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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS4393

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Submitted for recognition as an American National Standard

NUT, SELF-LOCKING, UNS S66286, 1200 °F, 160 000 psi, UNJ THREAD

FSC 5310

1. SCOPE:

1.1 Type:

This specification establishes the requirements for the following types of self-locking nuts:

a. Wrenching Nuts: i.e., hexagon and double hexagon nuts.
b. Anchor Nuts: i.e., plate nuts, gang channel nuts, and shank nuts.

The wrenching nuts, shank nuts, and nut elements of plate and gang channel nuts are made of corrosion and heat resistant precipitation hardenable iron base alloy of the type identified under the Unified Numbering System as UNS S66286 and of 160 000 psi axial tensile strength at room temperature, with maximum conditioning temperature of parts at 1200 °F prior to room temperature testing.

1.2 Application:

Primarily for use in aerospace propulsion systems up to approximately 1200 °F for tension height nuts made from bar, forging, or sheet. Nuts are designed for use with bolts capable of developing 160 000 psi tensile strength at room temperature and having UNJ profile threads.

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 2411	Silver Plating, High Temperature Application
AMS 2645	Fluorescent Penetrant Inspection
AMS 2759/3	Heat Treatment of Precipitation Hardening Corrosion and Maraging Steel Parts
AMS 5525	Steel Sheet, Strip, and Plate, Corrosion and Heat Resistant, 15Cr-25.5Ni-1.2Mo-2.1Ti-0.006B-0.30V, 1800 °F (980 °C) Solution Heat Treated
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 (980 °C) Solution Heat Treated
AMS 5734	Steel Bars, forgings, and Tubing, Corrosion and Heat Resistant, 15Cr-25.5Ni-1.3Mo-2.1Ti-0.006B-0.30V, Consumable Electrode Melted, 1650 °F (900 °C) Solution Heat Treated

2.1.1.2 Aerospace Standards:

AS870	Wrenching Configuration, Double Hexagon (12-Point), for Threaded Fasteners
AS954	Design Data and Standardization of Thin Wall 12-Point Sockets and Box Wrenches for Aerospace Engine Use
AS1310	Fastener Torque for Threaded Applications, Definitions of
AS7477	Bolts & Screws, Steel, Corrosion & Heat Resistant, Upset Headed, Heat Treated, Roll Threaded, 1800 °F Solution and Precipitation Heat Treated

2.1.1.3 Aerospace Information Report:

AIR1471	Torque Tightening Fasteners

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-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
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	Fastener Test Methods
MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

2.1.3 ASTM Publication: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 112 Determining Average Grain Size

2.1.4 ANSI Publications: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

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

2.1.5 NAS Publications: Available from National Standards Association, Inc., 1200 Quince Orchard Boulevard, Gaithersburg, MD 20878.

NAS3353 Fixture - Bearing Surface Squareness Test Self-Locking Nuts

2.2 Definitions:

Refer to AS1310 for definitions related to fastener torque.

PRODUCTION LOT: Shall consist of finished nuts fabricated by the same process 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.

INSPECTION LOT: Shall consist of nuts from a single production lot, of the same part number.

ROOM TEMPERATURE: Ambient temperature (68 °F approximately).

2.3 Unit Symbols:

°	- degree, angle
°C	- degree Celsius
°F	- degree Fahrenheit
h	- hour
%	- percent (1% = 1/100)
lbf	- pounds force
lbf·in	- pounds force-inch, torque
psi	- pounds force per square inch
μin Ra	- microinch, roughness arithmetical average

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be a corrosion and heat resistant steel, AMS 5731, or AMS 5734 bars or forgings, as specified on the part drawing for wrenching nuts, shank nuts, and nut elements of plate and gang channel nuts. When specified on the part drawing, wrenching nuts and nut elements of plate or gang channel nuts may be formed from AMS 5525 sheet. Material for the retaining plate for plate nuts and channel for gang channel nuts shall be capable of meeting the requirements of this specification, and shall be as specified on the part drawing.

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.

3.2.1.1 Bearing Surface Perpendicularity: Shall be as specified on the part drawing when tested in accordance with Appendix A.

3.2.1.2 Geometric Tolerances: Part features shall be within the geometric tolerance specified on the part drawing when tested by conventional measuring methods, except for bearing surface perpendicularity as in 3.2.1.1.

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

3.2.3 Threads: Screw thread UNJ profile in accordance with MIL-S-8879.

3.2.3.1 Countersink: The entering end of the thread at the bearing surface and the end of the thread at the top of nut shall be countersunk as specified on the part drawing.

3.2.3.2 Plated Threads: Thread in plated nuts shall meet the material limits for coated threads specified in MIL-S-8879.

3.2.3.3 After Forming Self-Locking Feature: The upper threaded portion shall be formed out of round in any manner which provides self-locking nuts meeting the locking torque requirements of this specification. The plated nut shall allow the GO thread plug gage to enter a minimum of three turns before engagement of the locking element for tension nuts having overall length of threaded portion not less than 1.2 times the nominal thread diameter; nuts having shorter threaded portion shall allow GO thread plug gage to enter a minimum of three quarters of a turn.

3.2.4 Construction: The nut shall be of the prevailing torque-type, self-contained, all metal unit, including the self-locking feature. The locking feature shall not operate by means of separate movement and shall not depend upon pressure on the bearing surface for the locking action. Tool marks resulting from producing the self-locking feature shall blend smoothly without abrupt change.

3.3 Heat Treatment:

The nuts shall be solution and precipitation heat treated in accordance with AMS 2759/3 requirements for UNS S66286.

3.4 Product Marking:

Each part shall be identification marked as specified on the part drawing. Depressed characters shall have a rounded root form, depressed 0.010 in maximum.

3.5 Plating:

Unless otherwise specified on the part drawing, parts shall be silver plated in accordance with AMS 2411. On nuts with nominal thread diameter 0.250 in and larger, the plating on the thread flanks shall be not less than 0.0002 in thick when measured on the pitch diameter. Microscopic measurement of a sectioned nut shall be used as the referee method. Nuts with nominal thread diameter below 0.250 in shall show complete coverage on the thread surfaces. Plating on the other surfaces shall be 0.0003 to 0.0006 in thick, unless otherwise specified on the part drawing. No plating shall be applied to the retaining plate for floating plate nuts and channel for gang channel nuts, unless otherwise specified on the part drawing.

3.6 Mechanical Properties:

3.6.1 Hardness: Unless otherwise specified on the part drawing, the hardness after heat treatment as in 3.3 shall be uniform and within the range 32 to 39 HRC when tested in accordance with MIL-STD-1312-6. Sizes up to and including 0.375 in nominal thread diameter shall be sectioned and mounted. Mounting optional for larger sizes.

3.7 Metallurgical Properties:

3.7.1 Microstructure: Wrenching nuts and nut elements of anchor nuts shall have microstructure of completely recrystallized material, except for cold working effects of tapping and forming operation of locking feature.

3.7.2 Grain Size: Shall be predominantly 5 or finer with occasional grains as large as 2 in the base of the nut as determined by comparison of a polished and etched specimen with ASTM E 112 plate 2. In case of disagreement on grain size by the comparison method, the intercept (Heyn) procedure shall be used.

3.8 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.

3.8.1 Fluorescent Penetrant Inspection: Parts shall be subject to fluorescent penetrant inspection, prior to plating or with plating removed, in accordance with AMS 2645. Acceptance criteria of surface discontinuities shall be in accordance with Appendix J.

3.9 Product Performance Test: Refer to Tables 7 and 8 for details of sample sizes for Acceptance Test Plan and Qualification Approval Test Plan.

3.9.1 Axial Tensile Strength: Nuts shall withstand the minimum tensile load as specified in Table 1 without rupture, stripping, or appearance of cracks when tested as follows:

3.9.1.1 As Received Condition at Room Temperature: Nuts in as received condition tested in accordance with MIL-STD-1312-8, using alloy steel test bolts hardened and tempered to 40 HRC minimum and having threads in accordance with 3.2.3, shall withstand the axial tensile load specified in Table 1, applied at the rate specified at room temperature.

3.9.1.2 After Bake, at Room Temperature: Prior to testing, the nut shall be assembled on a bolt as specified in 3.10 with at least two thread turns protruding through the nut and baked for 6 h ± 0.25 at 1200 °F ± 15, and then cooled to room temperature. A new test bolt shall be used for each axial tensile test. Nuts shall be tested, after baking, at room temperature in accordance with MIL-STD-1312-8 and shall withstand the axial tensile load in Table 1, applied at the rate specified.

TABLE 1 - Axial Tensile Load

Nut Thread Size	Axial Tensile Load at Room Temp. lbf minimum /1/
0.138 -32UNJC-3B	1 190
0.138 -40UNJF-3B	1 400
0.164 -32UNJC-3B	1 914
0.164 -36UNJF-3B	2 056
0.190 -32UNJF-3B	2 805
0.250 -28UNJF-3B	5 210
0.3125-24UNJF-3B	8 389
0.375 -24UNJF-3B	12 940
0.4375-20UNJF-3B	17 440
0.500 -20UNJF-3B	23 780
0.5625-18UNJF-3B	30 210
0.625 -18UNJF-3B	38 410

NOTES:

/1/ Requirements above apply to companion bolts with UNJ threads to Class 3A tolerance. Area upon which stress for axial strength load requirements is based on the area at 0.75H thread depth and calculated from equation:

$$A = 0.7854[D - (1.5H)]^2 = 0.7854[D - (1.2990/n)]^2 \quad \text{(Eq.1)}$$

where:

A = area at 0.75H thread depth, in^2
H = height of sharp V-thread = (cos 30°)/n, in
n = number of thread pitches per inch
D = major diameter, maximum, in

Load requirements for axial strength load is based on 160 000 psi stress induced on area A. Axial tensile load is calculated from equation:

$$\text{Axial Tensile Load} = 160\,000 \times A, \text{ for load in lbf} \quad \text{(Eq.2)}$$

For sizes not shown, axial tensile strength load for nuts shall be based upon the respective bolt stress area using above equations and 160 000 psi stress.

3.9.1.3 Shank Nuts: Nuts with shanks designed to be flared at assembly (see Figure 1) shall be tested as in 3.9.1 except that the bearing plate hole shall be 0.004 to 0.008 in greater than the maximum shank diameter. It is not necessary to flare the shank for this test. The bearing plate hole shall be chamfered sufficiently to clear the shank nut bearing surface-to-shank maximum fillet.

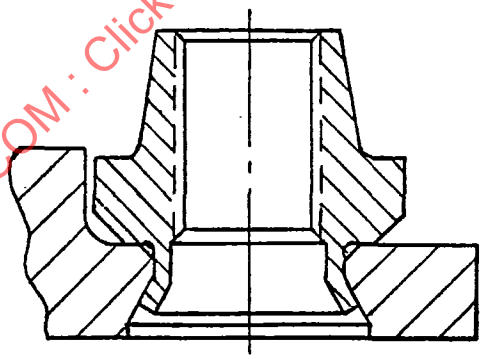


FIGURE 1 - Flange Assembly, Flared Shank Nut

3.9.2 Wrench Torque: Wrenching nuts with hexagon or double hexagon wrenching feature conforming to AS870 shall be tested as specified in Appendix A and shall withstand the wrench torques specified in Table 2 applied through 15 engagement cycles without any permanent deformation which can interfere with the use of socket wrenches conforming to AS954.

TABLE 2 - Wrench Torque

Nominal Thread Diameter in	Wrench Torque Minimum lbf·in
0.138	32
0.164	55
0.190	89
0.250	205
0.3125	410
0.375	720
0.4375	1 130
0.500	1 730
0.5625	2 460
0.625	3 390

3.9.3 Push Out Load: Anchor nuts shall be tested as specified in Appendix C and shall withstand the push out load specified in Table 3 without separating from the plate or channel. Nuts shall be serviceable after this test.

TABLE 3 - Push-Out Load

Nominal Thread Diameter in	Push Out Load minimum lbf
0.138	60
0.164	80
0.190	100
0.250	125
0.3125	125
0.375	125
0.4375	125
0.500	125
0.5625	125
0.625	125

3.9.3.1 The push out test in 3.9.3 is applicable to gang channel nuts, plate nuts (floating and nonfloating except side by side, corner and side mounted types). See Appendix A for definition of types.

3.9.4 Torque Out: Anchor nuts of the types in 3.9.3.1 shall be tested as specified in Appendix D and shall withstand the torque out loads in Table 4 without cracking, rupture, or being deformed to a degree which will prevent normal use. This test shall be performed with no axial load on the bearing surface of the nut retainer plate or channel.

TABLE 4 - Torque-Out Load

Nominal Thread Diameter in	Torque-Out Load minimum lbf·in
0.138	30
0.164	45
0.190	60
0.250	100
0.3125	160
0.375	240
0.4375	350
0.500	450
0.5625	600
0.625	900

3.9.5 Permanent Set: Nuts shall be tested as specified in Appendix E and shall not exceed the maximum permissible locking torque or be less than the minimum breakaway torque values specified in Table 5. The bolt or mandrel shall protrude through the nut a minimum of three full thread turns.

3.9.6 Reusability Test at Room Temperature, After Bake: Nuts shall be tested for five consecutive cycles as specified in Appendix F, loading initially to 75 000 psi in accordance with 3.9.6.3. The assembly shall be heated in a furnace to 1200 °F ± 15 and held at heat for 6 h ± 0.25, removed from the furnace and cooled to room temperature.

3.9.6.1 Wrenching and Reference Recording: Wrenchable nuts shall be wrenched by turning the nut relative to the fixture. The wrenchability of the tested nuts shall permit assembly of standard wrench. For reference information, the assembly and breakloose torques shall be recorded for each heat cycle.

3.9.6.2 Locking Feature Torque Requirements: Nuts tested as in 3.9.6 shall conform to the minimum breakaway torque in Table 5, Column (1), for each cycle. The self-locking torque shall be measured on installation and removal, and shall not exceed the torque in Table 5, Column (4), nor shall be less than the breakaway torque in Table 5, Column (1).

3.9.6.3 Loading by Elongation: Loading shall be determined by measurement of elongation of the bolt at room temperature using bolts having a shank diameter equal to the thread pitch diameter. The bolt elongation used to load the nut-bolt assembly to induce 75 000 psi axial tensile stress in the bolted assembly is based on a modulus of elasticity of 29 500 000 psi and the following equations:

$$e = s/E, \text{ unit elongation, in/in} \quad \text{(Eq.3)}$$

$$eL = \text{bolt elongation, in} \quad \text{(Eq.4)}$$

3.9.6.3 (Continued):

where:

e = unit strain of bolt loaded shank, in/in
s = 75 000 psi bolt stress at area of max (root) dia
E = 29 500 000 psi modulus of elasticity
L = bushing length (see Appendix F) in loaded nut-bolt assembly

The elongation of bolts for nut sizes not listed herein shall be 0.0025424L, where L = bushing length as in Appendix F.

3.9.7 Reusability Test at Room Temperature, As Received Condition: Nuts shall be tested for 15 cycles as specified in Appendix G, loading to assembly torque specified in Table 5, Column (5). Wrenchable nuts shall be turned relative to the fixture. For nonwrenchable nuts, the bolt head shall be turned. Locking feature torque shall conform to the minimum breakaway torque and maximum self-locking torque in Table 5, Column (1) and (3), respectively, for each cycle. The self-locking torque shall be measured on installation and removal, and shall not exceed the torque in Table 5, Column (3), nor shall be less than the breakaway torque in Table 5, Column (1). After testing, the nut shall assemble freely, with the fingers, up to the self-locking feature. Bolt threads shall remain serviceable and permit assembly of a new nut freely, with the fingers, up to the self-locking feature.

3.9.8 3-Cycle Test at Room Temperature: Nuts shall be tested as specified in Appendix H, loading to assembly torque specified in Table 5, Column (5). Wrenchable nuts shall be turned relative to the fixture. For nonwrenchable nuts, the bolt head shall be turned. Nuts shall conform to the minimum breakaway torque in Table 5, Column (2a) for the first cycle, and Column (2b) for the subsequent 2nd and 3rd cycles. The self-locking torque shall be measured on installation and removal, and shall not exceed the torque in Table 5, Column (3), nor shall be less than the breakaway torque in Table 5, Column (2b).

TABLE 5 - Locking Feature Torques and Assembly Torque

Nominal Thread Size	Minimum Breakaway Torque lbf·in (1)	Minimum Breakaway Torque lbf·in (2a)	Minimum Breakaway Torque lbf·in (2b)	Maximum Self-Locking Torque lbf·in (3)	Maximum Self-Locking Torque lbf·in (4)	Assembly Torque lbf·in (5)
0.138 -32	1	2	1.2	7	14	15
0.138 -40	1	2	1.2	7	14	16
0.164 -32	1.5	3	1.8	11	22	25
0.164 -36	1.5	3	1.8	11	22	26
0.190 -32	2	4	2.4	15	30	42
0.250 -28	3.5	7	4.2	30	60	95
0.3125-24	6.5	13	7.8	60	120	185
0.375 -24	9.5	19	11.4	80	160	330
0.4375-20	14	28	16.8	100	200	530
0.500 -20	18	36	21.6	150	300	800
0.5625-18	24	48	28.8	200	400	1 150
0.625 -18	32	64	38.4	300	600	1 580

TABLE 5 (Continued)

(1) Minimum breakaway torque for 15-cycle, room temperature, as received test; 5-cycle, loaded and conditioned test; permanent set test.

(2a) Minimum breakaway torque for first-cycle, of 3-cycle, loaded, room temperature test.

(2b) Minimum breakaway torque for second and third cycle of 3-cycle, loaded, room temperature test.

(3) Maximum self-locking torque for 15-cycle, room temperature, as received test; 3-cycle, loaded, room temperature test; permanent set test.

(4) Maximum self-locking torque for 5-cycle, loaded and conditioned test.

(5) Assembly torque for 15-cycle and 3-cycle tests for nuts. Values equal torque to induce 60 000 psi in companion bolt mean stress area (see AIR1471) when one member is silver plated where threads and bearing surfaces are lubricated with MIL-L-7808 aircraft engine oil.

3.9.9 Accelerated Vibration Test: Nuts shall be tested in accordance with MIL-STD-1312-7 and shall be loaded to assembly torques specified in Table 6. The loaded nut assembly shall withstand 30 000 cycles continuous vibration at 30 cycles per second and an amplitude (total travel) of 0.44 in without relative rotation exceeding 360°, without cracking of the nut, and without being capable of turning nut by hand. Nut sizes to be tested shall be as shown in Table 6; testing of other nuts sizes shall be as agreed upon by purchaser and vendor.

3.9.9.1 At Room Temperature, As Received Condition: Nut shall be loaded as specified in 3.9.9 on spacer then removed and reinstalled four additional times on the same bolt to the assembly torques in Table 6. The final assembly shall be with the block ready for the vibration test. The loaded nut assembly shall then be vibrated at room temperature in accordance with 3.9.9 requirements, and nuts shall conform to the requirements of 3.9.9 after the vibration test.

3.9.9.2 At Room Temperature After Baking: Nuts shall be loaded as specified in 3.9.9 on spacer as specified in Appendix F, and the loaded nut assembly shall be heated in a furnace to 1200 °F ± 15 and held at heat for 6 h ± 0.25, and cooled to room temperature. Nut shall then be removed from the assembly and reinstalled four additional times on the same bolt to the assembly torques in Table 6. The final assembly shall be on the test fixture in the block ready for the vibration test. The loaded nut assembly shall then be vibrated at room temperature in accordance with 3.9.9 requirements, and nuts shall conform to the requirements of 3.9.9 after the vibration test.

3.9.10 Flareability: Unless otherwise specified on the part drawing, the shank of shank nuts shall be capable of being flared with a 60° included angle conical tool to a diameter equal to 120% of the maximum shank diameter without cracking.

TABLE 6 - Assembly Torque for Accelerated Vibration Test

Nominal Thread Size	Assembly Torque lbf·in
0.164 -32	22
0.164 -36	22
0.190 -32	30
0.250 -28	60
0.3125-24	120
0.375 -24	160
0.4375-20	200
0.500 -20	300
0.5625-18	400
0.625 -18	600

3.10 Test Bolts:

Except as specified in 3.9.1.1, test bolts shall be unplated and conform to AS7477 with threads in accordance with MIL-S-8879.

3.11 Test Lubrication:

Stud-mandrel or bolt threads and nut bearing surface, and for nonwrenchable nut tests, the bolt bearing surface shall be lubricated with aircraft engine oil MIL-L-7808 or equivalent before each installation of the nut.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of parts shall supply all parts for vendor tests and shall be responsible for performing all required tests. Subsequent to qualification, there shall be no changes in the manufacturing method and operations sequence without requalification of the parts. Results of such tests shall be reported to the purchaser. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that parts conform to the requirements of this specification.

4.2 Classification of Tests:

The inspection and testing of parts shall be classified as follows:

a. Acceptance Tests
b. Qualification Tests

4.2.1 Acceptance Tests: Tests classified as acceptance or routine control tests are listed in Table 7.

4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification and part drawing are listed in Table 8.

4.3 Sampling:

4.3.1 Acceptance Tests: Acceptance tests shall be performed on each inspection lot.

4.3.1.1 Nondestructive Tests, Visual and Dimensional: A random sample shall be selected from each inspection lot, the size of the sample to be as specified in Table 10. The classification of defects for nuts will be as specified in Table 9. Defects not classified in Table 9 shall be classified as Minor B defects. All dimensional characteristics are considered defective when out of tolerance.

4.3.1.2 Destructive Tests: A random sample shall be selected from each inspection lot, the size of the sample shall be as specified in Table 11, Column B. The sample nuts may be selected from those that have been subjected to and passed the nondestructive tests.

4.3.2 Qualification Tests: The qualification test samples shall consist of the applicable number of nuts for each thread size to be tested as specified in Table 8.

TABLE 7 - Production Acceptance Plan

Characteristic	Req. Para.	Sample Size	Test Method
		Destructive Tests	
Material	3.1	Table 11, Col B	Analysis per material spec.
Hardness	3.6.1	Table 11, Col B	MIL-STD-1312-6
Microstructure	3.7.1	Table 11, Col B	Microscopic exam. 100X
Grain Size	3.7.2	Table 11, Col B	Microscopic exam. with chart in ASTM E 112
Flareability	3.9.10	Table 11, Col B	Conventional flaring tool
Plating	3.5	Table 11, Col B	Microscopic measurement of sectioned nut
3-Cycle Test	3.9.8	Table 11, Col A	Appendix H
		Nondestructive Tests	
Dimensions	3.2.1	Tables 9 & 10	Conventional meas. methods
Bearing Surface Squareness	3.2.1.1	Tables 9 & 10	Appendix A
Geometric Tolerances	3.2.1.2	Tables 9 & 10	Conventional meas. methods
Thread Size	3.2.3	Tables 9 & 10	Gaging methods per MIL-S-8879
Surface Texture	3.2.2	Table 11, Col A	Per ANSI/ASME B46.1 by visual or fingernail comparison with standard texture specimens. In case of conflict, stylus instrument may be used if surface is accessible.
Product Marking	3.4	Tables 9 & 10	Visual examination
Workmanship	3.8	Tables 9 & 10	Visual examination
Fluorescent Penetrant Inspection	3.8.1	Tables 9 & 10	Inspection per AMS 2645 Criteria per Appendix J
Packaging & Identification	5.1 & 5.2	100%	Visual examination

TABLE 8 - Qualification Approval Test Plan

Characteristic	Req. Para.	Sample Size	Test Method
		Destructive Tests /1/	
Material	3.1	3	Analysis per material specification
Hardness	3.6.1	5	MIL-STD-1312-6
Microstructure	3.7.1	5	Microscopic examination 100X
Grain Size	3.7.2	5	Microscopic examination with chart in ASTM E 112
Plating	3.5	5	Microscopic examination of sectioned nut
Axial Tensile Strength	3.9.1		
As Received	3.9.1.1	4	MIL-STD-1312-8
After 1200 °F Bake	3.9.1.2	4	MIL-STD-1312-8
Wrench Torque	3.9.2	3	Appendix B
Push Out Load	3.9.3	5	Appendix C
Torque Out	3.9.4	5	Appendix D
Permanent Set Test	3.9.5	3	Appendix E
Reusability Test			
After 1200 °F Bake	3.9.6	10	Appendix F
As Received	3.9.7	10	Appendix G
Accelerated Vibration Test	3.9.9		
As Received	3.9.9.1	5	MIL-STD-1312-7
After 1200 °F Bake	3.9.9.2	5	MIL-STD-1312-7
Flareability	3.9.10	3	Conventional flaring tool

NOTE:

/1/ Total number of samples for destructive tests equals 80; all samples shall be subjected to the nondestructive tests (see next page) prior to being subjected to the destructive tests. The same test sample may be used for more than one test provided that none of the characteristics of the samples are altered during the test procedure.

(continued on next page)

TABLE 8 (Continued)

Characteristic	Req. Para.	Sample Size	Test Method
	Nondestructive Tests		
Dimensions	3.2.1	All	Conventional measuring methods.
Bearing Surface Squareness	3.2.1.1	All	Appendix A
Geometric Tolerances	3.2.1.2	All	Conventional measuring methods.
Thread Size	3.2.3	All	Gaging methods per MIL-S-8879.
Surface Texture	3.2.2	All	Per ANSI/ASME B46.1 by visual or fingernail comparison with std. texture specimens or by stylus instrument.
Product Marking	3.4	All	Visual examination.
Workmanship	3.8	All	Visual examination.
Fluorescent Penetrant Inspection	3.8.1	All	Inspection per AMS 2645, Criteria per Appendix J.

NOTE: Sample size includes all samples for destructive tests (see page 15).

(concluded)

TABLE 9 - Classification of Defects

Category No.	A.Q.L.	Characteristic
Major A		
101		Presence of locking element.
102	0.4%	Surface discontinuities revealed by fluorescent penetrant inspection.
Major B		
201		Thread size
202		Squareness of bearing surface
203		Plating
204		Product marking
205	1.0%	Shank diameter
206		Shank length
207		Rivet hole size
208		Rivet hole location
209		Surface texture
210		3-cycle test
Minor A		
301		Wrenching size & configuration
302		Nut height
303		Bearing surface diameter
304	2.5%	Float of nut element
305		Burrs and sharp corners
306		Depth of counterbore
307		Flange thickness
Minor B		
401		Runout of wrenching form to thread
402		Runout of shank OD to thread
403	4.0%	Runout of flange OD to thread
404		Countersink on thread end
405		Other dimensional characteristics

TABLE 10 - Sampling Data

Visual and Dimensional Characteristics
Sample Size (n), Acceptance No. (AC), and Limiting Quality (LQ) in Percent Defective

Lot Size	AQL 0.4% (n)	AQL 0.4% (AC)	AQL 0.4% (LQ)%	AQL 1.0% (n)	AQL 1.0% (AC)	AQL 1.0% (LQ)%	AQL 2.5% (n)	AQL 2.5% (AC)	AQL 2.5% (LQ)%	AQL 4.0% (n)	AQL 4.0% (AC)	AQL 4.0% (LQ)%
51 to 90	32	0	6.9	13	0	16	20	1	18	13	1	27
91 to 150	32	0	6.9	13	0	16	20	1	18	20	2	25
151 to 280	32	0	6.9	50	1	7.6	32	2	16	32	3	20
281 to 500	32	0	6.9	50	1	7.6	50	3	13	50	5	18
501 to 1200	125	1	3.1	80	2	6.5	80	5	11	80	7	14
1201 to 3200	125	1	3.1	125	3	5.4	125	7	9.4	125	10	12
3201 to 10000	200	2	2.7	200	5	4.6	200	10	7.7	200	14	10
10001 to 35000	315	3	2.1	315	7	3.7	315	14	6.4	315	21	9
35001 to 150000	500	5	1.9	500	10	3.1	500	21	5.6	315	21	9

Sampling sizes listed above are based on single sampling plans for normal inspection in MIL-STD-105. It is permissible to use other sampling plans per MIL-STD-105 which provide the same quality protection. When sample size equals or exceeds lot size, 100% inspection is required.

TABLE 11 - Sampling Data

Mechanical and Metallurgical Characteristics
Sample Size (n) and Acceptance Number (AC)

Lot Size	Sample Size (n) Nondestructive A	Sample Size (n) Destructive B	Acceptance Number (AC)
Up to 500	8	3	0
501 to 3200	13	5	0
3200 to 35000	20	5	0
35001 and over	32	8	0

4.4 Reports:

4.4.1 The vendor shall furnish with, or prior to, the first shipment of parts of each part number a report of test data showing that the parts conform to all technical requirements of this specification and the part drawing.

4.4.2 The vendor of parts shall furnish with each production lot shipment a report stating that the chemical composition of the parts conform to the applicable material specification, and showing the results of tests to determine conformance to the acceptance tests, and where applicable, the flareability requirements of this specification. This report shall include the purchase order number, production lot number, AS4393, contractor or direct supplier of material, part number, nominal size, and quantity.

4.5 Resampling and Retesting:

If any part used in the above tests fails to meet the specified requirement, disposition of the parts may be based on the results of testing three additional parts for each original nonconforming part. Failure of any retest part to meet the specified requirements 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:

NUTS, SELF-LOCKING STEEL, CORROSION AND HEAT RESISTANT
AS4393
PART NUMBER
PURCHASE ORDER NUMBER
QUANTITY
MANUFACTURER'S IDENTIFICATION

5.1.3 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.

5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, industrial packaging, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention AS4393 in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

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

8. NOTES:

8.1 Direct U.S. Military Procurement:

Purchase documents should specify the following:

Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired
Level A packaging, if required (see 5.1.4)

8.2 Key Words:

Nuts, Self-Locking Nuts, Procurement Specification.

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

APPENDIX A
MEASUREMENT OF PERPENDICULARITY VARIATION OF THE BEARING SURFACE

A.1 SCOPE:

This appendix is a mandatory part of this specification.

A.1.1 Purpose of Test:

To measure the variation from perpendicularity of the nut bearing surface "A" (see Figure A1) relative to the thread. This inspection is applicable to all nuts.

A.1.2 Floating Nuts:

This measurement applies only to the nut element of floating nuts, when the retaining plate or channel has been removed.

A.2 APPLICABLE DOCUMENTS:

MIL-S-8879 Screw Threads, UNJ Profile
NAS3353 Fixture - Bearing Surface Squareness Test, Self-Locking Nuts

A.3 APPARATUS:

A.3.1 Particulars:

Particulars of the fixture are given in NAS3353; the mandrel shall be in accordance with the maximum mandrel in Appendix E, Figure E1.

A.4 PROCEDURE:

A.4.1 The perpendicularity of the bearing surface relative to the thread shall be measured within the basic area "A" as defined in Figure A1.

A.4.2 Nuts may be checked for perpendicularity before or after forming the self-locking feature.

A.4.3 The maximum threaded mandrel is manually assembled into the nut a minimum of three turns if checked before forming the locking feature, or until the end of the mandrel is through the locking feature if checked after forming. The variation from perpendicularity is evaluated with a shim of the required thickness.

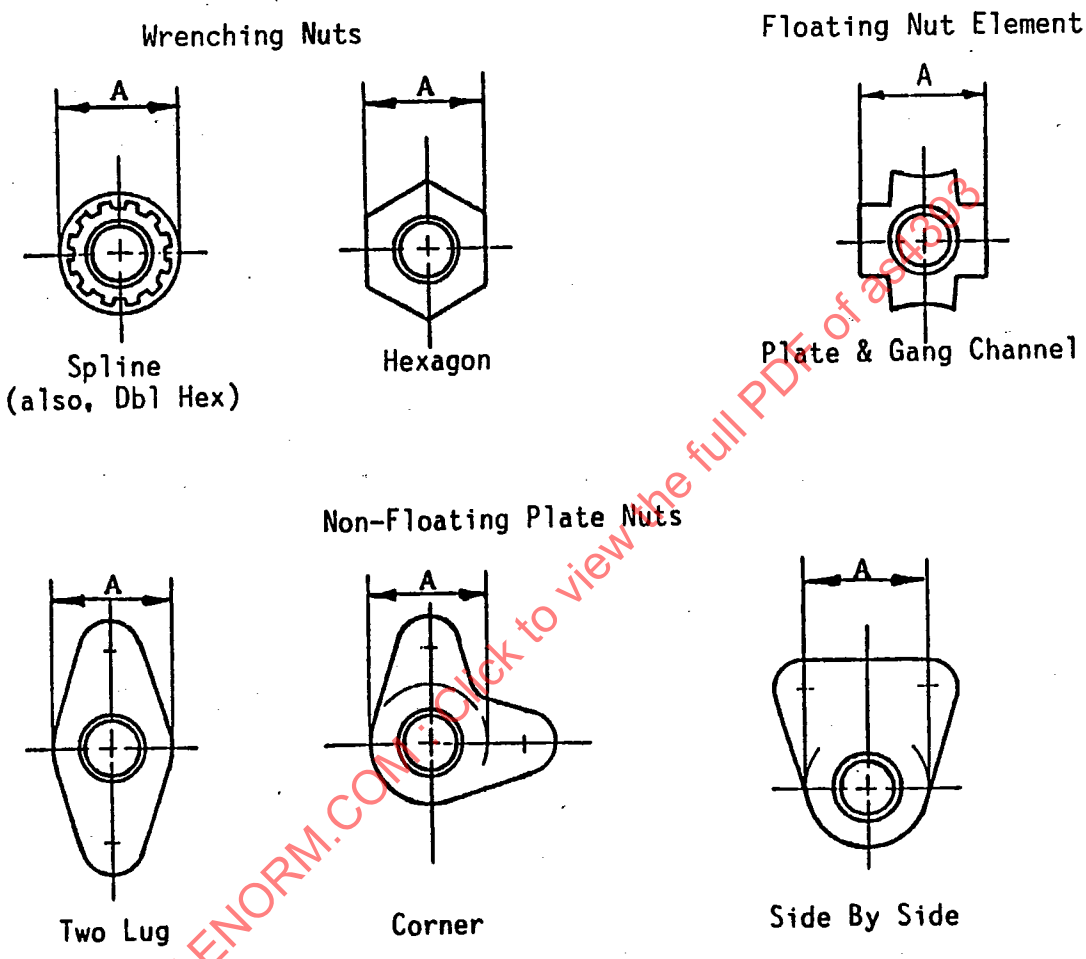


FIGURE A1 - Bearing Surface Area "A" Under Perpendicularity Control for Various Types of Nuts

APPENDIX B
WRENCH TORQUE TEST

B.1 SCOPE:

This appendix is a mandatory part of this specification.

B.1.1 Purpose of Test:

To test that the wrenching configuration is capable of withstanding the high breakloose torques encountered with nuts in hot areas of aerospace propulsion systems.

B.1.2 Nut Types to be Tested:

This test is applied to externally wrenched nuts of spline, double hexagon, and hexagon wrenching configuration.

B.2 APPLICABLE DOCUMENTS:

MIL-S-8879	Screw Thread, UNJ Profile
MIL-S-7742	Screw Thread, UN Profile
AS954	Thin Wall 12-Point Sockets for Aerospace Engine Use

B.3 APPARATUS:

B.3.1 Typical Apparatus:

The typical test apparatus is shown in Figure B1 comprises the following:

a. Stud with threads conforming to MIL-S-8879 or MIL-S-7742, tolerance Class 3A.

b. Two wrenches conforming to AS954; double hexagon sockets for hexagon and double hexagon drive nuts.

c. Square drive adapter for socket wrenches.

B.4 PROCEDURE:

B.4.1 Method Using Stud and Wrenches:

B.4.1.1 Place adapter in vise. For hexagon nuts, bottom hexagon nut is gripped in vise.

B.4.1.2 Locate first wrench socket on adapter.

B.4.1.3 Assemble nuts to be tested onto stud until bearing surfaces contact at mid length of stud. Ensure stud engages full length of nut thread but protrusion must not prevent full location of nut wrenching configuration into wrench socket.

B.4.1.4 Locate assembly into first wrench.

B.4.1.5 Engage second wrench onto upper nut and test to the requirement of this specification.

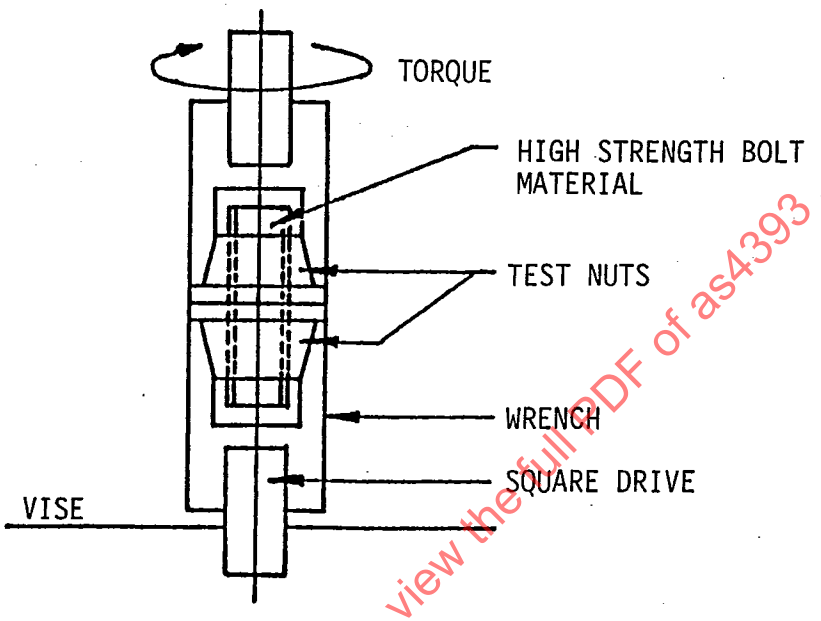


FIGURE B1 - Wrench Torque Test Apparatus

APPENDIX C
PUSH OUT TEST

C.1 SCOPE:

This appendix is a mandatory part of this specification.

C.1.1 Purpose of Test:

This test is to determine whether the nut retainer plate or channel is capable of withstanding the axial push out load specified in this specification after the nut is installed.

C.1.2 Types of Nuts to be Tested:

This test is applicable to floating plate nuts and gang channel nuts. It is not applicable to nonfloating plate nuts that are side by side mounting, and also, to floating angle plate nuts (see Figure C1).

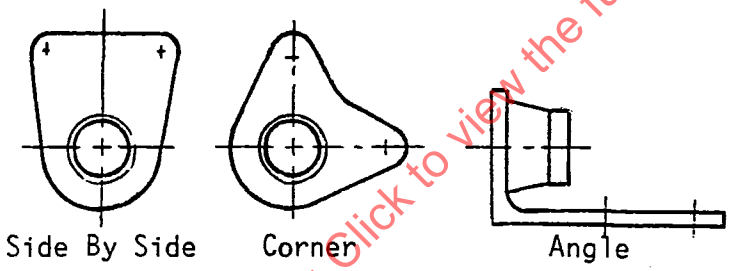


FIGURE C1 - Types of Nuts Not Applicable to Push Out Test

C.2 APPLICABLE DOCUMENTS:

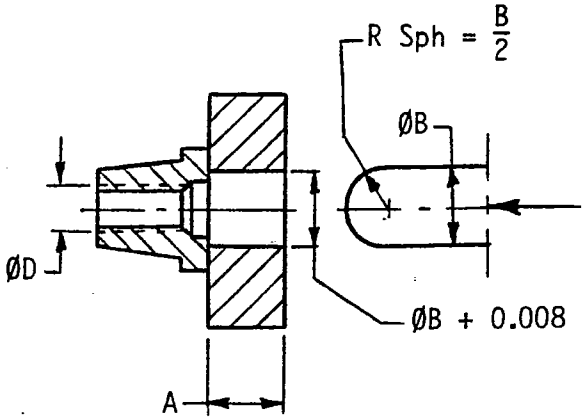
MIL-S-8879 Screw Threads, UNJ Profile

C.3 APPARATUS:

C.3.1 Parts Contained:

The test apparatus is shown in Figure C2 and comprises the following:

a. The retention plate.
b. Rivets or bolts to attach test nut to plate.
c. A push-out mandrel with spherical end.
d. A bolt with threads conforming to MIL-S-8879, tolerance Class 3A.



Dimensions in inch

A = 0.312 for D ≤ 0.190
A = 0.438 for D > 0.190
B = D + 0.020
D = nom major dia of thread

FIGURE C2 - Push Out Test Apparatus

C.4 PROCEDURE:

C.4.1 Attach the plate nut or section of gang channel to be tested to the plate by riveting or with bolts.

C.4.2 Apply the push-out load given in this specification to the spherically ended mandrel as shown in Figure C2.

C.4.3 Install a standard bolt with the fingers up to the locking feature using no supporting pressure on the nut.

C.4.4 Remove bolt and detach nut from retention plate or channel.

C.4.5 Submit the nut for visual examination and, if necessary, to an examination at low magnification after sectioning.

APPENDIX D
TORQUE OUT TEST

D.1 SCOPE:

This appendix is a mandatory part of this specification.

D.1.1 Purpose of Test:

This test is to determine that the retention device is capable of holding the nut element against rotation when tightening or untightening the mating bolt.

D.1.2 Types of Nuts to be Tested:

This test is applicable to the following types of nuts produced as multi-piece nuts:

a. Floating plate nuts or gang channel nuts.

b. Fixed plate nuts which have the nut body assembled on a plate by brazing or swaging.

D.2 APPLICABLE DOCUMENTS:

MIL-S-8879 Screw Threads, UNJ Profile
MIL-S-7742 Screw Threads, UN Profile

D.3 APPARATUS:

D.3.1 Typical Apparatus:

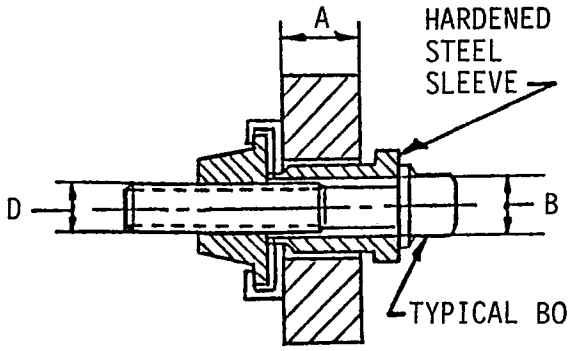
A typical test apparatus is shown in Figure D1 and comprises the following:

a. A retention plate.

b. Rivets or bolts to attach test nut to plate.

c. A bolt with threads conforming to MIL-S-8879 or MIL-S-7742 tolerance Class 3A.

d. A hardened steel sleeve that bears the axial load against the base of nut element and bolt bearing surface, with no axial load on the retention plate during the test.



Dimensions in inch

A = 0.312 for D ≤ 0.190
A = 0.438 for D > 0.190
B = D + 0.008
D = nom major dia of thread

FIGURE D1 - Torque Out Test Apparatus

D.4 PROCEDURE:

D.4.1 Attach the nut or section of gang channel to be tested to the plate by riveting or with bolts.

D.4.2 Apply the torque-out torque given in this specification in a clockwise direction.

D.4.3 Remove the bolt and detach nut from retention plate or channel.

D.4.4 Submit the nut for visual examination and, if necessary, to an examination at low magnification after sectioning.

APPENDIX E
PERMANENT SET TEST

E.1 SCOPE:

This appendix is a mandatory part of this specification.

E.1.1 Purpose of Test:

This test is applicable to all self-locking nuts (wrenching nuts and anchor nuts) and is to verify the ability of the nut locking feature to perform within the locking torques of this specification when assembled on a minimum threaded mandrel (or bolt) after having first been assembled onto a maximum threaded mandrel (or bolt).

E.2 APPLICABLE DOCUMENTS:

MIL-S-8879 Screw Threads, UNJ Profile
ANSI/ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

E.3 APPARATUS:

E.3.1 Test Mandrels:

The apparatus shown in Figures E1 and E2 comprises the following:

a. Maximum mandrel (Figure E1).

b. Minimum mandrel (Figure E2).

TABLE E1 - Maximum Mandrel Pitch Diameter

Nominal Thread Size	Pitch Diameter inch	Nominal Thread Size	Pitch Diameter inch
0.138-32	0.1167-0.1171	0.3125-24	0.2843-0.2847
0.138-40	0.1209-0.1213	0.375 -24	0.3467-0.3471
0.164-32	0.1427-0.1431	0.4375-20	0.4038-0.4042
0.164-32	0.1451-0.1455	0.500 -20	0.4663-0.4667
0.190-32	0.1687-0.1691	0.5625-18	0.5251-0.5255
0.250-28	0.2257-0.2261	0.625 -18	0.5876-0.5880

NOTES:

1. Maximum Mandrel:
2. Material: Steel heat treated to 39 HRC minimum.
3. Surface Roughness: Thread flanks to be 32 μin Ra in accordance with ANSI/ASME B46.1.
4. Threads: MIL-S-8879 except pitch diameter shall be as specified in Table E1.

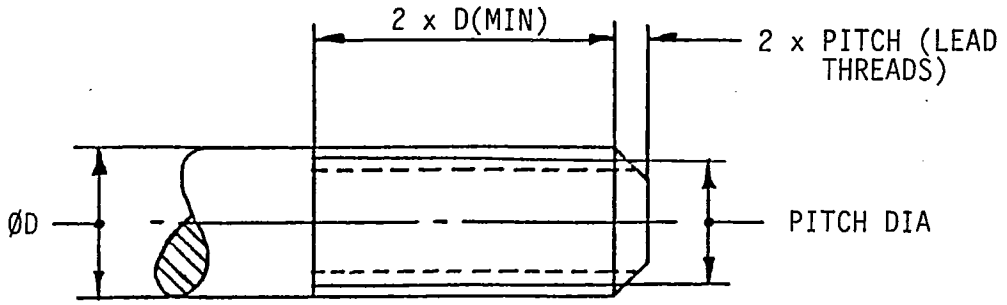


FIGURE E1 - Maximum Mandrel

E.4 PROCEDURE:

E.4.1 Lubricate the maximum mandrel (Figure E1) and nut in accordance with this specification.

E.4.2 Assemble nut onto the maximum mandrel until a minimum of three pitches protrude through the top of nut. Record the maximum self-locking torque achieved at any time during this assembly.

E.4.3 Remove the nut from the maximum mandrel.

E.4.4 Lubricate the minimum mandrel (Figure E2) in accordance with this specification.

E.4.5 Assemble the same nut onto the minimum mandrel until three thread pitches protrude through the top of nut. Record the self-locking torque on installation.

E.4.6 Remove the nut from the minimum mandrel, recording the breakaway torque.

NOTE: Nuts used for this test shall not be reused.

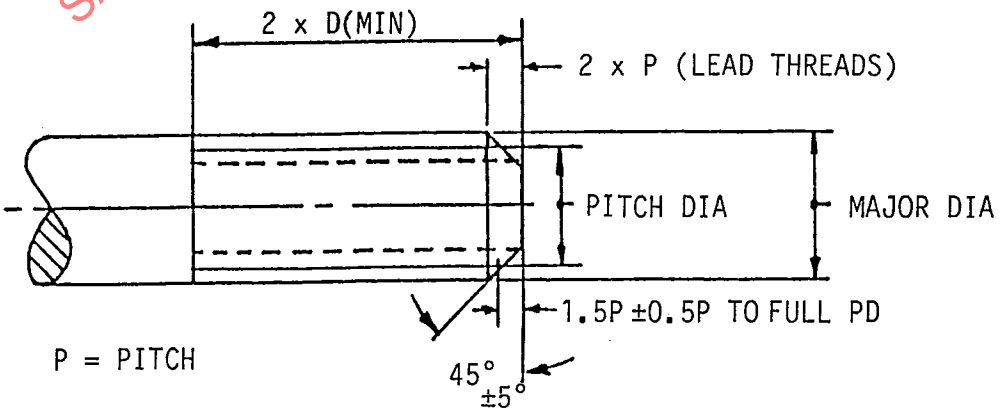


FIGURE E2 - Minimum Mandrel

TABLE E2 - Minimum Mandrel Thread Dimensions

Nominal Thread Size	Major Dia in	Pitch Dia in	Root Dia max in	Helix Tol in	Tol on Half Angle min
0.138 -32	0.1316-0.1312	0.1152-0.1156	0.0997	0.0003	±15
0.138 -40	0.1325-0.1329	0.1194-0.1198	0.1073	0.0002	±15
0.164 -32	0.1576-0.1580	0.1411-0.1415	0.1257	0.0003	±15
0.164 -36	0.1581-0.1585	0.1435-0.1439	0.1299	0.0002	±15
0.190 -32	0.1836-0.1840	0.1670-0.1674	0.1517	0.0003	±15
0.250 -28	0.2431-0.2435	0.2239-0.2243	0.2062	0.0003	±15
0.3125-24	0.3049-0.3053	0.2823-0.2827	0.2614	0.0003	±15
0.375 -24	0.3674-0.3678	0.3446-0.3450	0.3239	0.0003	±15
0.4375-20	0.4290-0.4294	0.4015-0.4019	0.3762	0.0003	±15
0.500 -20	0.4915-0.4919	0.4639-0.4643	0.4387	0.0003	±15
0.5625-18	0.5534-0.5538	0.5226-0.5230	0.4943	0.0003	±10
0.625 -18	0.6159-0.6163	0.5850-0.5854	0.5568	0.0003	±10

NOTES:

1. Minimum Mandrel:

2. Material: Steel heat treated to 39 HRC minimum.

3. Surface Roughness: Thread flanks to be 32 μin Ra in accordance with ANSI/ASME B46.1.

3. Threads: MIL-S-8879 except as otherwise specified in Table E2. Lead threads may be dressed or stoned to break edges 0.003 to 0.015 in.

4. The form tolerances on flank half angle and helix are independent of pitch diameter limits; thus, the effective pitch cylinder size may be increased beyond the maximum pitch diameter limit by the cumulative effect of the form tolerances.

APPENDIX F
REUSABILITY TEST AT ROOM TEMPERATURE, AFTER BAKING

F.1 SCOPE:

This appendix is a mandatory part of this specification.

F.1.1 Purpose of Test:

This test is applicable to all self-locking nuts (wrenching nuts and anchor nuts), and is to verify the performance and reusability of the nut self-locking feature at room temperature after a specified time and temperature under load for a specified number of cycles.

F.2 APPLICABLE DOCUMENTS:

MIL-S-8879	Screw Threads, UNJ Profile
AS7477	Bolts & Screws, UNS S66286, UNJ Thread, Procurement Specification
AMS 5732	Corrosion & Heat Resistant Steel, Bars & Forgings, UNS S66286
AMS 5737	Corrosion & Heat Resistant Steel, Bars & Forgings, UNS S66286
ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

F.3 APPARATUS:

F.3.1 Parts Contained:

The apparatus shown in Figures F1 through F3 comprises the following:

a. Spacer
b. Bolt with threads conforming to MIL-S-8879 and produced to AS7477.

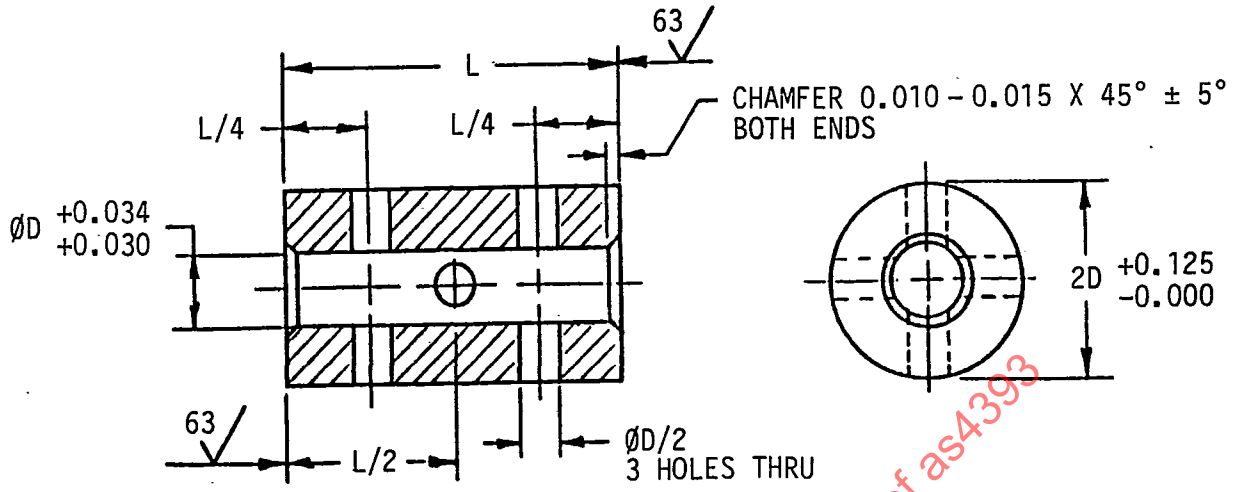
F.3.1.1 Spacer for Nuts (Except Shank Nuts): Material AMS 5732 or AMS 5737; Dimensions to Table F1.

F.3.1.2 Spacer for Shank (Clinch) Nuts: Material AMS 5732 or AMS 5737; Dimensions to Table F1.

F.4 PROCEDURE:

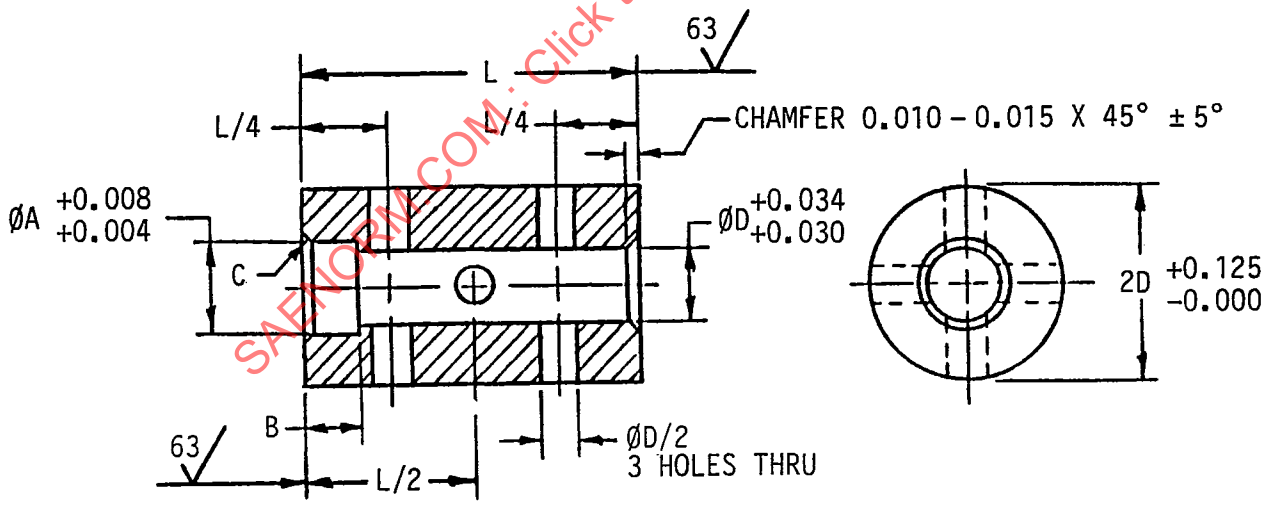
F.4.1 Lubricate the bolt and nut in accordance with this specification.

F.4.2 Assemble the bolt through the spacer and turn the nut so that the bolt protrudes through the nut a minimum of three pitches (see Figure F3), recording the maximum self-locking torque.



D = nominal diameter of bolt.
Dimensions in inches; surface roughness in μin Ra per ANSI/ASME B46.1.

FIGURE F1 - Spacer for Nuts (Except Shank Nuts)



Dimensions in inches; surface roughness in μin Ra per ANSI/ASME B46.1.
A = maximum diameter of nut shank uninstalled.
B = maximum length of nut shank + 0.040 inch.
C = 45° chamfer clearing maximum radius bearing face to shank of nut.
D = nominal diameter of bolt.

FIGURE F2 - Spacer for Shank (Clinch) Nuts

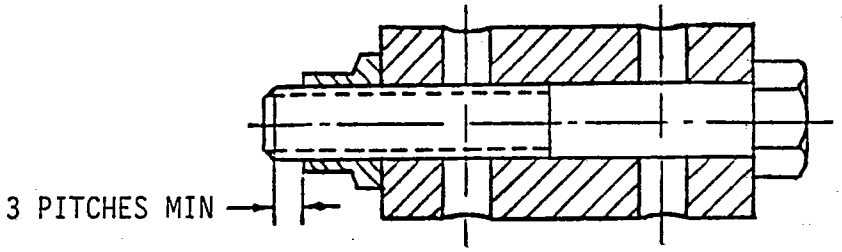


FIGURE F3 - Heat Soak Test Assembly

TABLE F1 - Bolt and Spacer Length and Bolt Elongation

Nominal Thread Diameter, in	Bolt Length Nom, in	Spacer Length L, in	Required Bolt Elongation, in	Reference Part No.
0.138	1.500	1.109-1.139	0.0029	MS9554-22
0.164	2.000	1.569-1.599	0.0040	MS9555-28
0.190	2.500	2.010-2.040	0.0051	MS9556-32
0.250	2.500	1.941-1.971	0.0050	MS9557-32
0.3125	2.500	1.845-1.875	0.0047	MS9558-30
0.375	2.500	1.823-1.853	0.0047	MS9559-28
0.4375	2.500	1.718-1.748	0.0044	MS9560-27
0.500	2.500	1.621-1.651	0.0042	MS9561-25
0.5625	2.500	1.518-1.548	0.0039	MS9562-25
0.625	2.500	1.433-1.463	0.0037	MS9496-23

NOTES:

1. Elongation based on 0.0025424 x L, L = nominal spacer length.
2. Reference part numbers are for bolts having UNJF threads.