SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE MA1573

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Nut, Self-Locking - Steel, Class 1100 MPa/235°C, MJ Thread Procurement Specification For, Metric

FSC 5310

1. SCOPE:

1.1 Type:

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

a. Wrenching nuts: that is, hex, double hex, spline drive
b. Anchor nuts: that is, plate nuts, gang channel nuts, shank nuts

The wrenching nuts and shank nuts are made of low alloy steels, and the nut elements of plate and gang channel nuts are made of carbon steels or low alloy steels and having MJ threads to ISO 5855/2. Nuts have 1100 MPa tensile strength class at room temperature. Maximum test temperature of parts at 235°C.

1.2 Application:

Primarily for use in aerospace propulsion systems.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Standards (AS & MA) shall apply. The applicable issue of other documents shall be as specified in AMS2350.

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

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

AMS2350 - Standards and Test Methods
AMS2400 - Plating, Cadmium
AMS2640 - Magnetic Particle Inspection
AMS2759 - Heat Treatment of Steel Parts, General Requirements
AMS5024 - Steel Bars, Forgings, and Tubing, 1.5Mn (0.32 - 0.39C), Free Cutting
AMS5085 - Steel Sheet, Strip, and Plate, 0.47 - 0.55C, Annealed
AMS6300 - Steel Bars and Forgings, 0.25Mo (0.35 - 0.40C)
AMS6304 - Steel Bars, Forgings, and Tubing, 0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C)
AMS6322 - Steel Bars, Forgings, and Rings, 0.50Cr - 0.55Ni - 0.25Mo (0.38 - 0.43C)
AMS6350 - Steel Sheet, Strip, and Plate, 0.95Cr - 0.20Mo (0.28 - 0.33C)
AMS6351 - Steel Sheet, Strip, and Plate, 0.95Cr - 0.20Mo (0.28 - 0.33C), Spheroidized
AMS6370 - Steel Bars, Forgings, and Rings, 0.95Cr - 0.20Mo (0.28 - 0.33C)
AS1310 - Fastener Torque for Threaded Applications, Definitions of
MA1520 - Areas for Calculating Stress or Load Values for Metric MJ Externally Threaded Fasteners
MA1586 - Wrench Configuration, 12 Spline Drive, Metric
MA3376 - Bolts & Screws, UNS G87400, 860 MPa, MJ Thread, Procurement Specification for, Metric

2.2 U.S. Government Publications:

Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

MIL-L-7808 - Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-1312 - Fastener Test Methods

2.3 ANSI Publications:

Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI/ASME B1.3M - Screw Thread Gaging Systems for Dimensional Acceptability - Inch and Metric Screw Threads (UN, UNR, UNJ, M and MJ)
ISO 965/2 - Metric Screw Threads - M Profile
ANSI/ASME B46.1 - Surface Texture (Surface Roughness, Waviness, and Lay)
ISO 5855/2 - Aerospace Construction - MJ Threads - Part 2: Dimensions for Bolts and Nuts

2.4 NAS Publications:

Available from National Standards Association, Inc., 1321 Fourteenth Street NW, Washington, DC 20005.

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

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be low alloy steel, AMS6300, AMS6304, or AMS6322, or carbon steel, AMS5024, 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, non-floating plate nuts and nut elements of plate or gang channel floating nuts may be formed from AMS 5085 carbon steel sheet or AMS6350 or AMS6351 alloy steel sheet. Material for the retaining plate for floating 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 ISO 5855/2, unless otherwise specified, and determined in accordance with ANSI/ASME B1.3M, System 22, including cumulative form variation inspection.

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: Thread in nuts requiring plating shall have the standard coating allowance G, unless otherwise specified on the part drawing; maximum thread dimensions before plating for pitch diameter and minor diameter shall be within the following tolerance class before forming the self-locking feature:

Tolerance Class 4G6G for sizes 1 through 5 mm
Tolerance Class 4G5G for sizes 6 mm and larger

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 hardened and tempered as required to produce the properties in this specification and the part drawing.

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 cadmium plated in accordance with AMS2400. Nuts heat treated to 39 HRC or higher and cadmium plated shall be baked for not less than 23 h at 190°C ± 14 within 1 h after plating. 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 sizes below 6 mm shall show complete coverage on the thread surfaces. Plating on other surfaces shall be 8 - 15 µm thick, unless otherwise specified on the part drawing. AMS2400 cadmium plating shall be applied to the retaining plate for floating plate nuts and channel for gang channel nuts that are made from carbon or alloy steels.

3.6 Mechanical Properties:

3.6.1 Hardness: Unless otherwise specified on the part drawing, the hardness after heat treatment shall be uniform and within the range of 35 - 40 HRC or equivalent, except nuts formed from carbon steel sheet shall be within the range of 35 - 44 HRC, 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 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 microstructure of tempered martensite.

3.7.2 Surface Hardening: Parts shall have no surface hardening resulting from carburization, recarburization, or nitriding. In case of dispute over results of microscopic examination, micro-hardness testing shall be used as a referee method; a Vickers hardness reading within 0.08 mm of the surface more than 30 points higher than the reading in the core will be evidence of nonconformance to this requirement.

3.7.3 Decarburization: No area of total decarburization is permissible. Partial decarburization is permissible provided that the thickness over the area is less than or equal to 0.1 mm, as determined by micro-examination specified in 3.7.2; a Vickers hardness reading within 0.1 mm of the surface shall not be more than 30 points lower than the reading in the core.

3.8 Quality:

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials and imperfections detrimental to their performance.

3.8.1 Magnetic Particle Inspection: Parts shall be subject to magnetic particle inspection in accordance with AMS2640. Acceptance criteria of surface discontinuities shall be in accordance with Appendix J.

3.9 Product Performance Test:

Refer to Tables VII and VIII 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 I 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 min or equivalent, shall withstand the axial tensile load specified in Table I, 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 pitches protruding and baked for 6 h ± 0.25 at 235°C ± 8, 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 DOD-STD-1312-108 and shall withstand the axial tensile load in Table I, applied at the rate specified.

TABLE I - Axial Tensile Load & Stress Area

Nut Thread Size	Axial Tensile Load at Room Temp. T, kN min 1/	Stress Area A, mm^2 1/
MJ4 x 0.7-4H6H	10.5	9.517
MJ5 x 0.8-4H6H	16.8	15.296
MJ6 x 1-4H5H	23.9	21.753
MJ7 x 1-4H5H	34.0	30.930
MJ8 x 1-4H5H	45.8	41.682
MJ10 x 1.25-4H5H	71.6	65.136
MJ12 x 1.25-4H5H	106.8	97.128

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

$$A = 0.7854(d_3)^2\left[2-\left(\frac{d_3}{d_2}\right)^2\right]$$

where

d_2 = max pitch diameter
d_3 = max root diameter

3.9.1.2 (Continued):

Load requirements for axial strength load is based on 1100 MPa stress. Axial tensile strength load, T = 1100 MPa x A divided by 1000 to obtain load in kN. For sizes not shown, axial tensile strength loads for nuts shall be based upon the respective companion bolt stress area and 1100 MPa stress.

3.9.1.3 Shank Nuts: Nuts with shanks designed to be flared at assembly (see Fig. 1) shall be tested as in 3.9.1 except that the bearing plate hole shall be 0.1 - 0.2 mm greater than the max 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 max fillet.

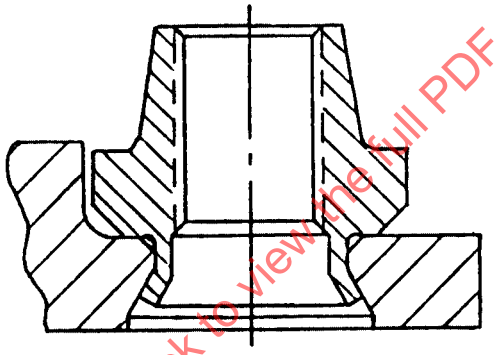

FIGURE 1 - Flange Assembly, Flared Shank Nut

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

TABLE II - Wrench Torque

Thread Size	Wrench Torque, Nm
MJ5 x 0.8	13.8
MJ6 x 1	24
MJ7 x 1	40
MJ8 x 1	60
MJ10 x 1.25	115
MJ12 x 1.25	200

3.9.3 Push Out Load: Anchor nuts of the types in 3.9.3.1 (normal series and miniature series rivet hole spacing) shall be tested as specified in Appendix C and shall withstand the push-out loads for the applicable series specified in Table III without separating from the plate for the normal and miniature series or from the channel for the normal series. Nuts shall be serviceable after this test.

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

TABLE III - Push-Out Load

Thread Size	Push-Out Load Normal Series N	Push-Out Load Miniature Series N
MJ4 x 0.7	---	360
MJ5 x 0.8	900	460
MJ6 x 1	950	570
MJ7 x 1	1050	---
MJ8 x 1	1100	---

3.9.4 Torque Out: Anchor nuts of the types in 3.9.3.1 (normal series and miniature series rivet hole spacing) shall be tested as specified in Appendix D and shall withstand the torque out loads for the applicable series specified in Table IV 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.

TABLE IV - Torque Out Load

Thread Size	Torque Out Normal Series Nm	Torque Out Miniature Series Nm
MJ4 x 0.7	--	6
MJ5 x 0.8	10	9
MJ6 x 1	16	13
MJ7 x 1	22	--
MJ8 x 1	33	--

3.9.5 Permanent Set: Nuts shall be tested as specified in Appendix F and shall not exceed the max permissible locking torque or be less than the min breakaway torque values specified in Table V. The bolt or mandrel shall project thru the nut a minimum of three full thread pitches.

3.9.6 Reusability Test at Room Temperature After Bake: Nuts 5 mm nominal thread size and larger shall be tested for five consecutive cycles as specified in Appendix F, loading initially to 621 MPa in accordance with 3.9.6.3. The assembly shall be heated in a furnace to 235°C ± 8 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 turned relative to the fixture. The wrenchability of the tested nuts shall permit assembly of standard wrench. For non-wrenchable 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 V, Column 1, for each cycle. The self-locking torque shall be measured on installation and removal, and shall not exceed the torque in Table V, Column 4, nor shall be less than the breakaway torque in Table V, 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 correct loading shall be determined by using a modulus of elasticity of 203.4 GPa. Stress area for the bolt shall be based on Formula (2) area given in MA1520. The elongation shall be equal to 0.0030531L (where L = length of bushing) elongation of bolts using standard bushing as specified 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 V, Column 5. Wrenchable nuts shall be turned relative to the fixture. For non-wrenchable nuts, the bolt head shall be turned. Locking feature torque shall conform to the minimum breakaway torque and maximum self-locking torque in Table V, Columns 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 V, Column 3, nor shall be less than the breakaway torque in Table V, 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 Cycles at Room Temperature: Nuts shall be tested as specified in Appendix H, loading to assembly torque specified in Table V, Column 5. Wrenchable nuts shall be turned relative to the fixture. For non-wrenchable nuts, the bolt head shall be turned. Nuts shall conform to the minimum breakaway torque in Table V, Column 2, for the first cycle, and Column 1 for the subsequent two cycles. The self-locking torque shall be measured on installation and removal, and shall not exceed the torque in Table V, Column 3, nor shall be less than the breakaway torque in Table V, Column 1.

TABLE V - Locking Feature Torques and Assembly Torque

Thread Size	Breakaway Torque Min, Nm		Self-Locking Torque, Max, Nm		Assembly Torque, Nm
	1	2	3	4	5
MJ4 x 0.7	0.15	0.30	1.6	3.2	2.8
MJ5 x 0.8	0.25	0.50	2.0	4.0	5.5
MJ6 x 1	0.35	0.70	3.2	6.4	9.6
MJ7 x 1	0.50	1.00	4.6	9.2	16.0
MJ8 x 1	0.65	1.30	6.0	12.0	24.0
MJ10 x 1.25	1.20	2.40	9.5	19.0	46.0
MJ12 x 1.25	1.80	3.60	15.0	30.0	80.0

1. Minimum breakaway torque for 15-cycle test, 5-cycle test, 2nd & 3rd cycle of 3-cycle test, and permanent set test.

2. Minimum breakaway torque for 1st cycle 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.

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 VI. 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 deg, without cracking of nut, and without being capable of turning nut by hand.

TABLE VI - Assembly Torque for Accelerated Vibration Test

Thread Size	Assembly Torque, Nm
MJ5 x 0.8	3.6
MJ6 x 1	6.0
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: 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 VI. 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 235°C ± 8 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 VI. 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 Stress Embrittlement Test: This requirement is applicable only to nuts 5 mm nominal thread size and larger with hardness equal to or greater than 39 HRC. Ten nuts or 10%, whichever is less, shall be selected from each inspection lot and tested in accordance with MIL-STD-1312-14 (Metric). The test load shall be 75 - 80% of the axial tensile load specified in Table I. The duration of the test shall be 48 hours. Heat treatment and plating shall not cause any embrittlement that may prevent the nuts from withstanding continuously, without cracking or rupturing, the above axial test load.

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

3.10 Test Bolts:

Except as specified in 3.9.1.1, test bolts shall be plated in accordance with AMS2400, and conform to MA3376 with a hardness of 32 HRC minimum and threads to ISO 5855/2 class 4h6h.

3.11 Test Lubrication:

Stud-mandrel or bolt threads and nut bearing surface, and for non-wrenchable 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. Results of such tests shall be reported to the purchaser as required by 4.4. 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 VII.

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

4.3 Sampling:

4.3.1 Acceptance Tests: Acceptance tests shall be performed on each inspection lot (see 8.2.3).

4.3.1.1 Non-Destructive 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 X. The classification of defects for nuts will be as specified in Table IX. Defects not classified in Table IX 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 XI, Column B. The sample nuts may be selected from those that have been subjected to and passed the non-destructive 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 VIII.

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 conforms 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 above 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, STEEL
MA1573
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. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.1 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

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

8. NOTES:

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

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

8.2 Definitions:

8.2.1 Refer to AS1310 for definitions related to fastener torque.

8.2.2 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.

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

8.2.4 Room Temperature: 20°C ± 10.

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TABLE VII - Production Acceptance Test Plan

Characteristic	Req. Para.	Sample Size	Test Method
Destructive Tests			
Hardness	3.6.1	Table XI, Col B	MIL-STD-1312-6, metric
Microstructure	3.7.1	Table XI, Col B	Microscopic examination 100X
Surface Hardening	3.7.2	Table XI, Col B	Vickers hardness measurement
Decarburization	3.7.3	Table XI, Col B	Microscopic examination
Stress Embrittlement Test	3.9.10	3.9.10	MIL-STD-1312-14, metric
Flareability	3.9.11	Table XI, Col B	Conventional flaring tool
Plating	3.5	Table XI, Col B	Microscopic measurement of sectioned nut
Three-Cycle Test	3.9.8	Table XI, Col A	Appendix H
Non-Destructive Tests			
Dimensions	3.2.1	Tables IX & X	Conventional measuring methods
Bearing surface squareness	3.2.1.1	Tables IX & X	Appendix A

TABLE VII - Production Acceptance Test Plan (Continued)

Characteristic	Req. Para.	Sample Size	Test Method
Geometric Tolerances	3.2.1.2	Tables IX & X	Conventional measuring methods
Thread size	3.2.3	Tables IX & X	Gaging methods per ANSI/ASME B1.3M, System 22, including cumulative form variation inspection
Surface Texture	3.2.2	Table XI, 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 IX & X	Visual examination
Workmanship	3.8	Tables IX & X	Visual examination
Magnetic Particle Inspection	3.8.1	Tables IX & X	Inspection per AMS2640 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 VIII - 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
Surface Hardening	3.7.2	5	Vickers hardness measurement
Decarburization	3.7.3	5	Microscopic examination 100X
Stress Embrittlement Test	3.9.10	10	MIL-STD-1312-14, metric
Axial Tensile Strength As Received After 235°C Bake	3.9.1 3.9.1.1 3.9.1.2	 4 4	 DOD-STD-1312-108 DOD-STD-1312-108
Wrench Torque	3.9.2	3	Appendix B
Push-Out Test	3.9.3	5	Appendix C
Torque Out Test	3.9.4	5	Appendix D
Permanent Set Test	3.9.5	3	Appendix E
Reusability Test After 235°C Bake As Received	 3.9.6 3.9.7	 10 10	 Appendix F Appendix G

TABLE VIII - Qualification Approval Test Plan (Continued)

Characteristic	Req. Para.	Sample Size	Test Method
Destructive Tests 1/			
Accelerated Vibration Test As Received After 235°C Bake	3.9.9 3.9.9.1 3.9.9.2	 5 5	 DOD-STD-1312-107 DOD-STD-1312-107
Flareability	3.9.10	3	Conventional flaring tool
Plating	3.5	5	Microscopic measurement of section nut
Non-Destructive 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 ANSI/ASME B1.3M, System 22, including cumulative form variation inspection
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

TABLE VIII - Qualification Approval Test Plan (Continued)

Characteristic	Req. Para.	Sample Size	Test Method
Destructive Tests 1/			
Workmanship	3.8	All	Visual examination
Magnetic Particle Inspection	3.8.1	All	Inspection per AMS2640 & Appendix J

1/ Total number of samples for destructive tests equals 92; all samples shall be subjected to the non-destructive tests 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 IX - Classification of Defects

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

TABLE X - 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%			AQL 1.0%			AQL 2.5%			AQL 4.0%		
	(n)	(AC)	(LQ)%	(n)	(AC)	(LQ)%	(n)	(AC)	(LQ)%	(n)	(AC)	(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 XI - Sampling Data

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

Lot Size	Sample Size (n)		Acceptance Number
	Non-Destructive	Destructive	
	A	B	(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

APPENDIX A
MEASUREMENT OF PERPENDICULARITY VARIATION OF THE BEARING SURFACE

A1. SCOPE:

This appendix is a mandatory part of this specification.

A1.1 To measure the variation from perpendicularity of the nut bearing surface "A" (see Fig. A1) relative to the thread. This inspection is applicable to all nuts.

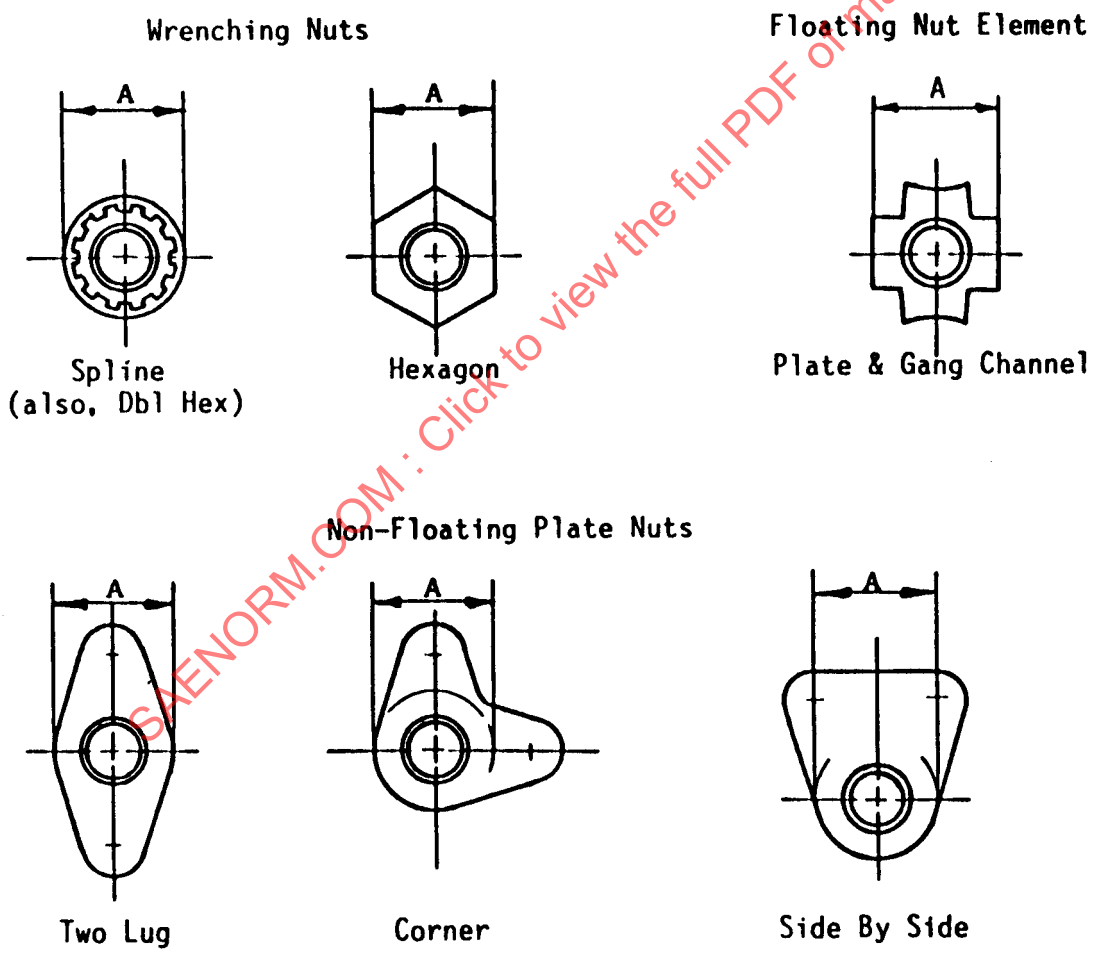


FIGURE A1 - Bearing Surface Area "A" Under Perpendicularity Control for Various Types of Nuts

A1.2 For floating nuts, this measurement applies only to the nut element, when the retaining plate or channel has been removed.

A2. APPLICABLE DOCUMENTS:

ISO 5855/2 - Screw Threads, MJ Profile, Metric
NA 0012 - Fixture - Bearing Surface Squareness Test, Self-Locking Nuts, Metric

A3. APPARATUS:

A3.1 Particulars of the fixture are given in NA 0012 except the mandrel shall be in accordance with the maximum mandrel in Appendix E, Fig. E1.

A4. PROCEDURE:

A4.1 The perpendicularity of the bearing surface relative to the thread shall be measured within the basic area "A" as defined in Fig. A1.

A4.2 Nuts may be checked for perpendicularity before or after forming the self-locking feature.

A4.3 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

B1. SCOPE:

This appendix is a mandatory part of this specification.

B1.1 This test is applied to externally wrenched nuts of spline, double hexagon and hexagon wrenching configuration.

B1.2 The purpose is to test if the wrenching configuration is capable of withstanding the high breakloose torques encountered with nuts used in hot areas of aerospace propulsion systems.

B2. APPLICABLE DOCUMENTS:

ISO 5855/2 - Screw Threads, MJ Profile, Metric or ISO 965/2 - Metric Screw Threads, M Profile
MA1586 - Wrench Configuration 12 Spline Drive, Metric

B3. APPARATUS:

B3.1 The typical test apparatus is shown in Fig. B1 and comprises the following:

a. Stud with threads conforming to ISO 5855/2 or ISO 965/2 tolerance class 4h6h.
b. Two wrenches conforming to MA1586, double hex sockets for double hex drive nuts and for hex drive nuts.
c. Square driver adaptor for socket wrenches.

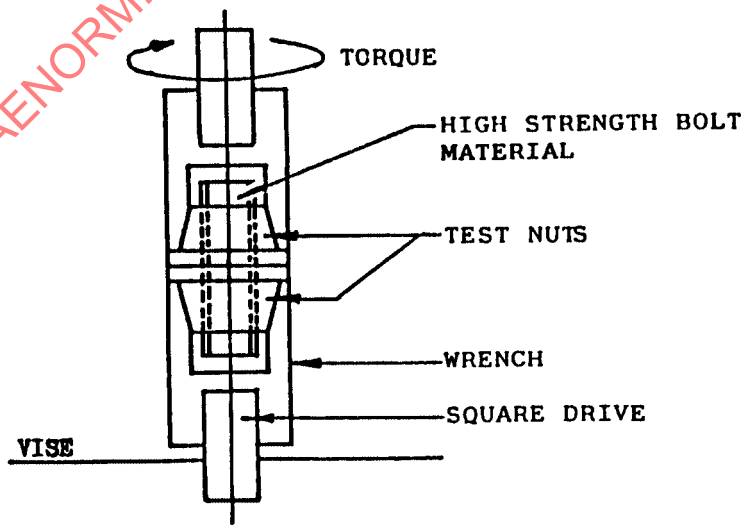


FIGURE B1 - Wrench Torque Test Apparatus

B4. PROCEDURE:

B4.1 Method using stud and wrenches.

B4.1.1 Place adaptor in vise. For hex nuts, bottom hex nut is gripped in vise.

B4.1.2 Locate first wrench socket on adaptor.

B4.1.3 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.

B4.1.4 Locate assembly into first wrench.

B4.1.5 Engage second wrench onto upper nut and test to the requirements of this specification.

APPENDIX C
PUSH-OUT TEST

C1. SCOPE:

This appendix is a mandatory part of this specification.

C1.1 This test is applicable to floating plate nuts and gang channel nuts. It is not applicable to non-floating plate nuts that are side by side mounting or corner mounting, and also, to floating angle plate nuts (see Fig. C1).

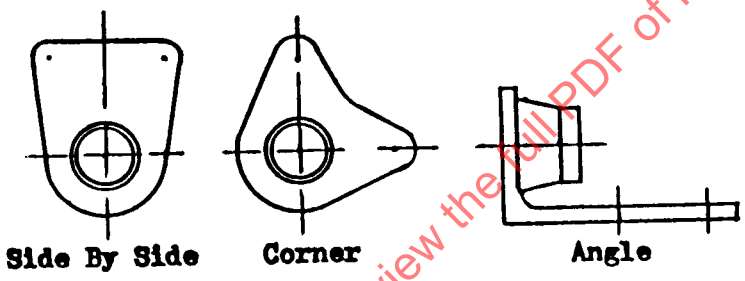


FIGURE C1 - Types of Nuts Not Applicable to Push Out Test

C1.2 This test is to determine whether the nut retainer plate or channel is capable of withstanding the axial push-out load in this specification after the nut is installed.

C2. APPLICABLE DOCUMENTS:

ISO 5855/2 - Screw Threads, MJ Profile, Metric

C3. APPARATUS:

C3.1 The test apparatus is shown in Fig. 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 ISO 5855/2, tolerance class 4h6h

C4. PROCEDURE:

C4.1 Attach the plate nut or section of gang channel to be tested to the plate by riveting or with bolts.

C4.2 Apply the push-out load given in this specification to the spherically ended mandrel as shown in Fig. C2.

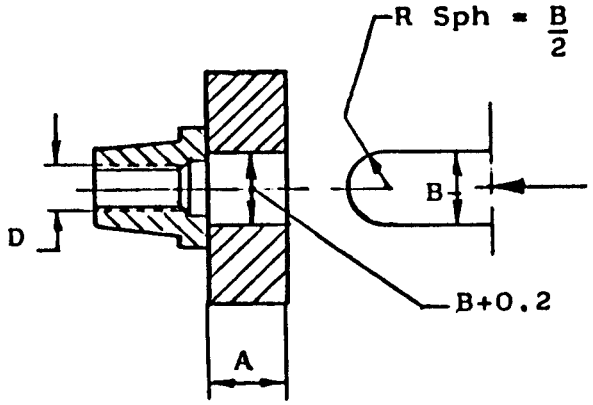


FIGURE C2 - Push-Out Test Apparatus

TABLE CI - Dimensions for Test Apparatus, mm

Nom Thd Size D	4	5	6	7	8
A	8	8	8	14	14
B	4.5	5.5	6.5	7.5	8.5

C4.3 Install a standard bolt with the fingers up to the locking feature using no supporting pressure on the nut.

C4.4 Remove bolt and detach nut from retention plate or channel.

C4.5 Submit the nut for visual examination and, if necessary, to an examination at low magnification after sectioning.

APPENDIX D
TORQUE-OUT TEST

D1. SCOPE:

This appendix is a mandatory part of this specification.

D1.1 This test is applicable to nuts produced as multi-piece nuts as the following:

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

D1.2 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.

D2. APPLICABLE DOCUMENTS:

ISO 5855/2 - Screw Threads, MJ Profile, Metric or ISO 965/2 - Metric Screw Threads, M Profile

D3. APPARATUS:

D3.1 A typical test apparatus is shown in Fig. 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 ISO 5855/2 or ISO 965/2 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

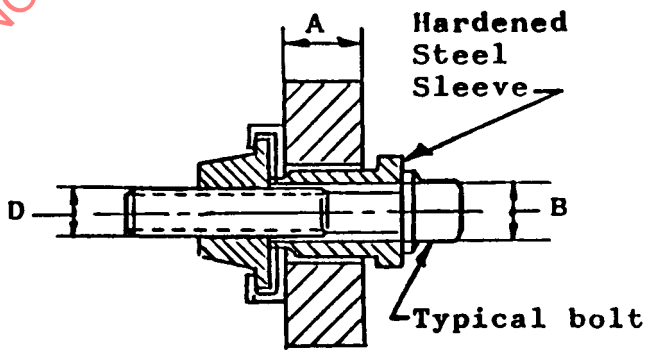


FIGURE D1 - Torque Out Test Apparatus

TABLE DI - Dimensions for
Test Apparatus, mm

Nom Thd Size D	4	5	6	7	8
A	8	8	8	14	14
B	4.2	5.2	6.2	7.2	8.2

D4. PROCEDURE:

D4.1 Attach the plate nut or section of gang channel to be tested to the plate by riveting or with bolts.

D4.2 Apply the torque-out torque given in this specification in a clockwise direction.

D4.3 Remove the bolt and detach nut from retention plate or channel.

D4.4 Submit the nut for visual examination and, if necessary, to an examination at low magnification after sectioning.

APPENDIX E
PERMANENT SET TEST

E1. SCOPE:

This appendix is a mandatory part of this specification.

E1.1 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).

E2. APPLICABLE DOCUMENTS:

ISO 5855/2 - Screw Threads, MJ Profile, Metric
ANSI/ASME B46.1- Surface Texture (Surface Roughness, Waviness, and Lay)

E3. APPARATUS:

E3.1 The apparatus shown in Figs. E1 and E2 comprises the following:

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

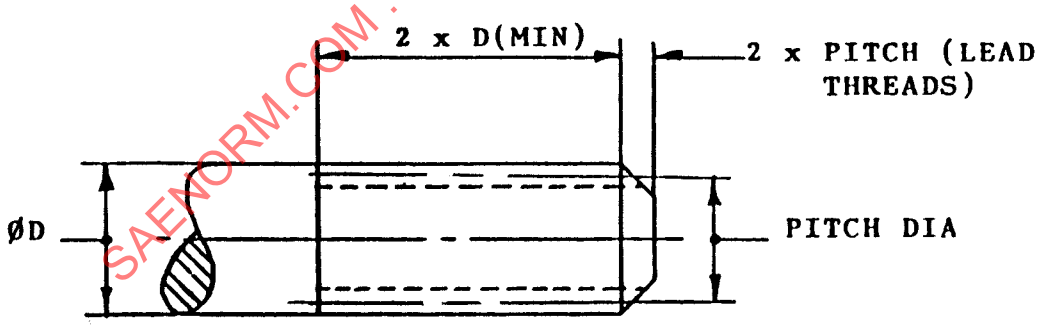


FIGURE E1 - Maximum Mandrel

TABLE EI - Maximum Mandrel Pitch Diameter

Nom Thd Size	Pitch Dia, mm	
	Max	Min
MJ4 x 0.7	3.530	3.520
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 min.

Finish: None

Surface Roughness: Thread flanks to be 0.8 µm Ra in accordance with ANSI/ASME B46.1.

Threads: ISO 5855/2 except pitch diameter shall be as specified in Table EI.

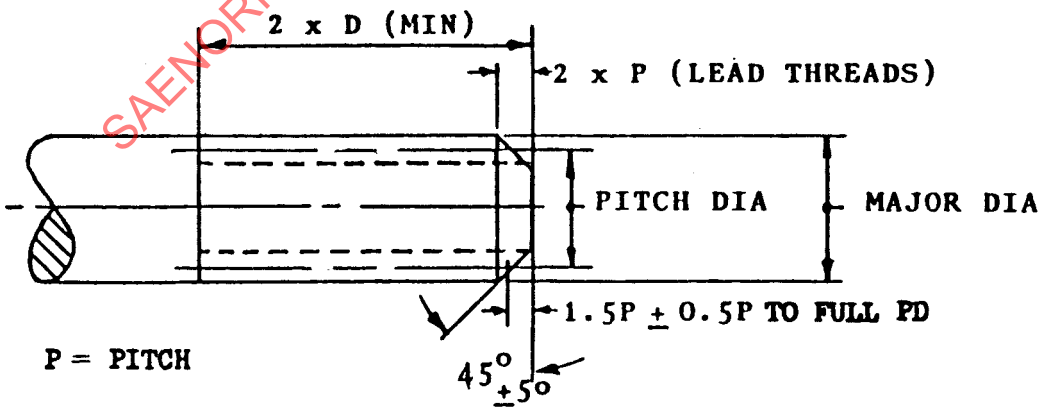


FIGURE E2 - Minimum Mandrel

TABLE EII - Minimum Mandrel Thread Dimensions

Nom Thd Size	Major Dia, mm		Pitch Dia, mm		Tol on Half Angle, minutes	Helix Tolerance µm 1/
	Max	Min	Max	Min		
MJ4 x 0.7	3.850	3.840	3.489	3.479		
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 min

Finish: None

Surface Roughness: Thread flanks to be 0.8 µm Ra in accordance with ANSI/ASME B46.1.

Threads: ISO 5855/2 except as otherwise specified in Table EII. Lead threads may be dressed or stoned to break sharp edges 0.1 – 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 of the form tolerance.

E4. PROCEDURE:

E4.1 Lubricate the maximum mandrel (Fig. E1) and nut in accordance with this specification.

E4.2 Assemble nut onto the maximum mandrel until a minimum of three pitches protrude thru the top of nut. Record the maximum self-locking torque achieved at any time during this assembly.

E4.3 Remove the nut from the maximum mandrel.

E4.4 Lubricate the minimum mandrel (Fig. E2) in accordance with this specification.

E4.5 Assemble the same nut onto the minimum mandrel until three threads protrude through the top of nut. Record the self-locking torque on installation.

E4.6 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 BAKING

F1. SCOPE:

This appendix is a mandatory part of this specification.

F1.1 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 and temperature under load for a specified number of cycles.

F2. APPLICABLE DOCUMENTS:

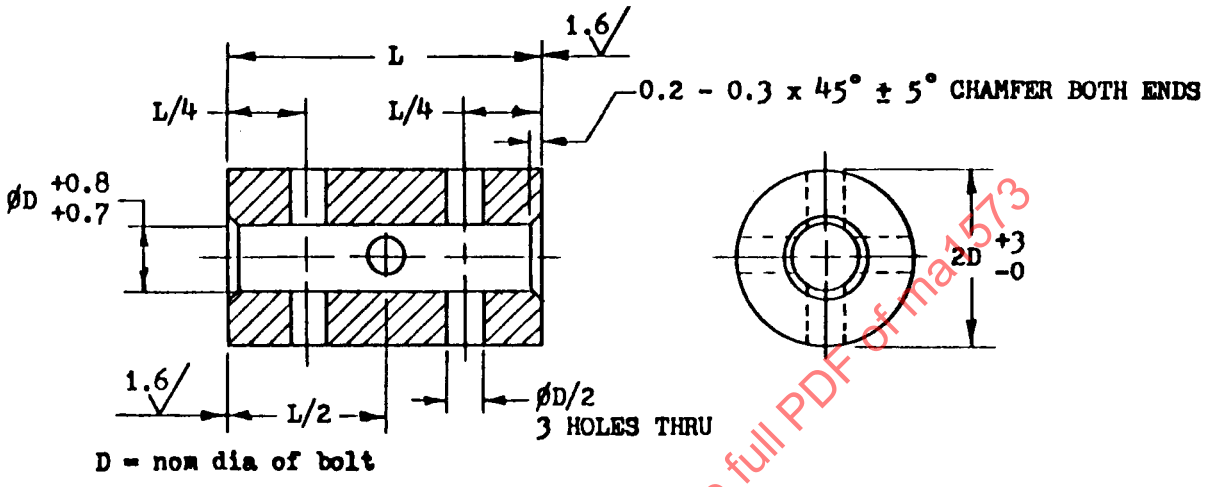
ISO 5855/2 - Screw Threads, MJ Profile, Metric
MA3376 - Bolts & Screws, UNS G87400, MJ Thread, Procurement Specification for, Metric, with a hardness of 32 HRC min
AMS6322 - Steel Bars, Forgings, and rings, UNS G87400
ANSI/ASME B46.1- Surface Texture (Surface Roughness, Waviness, and Lay)

F3. APPARATUS:

F3.1 The apparatus shown in Figs. F1 through F3 comprises the following:

a. Spacer: Material AMS6322, Hardness 32 HRC min
b. Bolt: Threads to ISO 5855/2, Manufactured to MA3376, Hardness 32 HRC min, cadmium plated to AMS2400

F3.1.1 Spacer for Nuts (Except Shank Nuts): Dimensions per Table FI.



Dimensions in millimetres; surface roughness in micrometres, Ra.

FIGURE F1 - Spacer for Nuts (except Shank Nuts)