SAE Aerospace
An SAE International Group

METRIC AEROSPACE STANDARD

SAE MA1943 | REV. A

Issued 1987-07
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Reaffirmed 2012-11

Superseding MA1943

Nuts, Self-Locking, UNS N07001 730°C, 1100 MPa, and 1210 MPa Procurement Specification For, Metric

FSC 5310

RATIONALE

MA1943A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This procurement specification covers aircraft quality self-locking nuts for wrenching (hex, spline) and anchor (plate, gang channel, shank) types of nuts made from a corrosion and heat resistant nickel-base alloy of the type identified under the Unified Numbering System as UNS N07001. Tension height nuts having overall length of threaded portion not less than 1.2 times the nominal thread diameter have 1210 MPa minimum tensile strength at room temperature. Shear height nuts having shorter threaded portion have 1100 MPa minimum tensile strength at room temperature. Maximum test temperature of parts is 730°C

1.1 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 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.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/MA1943A

2.1.1.1 Aerospace Material Specifications:

AMS-2411	Plating, Silver, for High Temperature Applications
AMS-2645	Fluorescent Penetrant Inspection
AMS-5544	Sheet, Strip, and Plate, Alloy, 57Ni 19.5Cr 13.5Co 4.2Mo 3.0Ti 1.4Al 0.05Zr 0.006B, Consumable Electrode or Vacuum Induction Melted, Annealed
AMS-5706	Bars, Forgings, and Rings, Alloy, 57Ni 19.5Cr 13.5Co 4.3Mo 3.0Ti 1.4Al 0.006B 0.05Zr, Consumable Electrode or Vacuum Induction Melted, 995° – 1040°C Solution Heat Treated
AMS-5707	Bars, Forgings and Rings, Alloy, 58Ni 19.5Cr 13.5Co 4.3Mo 3.0Ti 1.4Al 0.05Zr 0.006B, Consumable Electrode or Vacuum Induction Melted, 1825 – 1900°F (996 – 1038°C) Solution, Stabilization and Precipitation Heat Treated
AMS-5708	Bars and Forgings, Alloy, 58Ni 19.5Cr 13.5Co 4.3Mo 3.0Ti 1.4Al, Consumable Electrode or Vacuum Induction Melted, 1975°F Solution Heat Treated
AMS-5709	Bars and Forgings, Alloy, 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, Stabilization and Precipitation Heat Treated

2.1.1.2 Aerospace Standards:

AS1310	Fastener Torque for Threaded Applications, Definitions of
MA1370	Screw Threads - MJ Profile, Metric
MA1520	Areas for Calculating Stress or Load Values for Metric MJ Externally Threaded Fasteners
MA1566	Gaging Practice and Gage Requirements for MJ Metric Screw Threads
MA1586	Wrench Configuration, 12 Spline Drive, Metric
MA3378	Bolts & Screws, UNS N07001, 730°C, 1210 MPa, Procurement Specification For, Metric

2.1.2 U.S. Government Publications: Available from Standardization Documents Order Desk, Building d4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2.1 Military Specification:

MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base

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 Material, Procedures for Development and Application of Packaging Requirements

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

ANSI B1.13M Metric Screw Threads - M Profile
ANSI/ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

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

ASTM E 112 Estimating the Average Grain Size of Metals

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

NA 0012 Fixture - Bearing Surface Squareness Test, Self Locking Nuts, Metric

2.2 Definitions:

Refer to AS1310 for definitions related to fastener torque.

2.2.1 Production Lot: A 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.

2.2.2 Inspection Lot: An inspection lot shall consist of nuts from a single production lot, of the same part number.

2.2.3 Room Temperature: Ambient temperature (20°C approximately).

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be corrosion and heat resistant nickel alloy, AMS-5706, AMS-5707, AMS-5708, or AMS-5709 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, nut elements of plate and gang channel nuts may be formed from AMS-5544 sheet stock. Material for the retaining plate for plate nuts and channel for gang channel nuts shall be capable of withstanding 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.

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 on the part drawing, determined in accordance with ANSI/ASME B46.1.

3.2.3 Threads: Metric screw thread MJ profile and dimensions in accordance with MA1370.

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 the nut shall be countersunk as specified on the part drawing.

3.2.3.2 Plated Threads: Threads in nuts requiring plating shall meet the coating requirements of MA1370 before forming the self-locking feature.

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 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 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, stabilization, and precipitation heat treated in accordance with the heat treating procedure specified in the material specification.

3.4 Product Marking:

Each part shall be identification marked as specified on the part drawing. Markings shall be stamped, depressed 0.25 mm maximum, using a rounded tool form.

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 sizes 6 mm and larger, the plating on the thread shall be not less than 5 µm when measured on the pitch diameter. Microscopic measurement of a sectioned nut shall be used as the referee method. Nuts with nominal thread size below 6 mm shall show complete coverage on the thread surfaces. Plating on other surfaces shall be 8 to 15 µm thick, unless otherwise specified on the part drawing. No plating shall be applied to the retaining plate for plate nuts and channel for 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 of 32 to 42 HRC, 301 to 390 HB, or 318 to 412 HV when tested in accordance with MIL-STD-1312-6. Sizes up to and including 10 mm nominal thread size shall be sectioned and mounted. Mounting is optional for other sizes.

3.7 Metallurgical Properties:

3.7.1 Microstructure: Wrenching nuts, shank nuts, and nut elements of plate and gang channel nuts shall have a microstructure of completely recrystallized material.

3.7.2 Grain Size: Shall be predominantly two to six with no grains finer than seven or coarser than one as determined by comparison of a polished and etched specimen with the chart in ASTM E 112. In the case of disagreement on the grain size by the comparison method, then 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 in accordance with AMS-2645. Acceptance criteria of surface discontinuities shall be in accordance with Appendix J.

3.9 Product Performance Tests:

Refer to Tables 7 and 8 for details of sample sizes for Acceptance Test Plan and Qualification 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 DOD-STD-1312-108, using alloy steel test bolts hardened and tempered to 40 HRC minimum, 371 HB minimum or 392 HV minimum, shall withstand the axial tensile load specified in Table 1, applied at the rate specified at room temperature.

3.9.1.2 After 730°C 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 pitches protruding and baked for 6 h ± 0.25 at 730°C ± 8 and 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 DOD-STD-1312-108 and shall withstand the axial tensile load specified in Table 1, applied at the rate specified.

TABLE 1 - Axial Tensile Load and Tensile Area

Nut Thread Size	Tensile Stress Area mm^2	Axial Tensile Load at Room Temp. T, kN min[1] Tension Height Nuts	Axial Tensile Load at Room Temp. T, kN min[1] Shear Height Nuts
MJ5 x 0.8-4H6H	15.296	18.5	16.8
MJ6 x 1-4H5H	21.753	26.3	23.9
MJ7 x 1-4H5H	30.930	37.4	34.0
MJ8 x 1-4H5H	41.682	50.4	45.9
MJ10 x 1.25-4H5H	65.136	78.8	71.6
MJ12 x 1.25-4H5H	97.128	117.5	106.8

[1]Requirements above apply to companion bolts with metric MJ threads to class 4h6h tolerances. The area upon which stress for axial tensile strength load requirements is based on is the tensile stress area as defined in MA1520, Formula (2), for companion bolt thread rolled after heat treatment, and calculated from the following:

$$A = 0.7854(d_3)^2[2 - (d_3/d_2)^2] \qquad \text{(Eq.1)}$$

where:

A = tensile stress area
d_2 = maximum pitch diameter of bolt thread
d_3 = maximum root diameter of bolt thread

The load requirements for axial tensile strength load are based on the following stresses:

a. 1210 MPa for tension height nuts
b. 1100 MPa for shear height nuts

Axial tensile strength load, T = (stress x A)/1000 to obtain load in kN.

For sizes not shown, tensile strength loads for nuts shall be based upon the respective companion bolt stress area and stress given above.

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 0.1 to 0.2 mm 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.

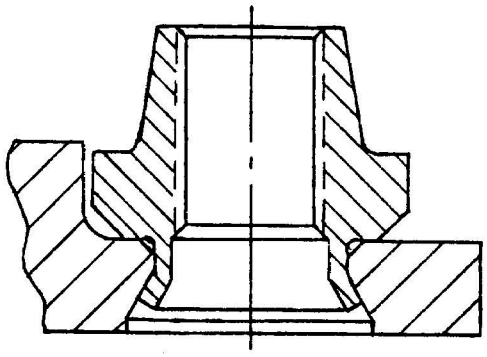


FIGURE 1 - Flange Assembly, Flared Shank Nut

3.9.2 Wrench Torque: Wrenching nuts with a spline drive wrenching feature shall be tested as specified in Appendix B 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 MA1586. Wrenching nuts with hexagon wrenching features shall be tested in the same manner and shall withstand Table 2 wrench torques in the same manner as spline drive nuts except a double hexagon socket-type wrench shall be used.

TABLE 2 - Wrench Torque

Thread Size	Wrench Torque, N·m Tension Height Nut	Wrench Torque, N·m Shear Height Nut
MJ5 x 0.8	22	11
MJ6 x 1	38	19
MJ7 x 1	64	32
MJ8 x 1	96	48
MJ10 x 1.25	184	92
MJ12 x 1.25	320	160

3.9.3 Push Out Load: Anchor nuts of the types in 3.9.3.1 shall be tested as specified in Appendix C and shall withstand the push out loads specified in Table 3 without separating from the plate or channel. Nuts shall be serviceable after this test.

TABLE 3 - Push Out Load

Thread Size	Push Out Load N
MJ5 x 0.8	900
MJ6 x 1	950
MJ7 x 1	1050
MJ8 x 1	1100

3.9.3.1 The push out test in 3.9.3 is applicable to gang channel nuts, plate nuts (floating and nonfloating nuts 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 specified 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.

TABLE 4 - Torque Out Load

Thread Size	Torque Out N·m
MJ5 x 0.8	10
MJ6 x 1	16
MJ7 x 1	22
MJ8 x 1	33

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 project through the nut a minimum of three thread pitches.

3.9.6 Reusability Test at Room Temperature After 730°C Bake: Nuts 5 mm nominal thread size and larger shall be tested for five consecutive cycles as specified in Appendix F, loading initially to 590 MPa in accordance with 3.9.6.3 for tension height nuts; and for shear height nuts, the initial load shall be 517 MPa in accordance with 3.9.6.3. The assembly shall be heated in a furnace to 730°C ± 8 and held for 6 h ± 0.25, removed from the furnace and cooled to room temperature.

3.9.6.1 Wrenching and Reference Recordings: Wrench type nuts shall be turned relative to the fixture. The wrenchability of the tested nuts shall permit assembly of standard wrench. For nonwrenchable nuts, the bolt head shall be turned. 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 bolt elongation at room temperature using bolts having a shank diameter equal to the thread pitch diameter. The correct loading shall be determined by using a modulus of elasticity of 213.7 GPa. Stress area for the bolt shall be based on Formula (2) areas given in MA1520. For tension height nuts, the elongation shall be equal to 0.002761L (where L = length of bushing) elongation of bolts using standard bushing as specified in Appendix F; similarly, for shear height nuts, the bolt elongation shall be equal to 0.002419L.

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 for shear height nuts, and Column 6 for tension height nuts. Wrenching type nuts shall be turned relative to the fixture. For nonwrenchable nuts, the bolt head shall be turned. The locking feature torque shall conform to the minimum breakaway 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 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 Three-Cycle Test at Room Temperature: Nuts shall be tested as specified in Appendix H, loading to assembly torque specified in Table 5, Column 5, for shear height nuts, and Column 6 for tension height nuts. Wrenching type 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 two 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

Thread Size	Breakaway Torque Min, N·m	Breakaway Torque Min, N·m	Breakaway Torque Min, N·m	Self-Locking Torque, Max, N·m	Self-Locking Torque, Max, N·m	Assembly Torque, N·m	Assembly Torque, N·m
	1	2a	2b	3	4	5	6
MJ5 x 0.8	0.25	0.5	0.3	2.0	4.0	7.0	8.0
MJ6 x 1	0.35	0.7	0.4	3.2	6.4	11.9	13.6
MJ7 x 1	0.50	1.0	0.6	4.6	9.2	19.6	22.4
MJ8 x 1	0.65	1.3	0.8	6.0	12.0	30.0	34.2
MJ10 x 1.25	1.20	2.4	1.4	9.5	19.0	58.4	66.6
MJ12 x 1.25	1.80	3.6	2.2	15.0	30.0	103.9	118.6

Column 1. Minimum breakaway torque for 15-cycle test, and permanent set test.

2a. Minimum breakaway torque for first cycle of 3-cycle test.

2b. Minimum breakaway torque for second and third cycles of 3-cycle test.

3. Maximum self-locking torque for 15-cycle test, 3-cycle test, and permanent set test.

4. Maximum self-locking torque for 5-cycle test.

5. Assembly torque for 15-cycle and 3-cycle tests for shear height nuts. Based on 517 MPa stress in companion test bolt, f = 0.14, calculated per AIR1551 formula.

6. Assembly torque for 15-cycle and 3-cycle tests for tension height nuts. Based on 590 MPa stress in companion test bolt, f = 0.14, calculated per AIR1551 formula.

3.9.9 Accelerated Vibration Test: Nuts shall be tested in accordance with DOD-STD-1312-107 and shall be loaded to assembly torques specified in Table 6. The loaded nut assembly shall withstand 30 000 cycles continuous vibration at 30 Hz and amplitude (total travel) 11.25 mm without relative rotation exceeding 360°, without cracking of nut, and without being capable of turning the nut by hand.

TABLE 6 - Assembly Torque for Accelerated Vibration Test

Thread Size	Assembly Torque, N·m
MJ5 x 0.8	4.0
MJ6 x 1	6.4
MJ7 x 1	9.2
MJ8 x 1	12.0
MJ10 x 1.25	19.0
MJ12 x 1.25	30.0

3.9.9.1 At Room Temperature, As Received Condition: The 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 730°C 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 730°C ± 8 and held for 6 h ± 0.25, and cooled to room temperature. The nut shall then be removed from the assembly and reinstalled four additional times on the same bolt to the assembly torque 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 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 115% of maximum shank diameter without cracking.

3.10 Test Bolts:

Except as specified in 3.9.1.1, test bolts shall be unplated and conform to MA3378 with threads to MA1370 class 4h6h.

3.11 Test Lubrication:

Stud-mandrel or bolt threads and nut bearing surface, and for nonwrenching nut tests the bolt bearing surface, shall be lubricated with 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. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the 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 the part drawing are listed in Table 8.

4.3 Sampling:

4.3.1 Acceptance Tests: Acceptance tests shall be performed on each inspection lot. See 2.2.2.

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 approval test samples shall consist of the applicable number of nuts for each thread size to be tested as specified in Table 8.

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 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, this specification number, contractor or direct supplier of material, material specification number, part number, nominal size, and quantity.

4.5 Resampling and Retesting:

If any part used in the tests fails to meet the specified requirements, 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 Identification:

Nuts of each different part number shall be packed in separate containers. Each container of parts shall be marked to show not less than the following information:

NUTS, SELF-LOCKING, NICKEL ALLOY, CORROSION AND HEAT RESISTANT
MA1943
PART NUMBER _____
PURCHASE ORDER NUMBER _____
QUANTITY _____
MANUFACTURER'S IDENTIFICATION _____
PRODUCTION LOT NUMBER _____
INSPECTION _____

5.2 Packaging:

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.

5.2.1 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 MA1943 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 The change bar (|) 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.

8.2 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification.
Part number of parts desired.
Quantity of parts desired.
Applicable level of packaging.

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

TABLE 7 - Production Acceptance Plan

Characteristic	Req. Para.	Sample Size	Test Method
Destructive Tests			
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
Three-Cycle Test	3.9.8	Table 11, Col A	Appendix H
Nondestructive Tests			
Dimensions	3.2.1	Tables 9 & 10	Conventional measuring methods
Bearing Surface Squareness	3.2.1.1	Tables 9 & 10	Appendix A
Geometric Tolerances	3.2.1.2	Tables 9 & 10	Conventional measuring methods
Thread Size	3.2.3	Tables 9 & 10	Gaging methods per MA1566
Surface Texture	3.2.2	Table 11, Col A	Per ANSI/ASME B46.1 by visual or fingernail comparison with std 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 and criteria per Appendix J
Packaging & Identification	5.1 & 5.2	100%	Visual examination

NOTE: 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.

TABLE 8 - Qualification Approval Test Plan

Characteristic	Req. Para.	Sample Size	Test Method
	Destructive Tests[1]		
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	DOD-STD-1312-108
After 730°C Bake	3.9.1.2	4	DOD-STD-1312-108
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	3.9.5	3	Appendix E
Reusability Test,			
After 730°C 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	DOD-STD-1312-107
After 730°C Bake	3.9.9.2	5	DOD-STD-1312-107
Flareability	3.9.10	3	Conventional flaring tool

[1]Total number of samples for destructive tests equals 77; 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.

TABLE 8 - Qualification Approval Test Plan (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 MA1566
Surface Texture	3.2.2	All	Per ANSI/ASME B46.1 by visual, fingernail comparison with standard 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 and Appendix J

NOTE: Sample size includes all samples for destructive tests (see page 16).

TABLE 9 - Classification of Defects

Category No.	A.Q.L.	Characteristic
Major A		
101	0.4%	Presence of locking element
102		Surface discontinuities revealed by fluorescent penetrant inspection
Major B		
201		Thread size
202		Squareness of bearing face to thread
203		Plating or coating
204		Product marking
205	1.0%	Shank diameter
206		Shank length
207		Rivet hole size
208		Rivet hole location
209		Surface texture
210		Three-cycle test
Minor A		
301		Wrenching size and configuration
302		Nut height
303		Bearing 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 Number (AC), and Limiting Quality (LQ) in Percent Defective
For AQL 0.4, 1.0, 2.5, and 4.0%

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	Sample Size (n) Destructive	Acceptance Number (AC)
	A	B	
Up to 500	8	3	0
501 to 3200	13	5	0
3201 to 35000	20	5	0
35001 and over	32	8	0

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 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.

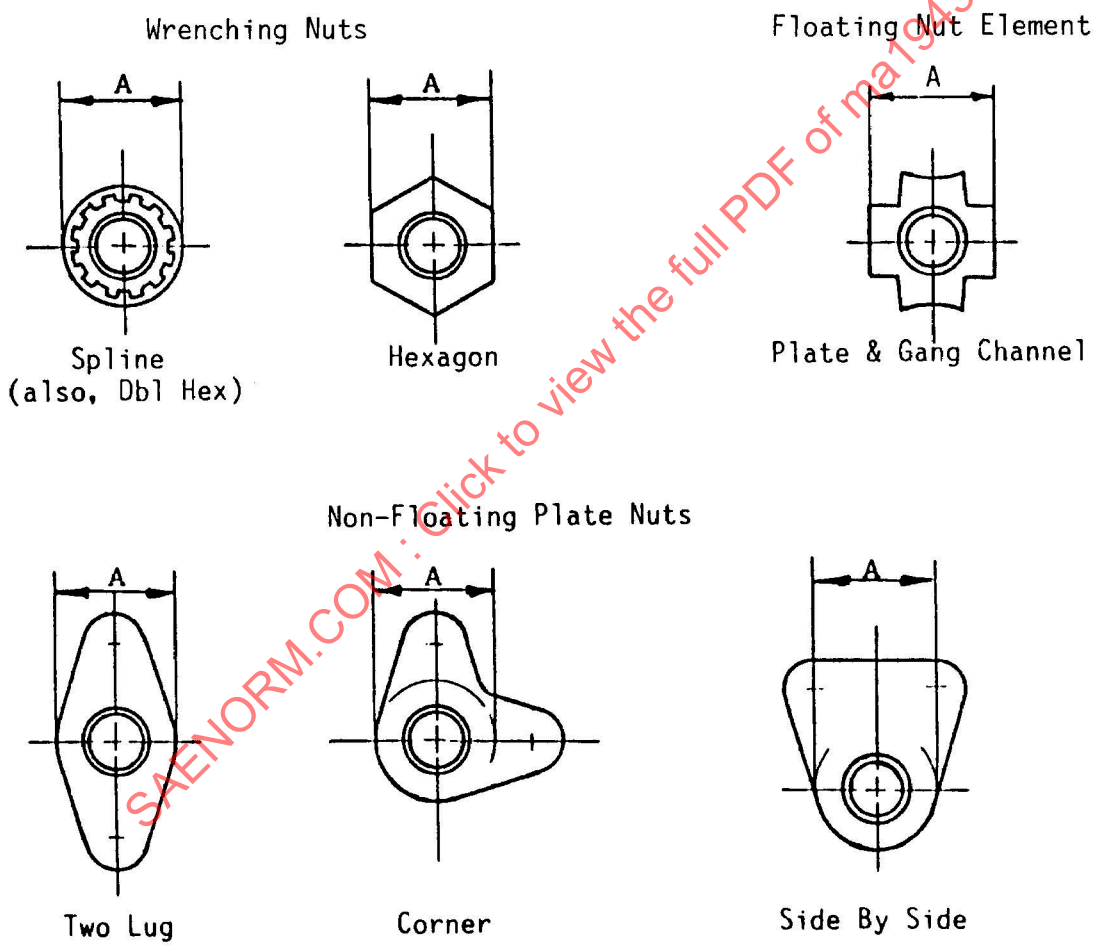


FIGURE A1 - Bearing Surface Area "A" Under Perpendicularity Control for Various Types of Nuts

A.1.2 For floating nuts this measurement applies only to the nut element when the retaining plate or channel has been removed.

A.2 APPLICABLE DOCUMENTS:

MA1370 Screw Threads - MJ Profile, Metric
NA 0012 Fixture - Bearing Surface Squareness Test, Self-Locking Nuts, Metric

A.3 APPARATUS:

A.3.1 Particulars of the fixture are given in NA 0012 except 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.

APPENDIX B

WRENCH TORQUE TEST

B.1 SCOPE:

This appendix is a mandatory part of this specification.

B.1.1 This test is applied to externally wrenched nuts of spline and hexagon wrenching configuration.

B.1.2 The purpose is 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.2 APPLICABLE DOCUMENTS:

MA1370	Screw Threads - MJ Profile, Metric or,
ANSI B1.13M	Metric Screw Threads M Profile
MA1586	Wrench Configuration, 12 Spline Drive, Metric

B.3 APPARATUS:

B.3.1 The typical test apparatus is shown in Figure B1 and comprises the following:

a. Stud with threads conforming to MA1370 or ANSI B1.13M, tolerance class 4h6h
b. Two wrenches conforming to MA1586; double hexagon sockets for hexagon drive nuts
c. Square drive adapter for socket wrenches

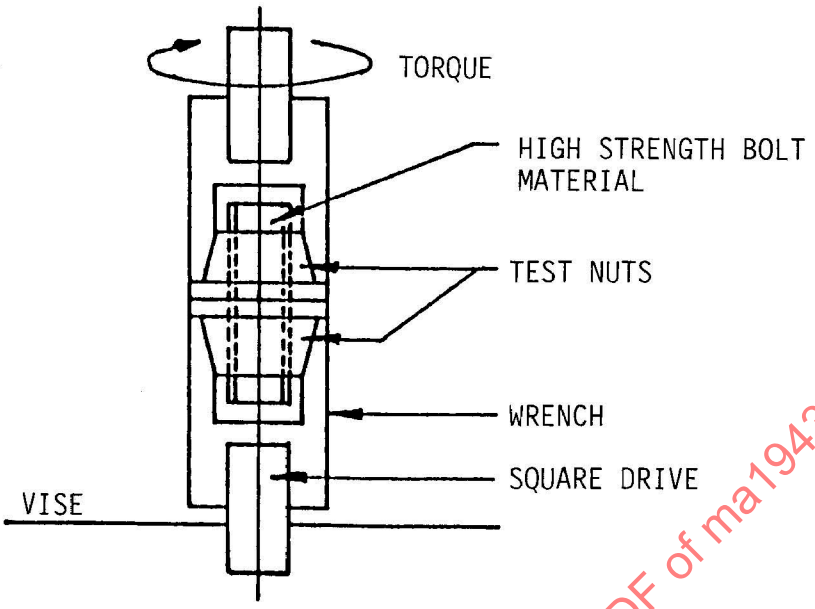


FIGURE B1 - Wrench Torque Test Apparatus

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.

APPENDIX C

PUSH OUT TEST

C.1 SCOPE:

This appendix is a mandatory part of this specification.

C.1.1 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).

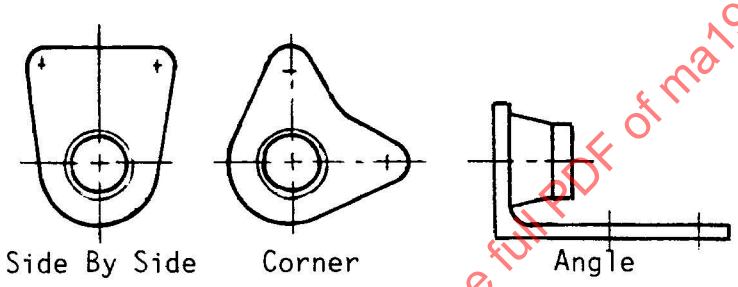


FIGURE C1 - Types of Nuts Not Applicable to Push Out Test

C.1.2 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.2 APPLICABLE DOCUMENTS:

MA1370 Metric Screw Threads - MJ Profile

C.3 APPARATUS:

C.3.1 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 MA1370, tolerance class 4h6h

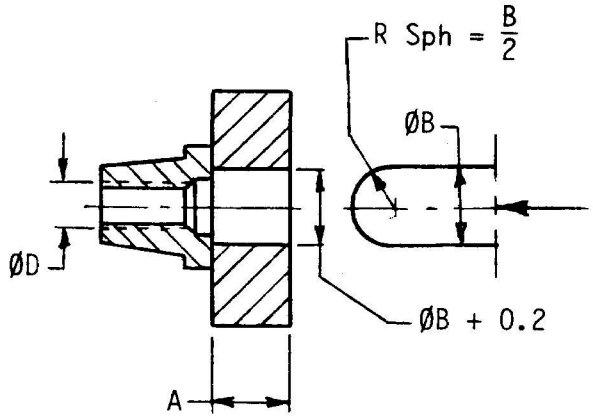


FIGURE C2 - Push Out Test Apparatus

TABLE C1 - Dimensions for Test Apparatus, mm

Nom Thd Size, D	5	6	7	8
A	8	8	14	14
B	5.5	6.5	7.5	8.5

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 the bolt and detach the nut from the 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 This test is applicable to nuts produced as multipiece nuts as the following:

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.1.2 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.2 APPLICABLE DOCUMENTS:

MA1370	Screw Threads - MJ Profile, Metric
ANSI B1.13M	Metric Screw Threads, M Profile

D.3 APPARATUS:

D.3.1 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 MA1370 or ANSI B1.13M, tolerance class 4h6h
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

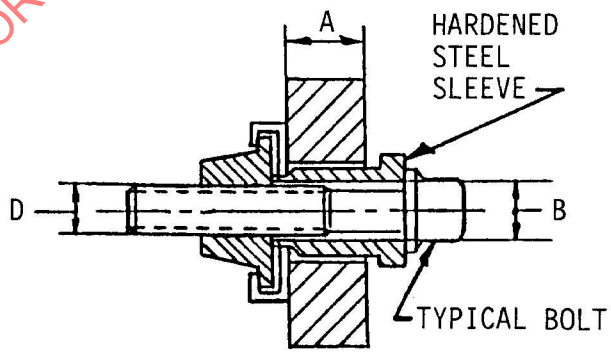


FIGURE D1 - Torque Out Test Apparatus

TABLE D1 - Dimensions for Test Apparatus, mm

Nom Thd Size, D	5	6	7	8
A	8	8	14	14
B	5.2	6.2	7.2	8.2

D.4 PROCEDURE:

D.4.1 Attach the plate 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 the nut from the 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 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:

MA1370	Screw Threads - MJ Profile, Metric
ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

E.3 APPARATUS:

E.3.1 The apparatus shown in Figures E1 and E2 comprises the following:

a. Maximum mandrel (Figure E1)
b. Minimum mandrel (Figure E2)

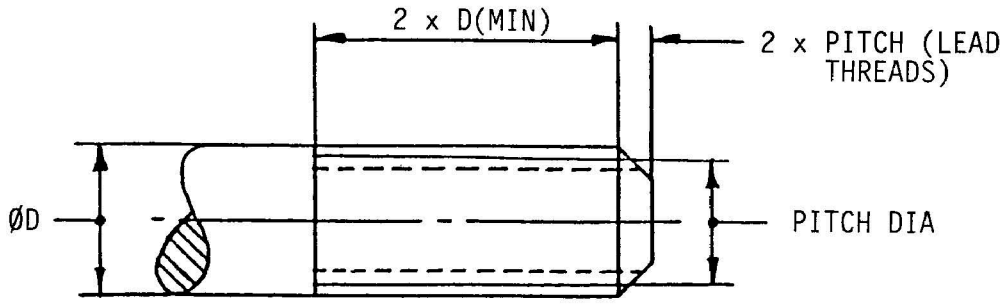


FIGURE E1 - Maximum Mandrel

TABLE E1 - Maximum Mandrel Pitch Diameter

Nom Thd Size	Pitch Dia, mm Max	Pitch Dia, mm Min
MJ5 x 0.8	4.464	4.454
MJ6 x 1	5.333	5.323
MJ7 x 1	6.333	6.323
MJ8 x 1	7.332	7.322
MJ10 x 1.25	9.169	9.159
MJ12 x 1.25	11.167	11.157

Material: Steel heat treated to 39 HRC minimum.
Surface Roughness: Thread Flanks to be 0.8 µm Ra in accordance with ANSI/ASME B46.1.
Threads: MA1370 except pitch diameter shall be as specified in Table E1.

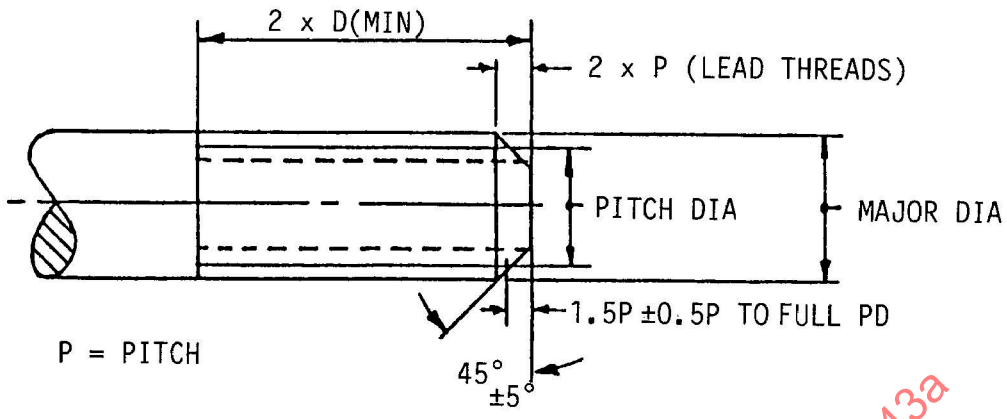


FIGURE E2 - Minimum Mandrel

TABLE E2 - Minimum Mandrel Thread Dimensions

Nom Thd Size	Major Dia mm Max	Major Dia mm Min	Pitch Dia mm Max	Pitch Dia mm Min	Tol on Half Angle, minutes	Helix Tolerance µm 1/
MJ5 x 0.8	4.850	4.840	4.420	4.410		
MJ6 x 1	5.820	5.810	5.279	5.269		
MJ7 x 1	6.820	6.810	6.279	6.269	±15	8
MJ8 x 1	7.820	7.810	7.279	7.269		
MJ10 x 1.25	9.788	9.778	9.113	9.103		
MJ12 x 1.25	11.788	11.778	11.103	11.093		

Material: Steel heat treated to 39 HRC minimum.
Surface Roughness: Thread Flanks to be 0.8 µm Ra in accordance with ANSI/ASME B46.1.
Threads: MA1370 except as otherwise specified in Table E2. Lead threads may be dressed or stoned to break sharp edges 0.1 to 0.4 mm.

1/ 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 on pitch diameter due to the form tolerances.

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 the 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.

APPENDIX F

REUSABILITY TEST AT ROOM TEMPERATURE AFTER 730°C BAKE

F.1 SCOPE:

This appendix is a mandatory part of this specification.

F.1.1 This test is applicable to all self-locking nuts (wrenching nuts and anchor nuts) 5 mm nominal thread size and larger, and is to verify the performance and reusability of the nut self-locking feature at room temperature after a specified time of 730°C bake under load for a specified number of cycles.

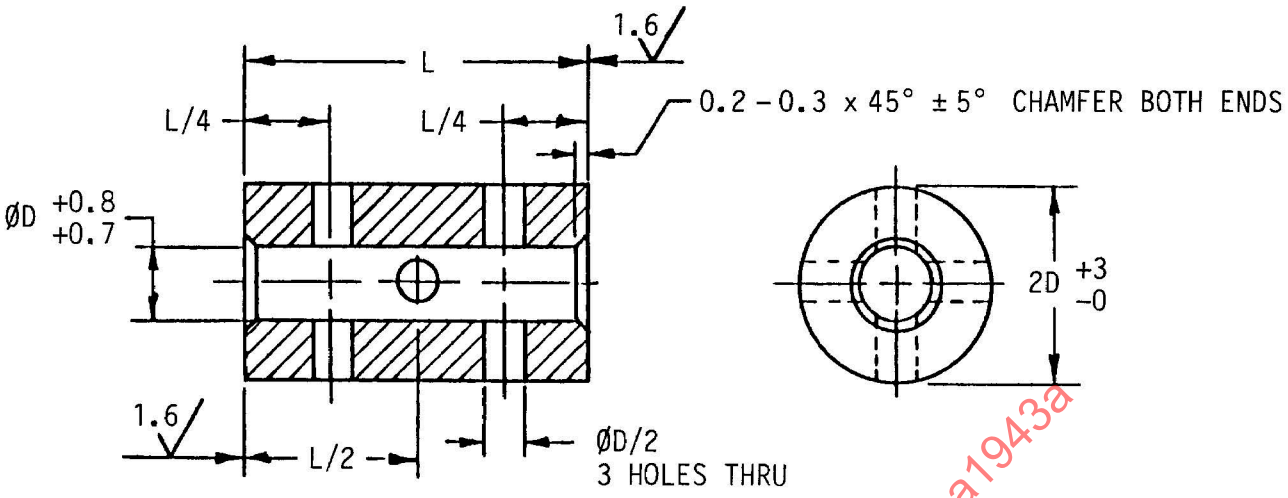
F.2 APPLICABLE DOCUMENTS:

MA1370	Screw Threads - MJ Profile, Metric
MA3378	Bolts & Screws, UNS N07001, 730°C, 1210 MPa Procurement Specification For, Metric
AMS-5707	Bars, Forgings and Rings, Alloy, 58Ni 19.5Cr 13.5Co 4.3Mo 3.0Ti 1.4Al 0.05Zr 0.006B, Consumable Electrode or Vacuum Induction Melted, 1825 – 1900°F (996 – 1038°C) Solution, Stabilization and Precipitation Heat Treated
AMS-5709	Bars and Forgings, Alloy, 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, Stabilization and Precipitation Heat Treated
ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

F.3 APPARATUS:

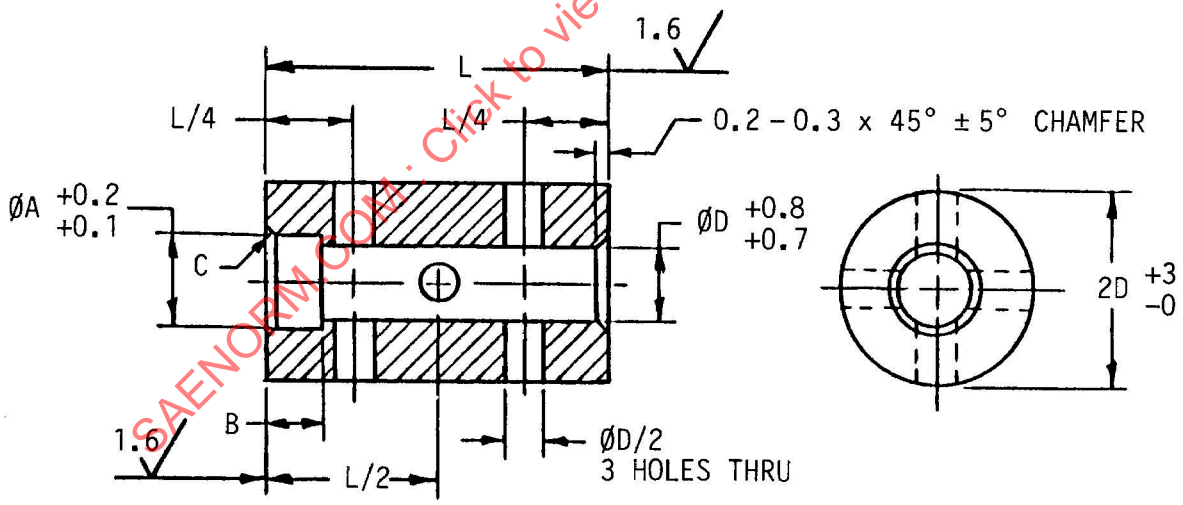
F.3.1 The apparatus shown in Figures F1 through F3 comprises the following:

a. Spacer
b. Bolt with threads conforming to MA1370 and manufactured to MA3378



D = nominal diameter of bolt
Dimensions in millimeters; surface roughness in micrometers, Ra

FIGURE F1 - Spacer for Nuts (Except Shank Nuts)



Dimensions in millimeters; surface roughness in micrometers, Ra
A = maximum diameter of nut shank uninstalled
B = maximum length of nut shank + 1 mm
C = 45° chamfer clearing maximum radius bearing face and shank of nut
D = nominal diameter of bolt

FIGURE F2 - Spacer for Shank Nuts

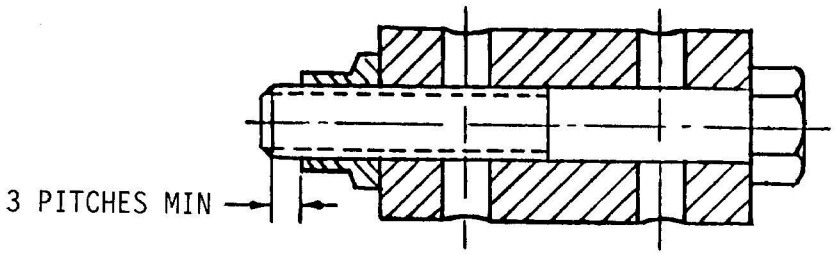


FIGURE F3 - Heat Soak Test Assembly

F.3.1.1 Spacer for Nuts (Except Shank Nuts): Material AMS-5707 or AMS-5709; dimensions Table F1.

F.3.1.2 Spacer for Shank Nuts: Material AMS-5707 or AMS-5709; dimensions Table F1.

TABLE F1 - Bolt and Spacer Length Dimensions and Bolt Elongation

Nom Thd Size	Bolt Length mm	Spacer Length mm	Required Bolt Elongation, mm 1	Required Bolt Elongation, mm 2
MJ5 x 0.8	42	30	0.073	0.083
MJ6 x 1	46	32	0.077	0.088
MJ7 x 1	46	32	0.077	0.088
MJ8 x 1	48	32	0.077	0.088
MJ10 x 1.25	52	32	0.077	0.088
MJ12 x 1.25	56	36	0.087	0.099

1. Based on 0.002419 x L for shear height nuts.
2. Based on 0.002761 x L for tension height nuts.

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.

F.4.3 Load the assembly to the requirements of this specification and record the elongation and assembly torque.