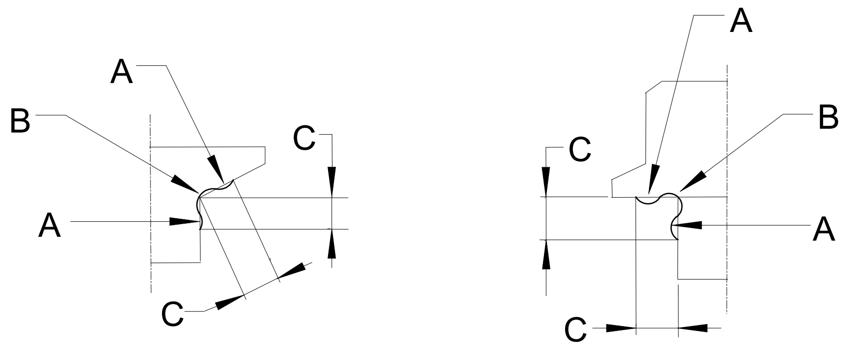
Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

## 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.




| Nominal Bolt Diameter | C Max Inch |
|---|---|
| Up to 0.3125 | 0.062 |
| 0.3125 to 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***

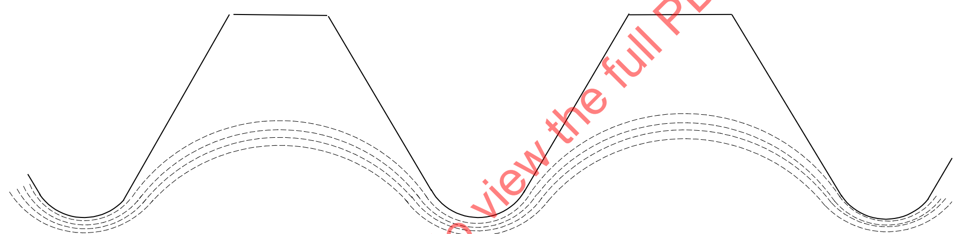


***Figure 2 - Flow lines, rolled thread***

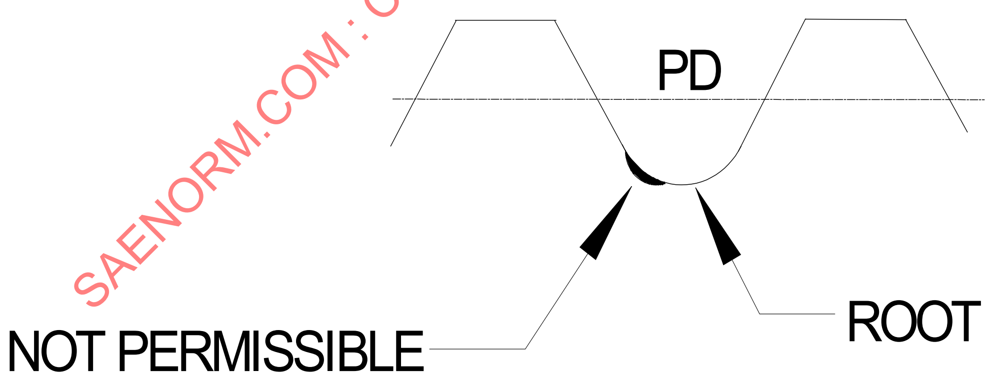



***Figure 3 - Root defects, rolled thread***

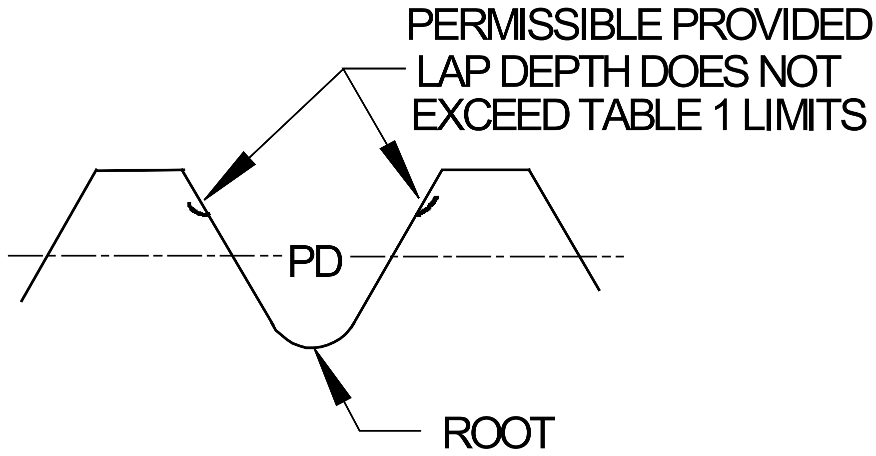



***Figure 4 - Laps above pitch diameter extending towards crest, rolled thread***

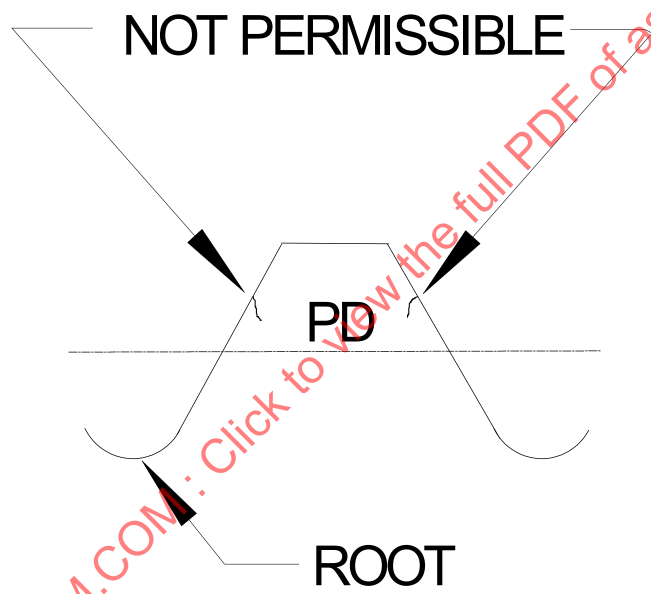



***Figure 5 - Laps above PD extending toward root, rolled thread***

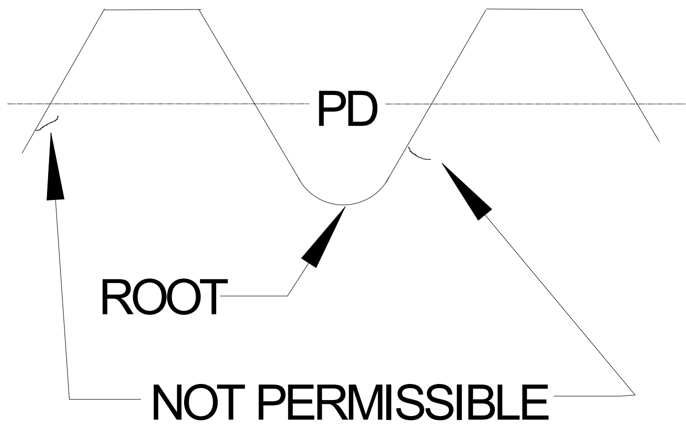



*Figure 6 - Laps below PD extending in any direction, rolled thread*

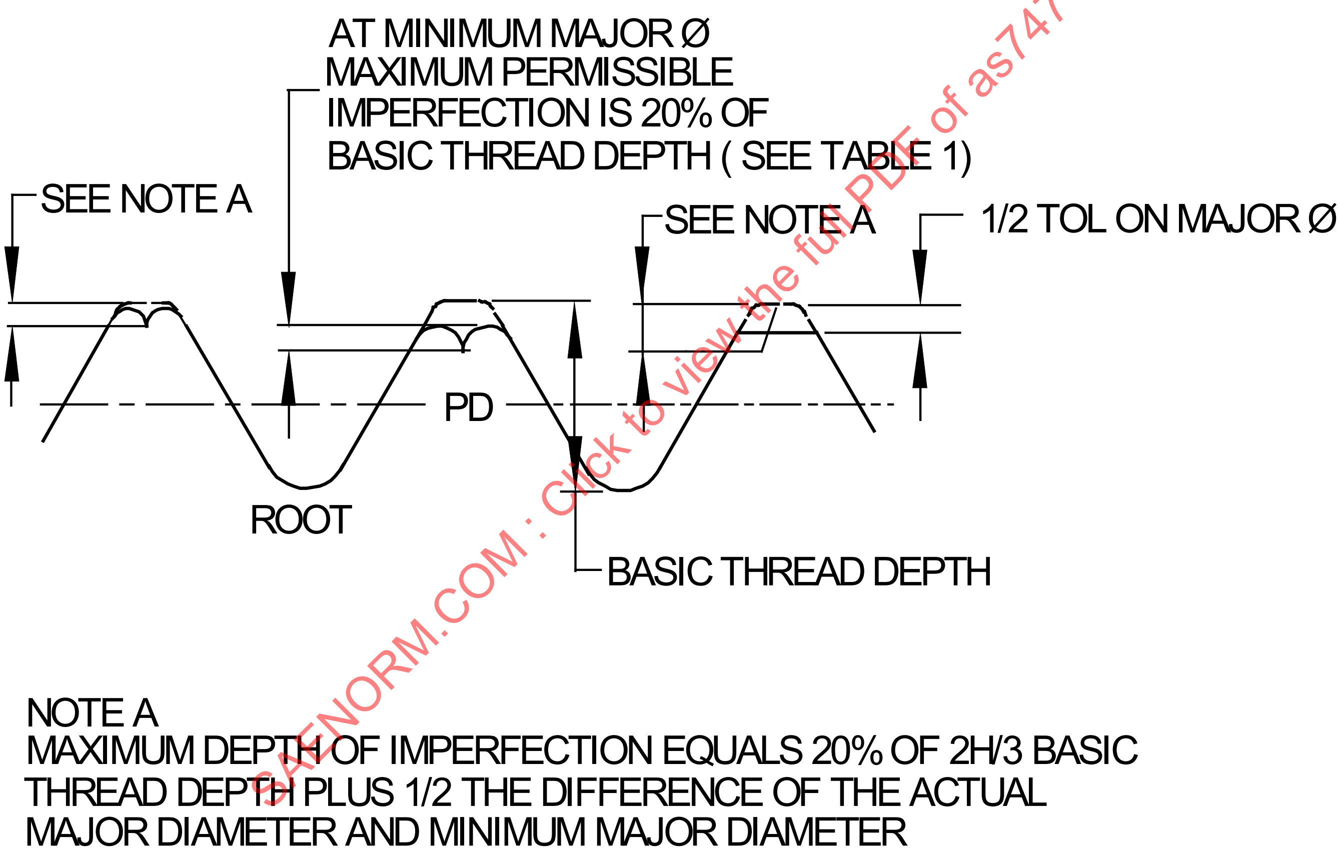



*Figure 7 - Crest craters and crest laps, rolled thread*

***Table 1 - UNJ ext thread depth at 2H/3 and allowable thread lap depths***

| Thread Pitches Per Inch n | UNJ External Thread Depth at 2H/3 Inch | Allowable Thread Lap Depth Inch /1/ |
|---|---|---|
| 80 | 0.0072 | 0.0014 |
| 72 | 0.0080 | 0.0016 |
| 64 | 0.0090 | 0.0018 |
| 56 | 0.0103 | 0.0021 |
| 48 | 0.0120 | 0.0024 |
| 44 | 0.0131 | 0.0026 |
| 40 | 0.0144 | 0.0029 |
| 36 | 0.0160 | 0.0032 |
| 32 | 0.0180 | 0.0036 |
| 28 | 0.0206 | 0.0041 |
| 24 | 0.0241 | 0.0048 |
| 20 | 0.0289 | 0.0058 |
| 18 | 0.0321 | 0.0064 |
| 16 | 0.0361 | 0.0072 |
| 14 | 0.0412 | 0.0082 |
| 12 | 0.0481 | 0.0096 |

NOTE 1: Allowable lap depth is based on 20% of UNJ external thread depth at 2H/3 in accordance with AS8879, and is calculated as follows:

Ext thread depth = 2H/3 = (2/3) (cos 30°)/n = 0.57735/n

Lap depth = 0.2(2H/3) = 0.2(2/3) (cos 30°)/n = 0.115447/n

***Table 2A - Test loads for bolts***

| Thread Size | Ultimate Tensile Strength Test Load, lbf, Minimum Standard Pitch Dia UN and UNJ Threads | Ultimate Tensile Strength Test Load, lbf, Minimum Reduced Pitch Dia UN Threads Only | Stress-Rupture Strength Test Load lbf, Standard Pitch Dia UN and UNJ Threads | Stress-Rupture Strength Test Load lbf, Reduced Pitch Dia UN and UNJ Threads Only | Ultimate Double Shear Test Load lbf, Minimum Room Temp |
|---|---|---|---|---|---|
| 0.1120-40 | 995 | 928 | 390 | 361 | 1950 |
| 0.1120-48 | 1090 | 1020 | 440 | 410 | 1950 |
| 0.1380-32 | 1500 | 1420 | 585 | 550 | 2960 |
| 0.1380-40 | 1670 | 1590 | 670 | 641 | 2960 |
| 0.1640-32 | 2310 | 2210 | 930 | 886 | 4180 |
| 0.1640-36 | 2430 | 2320 | 994 | 949 | 4180 |
| 0.1900-32 | 3300 | 3180 | 1360 | 1300 | 5610 |
| 0.2500-28 | 6000 | 5840 | 2500 | 2430 | 9720 |
| 0.3125-24 | 9580 | 9370 | 4020 | 3930 | 15200 |
| 0.3750-24 | 14500 | 14200 | 6180 | 6060 | 21900 |
| 0.4375-20 | 19600 | 19300 | 8340 | 8200 | 29800 |
| 0.5000-20 | 26400 | 26000 | 11300 | 11200 | 38900 |
| 0.5625-18 | 33500 | 33100 | 14400 | 14200 | 49200 |
| 0.6250-18 | 42200 | 41800 | 18300 | 18100 | 60700 |
| 0.7500-16 | 61500 | 61000 | 26700 | 26500 | 87500 |
| 0.8750-14 | 84100 | 63400 | 36500 | 36200 | 119000 |
| 1.0000-12 | 109400 | 108700 | 47500 | 47200 | 155500 |

NOTE 1: Requirements above apply to parts with UNC, UNF, UNJC, or UNJF threads, as applicable for the sizes shown, to Class 3A tolerances; requirements for reduced pitch diameter parts are based on 0.003 inch reduction below standard. The diameter of the area upon which stress for ultimate tensile strength test load is based is the UNJ basic minor diameter at 0.5625H thread depth, where H is the height of sharp V-thread, calculated from Equation 1:

$$\text{Std PD } A_1 = 0.7854\,[d - 1.125H]^2 = 0.7854\,[d - (0.9743/n)]^2 = 0.7854\,[d - (0.9743p)]^2 \qquad \text{(Eq. 1)}$$

$$\text{Reduced PD } A_2 = 0.7854\,[d - 0.003 - 1.125H]^2 = 0.7854\,[d - 0.003 - (0.9743/n)]^2 = 0.7854\,[d - 0.003 - (0.9743p)]^2 \qquad \text{(Eq. 2)}$$

where:

$A_1$ = area at the UN basic pitch diameter at 0.5625H thread depth, $in^2$

$A_2$ = area at the UN reduced basic pitch diameter at 0.5625H thread depth, $in^2$

d = maximum major diameter

H = height of sharp V-thread = (cos 30°)/n

n = number of threads per inch

p = pitch (1/n)