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METRIC AEROSPACE STANDARD

MA1943

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Submitted for recognition as an American National Standard

NUT, SELF LOCKING - UNS N07001, 760°C, 1250 MPa & 1100 MPa, 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: i.e., hex, double hex, spline drive.

b. Anchor nuts: i.e., plate nuts, gang channel nuts, shank (clinch) nuts.

The wrenching nuts, shank nuts, and nut elements of plate and gang channel nuts are made of corrosion and heat resistant nickel alloy of the type identified under the Unified Numbering System as UNS N07001.

1.2 Application: Primarily for use in aerospace propulsion systems where fasteners having high strength at temperatures up to 760°C is required. Nuts made from bar or forging stock are used with bolts capable of developing 1250 MPa tensile strength at room temperature and having MJ threads to MA1370; whereas, nuts formed from sheet stock are limited to 1100 MPa axial tensile stress in the bolt at room temperature.

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 AMS 2350.

2.1 SAE Publications: Available from SAE, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2411 - Plating, Silver, High Temperature Applications
AMS 2645 - Fluorescent Penetrant Inspection
AMS 5544 - Sheet, Strip, and Plate - 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 - 57Ni - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al - 0.05Zr - 0.006B, Consumable Electrode or Vacuum Induction Melted, 1825-1900°F Solution Heat Treated
AMS 5707 - Bars, Forgings and Rings - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al - 58Ni - 0.05Zr - 0.006B, Consumable Electrode or Vacuum Induction Melted, 1825-1900°F Solution, Stabilization and Precipitation Heat Treated
AMS 5708 - Bars and Forgings - 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 - 58Ni - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al, Consumable Electrode or Vacuum Induction Melted, 1975°F Solution, Stabilization and Precipitation Heat Treated

2.1.2 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
MA1586 - Wrench Configuration, 12 Spline Drive, Metric
MA3378 - Bolts & Screws, UNS N07001, 760°C, 1210 MPa, 1065°C Solution Heat Treatment, 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.

2.2.1 Military Specifications:

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

2.2.2 Military Standards:

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

2.4 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E112 - Determining Average Grain Size

2.5 NAS Publications: Available from National Standards Association, Inc., 1321 Fourteenth Street, NW, Washington, DC 20005.

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

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

3.2.3.2 Plated Threads: Thread 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 max, 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 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. No plating shall be applied to the retaining plate for plate nuts and channel for gang channel nuts, unless otherwise specified on the part drawing.

3.6 Mechanical Properties:

3.6.1 Hardness: Unless otherwise specified on the part drawing, the hardness after heat treatment as in 3.3 shall be uniform and within the range 32 - 42 HRC or equivalent 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 completely recrystallized material.

3.7.2 Grain Size: Shall be predominantly 2 - 6 with no grains finer than 7 or coarser than 1 as determined by comparison of a polished and etched specimen with the chart in ASTM E112. In case of disagreement on grain size by the comparison method, the intercept (Heyn) procedure shall be used.

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

3.8.1 Fluorescent Penetrant Inspection: Parts shall be subject to fluorescent penetrant inspection 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 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 760°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 hrs ± 0.25 at 760°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 I, applied at the rate specified.

TABLE I. Axial Tensile Load

Nut Thread Size	Axial Tensile Load at Room Temp. T, kN min 1/	
	Nuts Made From Bar or Forging	Nuts Formed From Sheet Stock
MJ5 x 0.8-4H6H	17.97	15.81
MJ6 x 1-4H5H	25.51	22.45
MJ7 x 1-4H5H	36.50	32.12
MJ8 x 1-4H5H	49.46	43.52
MJ10 x 1.25-4H5H	77.28	68.01
MJ12 x 1.25-4H5H	116.10	102.13

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

$$A = 0.7854[0.5(d_2 + d_3)]^2$$

where, A = tensile stress area at the mean of maximum diameters d_2 & d_3

d_2 = max pitch diameter of bolt thread

d_3 = max root diameter of bolt thread

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

1250 MPa for nuts made from bar or forging
1100 MPa for nuts formed from sheet stock

Axial tensile strength load, T = stress 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 stress given above.

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.

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 shall be tested as specified in Appendix C and shall withstand the push out loads specified in Table III without separating from the plate or channel. 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 nuts 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 N
MJ5 x 0.8	900
MJ6 x 1	950
MJ7 x 1	1050
MJ8 x 1	1100

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 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 Nm
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 V. The bolt or mandrel shall project through the nut a minimum of three thread pitches.

3.9.6 Reusability Test at Room Temperature After 760°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 nuts made from bar or forging; and for nuts formed from sheet stock, the initial load shall be 517 MPa in accordance with 3.9.6.3. The assembly shall be heated in a furnace to 760°C ± 8 and held for 6 hrs ± 0.25, removed from the furnace and cooled to room temperature.

3.9.6.1 Wrenching and Reference Recordings: Wrenching type 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 213.7 GPa. Stress area for the bolt shall be based on Formula (4) areas given in MA1520. For nuts made from bar or forging, 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 nuts formed from sheet stock, 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 V, Column 5 for nuts formed from sheet stock, and Column 6 for nuts made from bar or forging. Wrenching type 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, 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 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-Cycle Test at Room Temperature: Nuts shall be tested as specified in Appendix H, loading to assembly torque specified in Table V, Column 5 for nuts formed from sheet stock, and Column 6 for nuts made from bar or forging. Wrenching type 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	6
MJ5 x 0.8	0.25	0.50	2.0	4.0	5.5	6.2
MJ6 x 1	0.35	0.70	3.2	6.4	9.6	10.9
MJ7 x 1	0.50	1.00	4.6	9.2	16.0	18.1
MJ8 x 1	0.65	1.30	6.0	12.0	24.0	27.2
MJ10 x 1.25	1.20	2.40	9.5	19.0	46.0	52.2
MJ12 x 1.25	1.80	3.60	15.0	30.0	80.0	90.8

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 for nuts formed from sheet stock.
6. Assembly torque for 15-cycle and 3-cycle tests for nuts made from bar or forging.

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°, 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 760°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 760°C ± 8 and held at heat for 6 hrs ± 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 Flareability: Unless otherwise specified on the part drawing, the shank of shank (clinch) nuts shall be capable of being flared with a 60° included angle conical tool to a diameter equal to 115 % of max 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 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 the 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 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 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 OF 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. 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.

Prepared by SAE Committee E-25, General Standards for Aerospace Propulsion Systems.

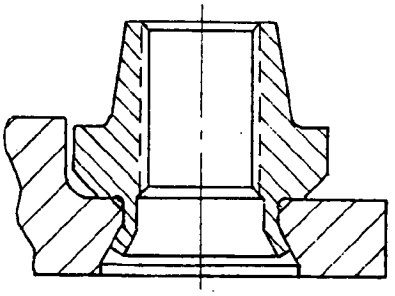


FIGURE 1. Flange Assembly, Flared Shank Nut

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
Microstructure	3.7.1	Table XI, Col B	Microscopic examination 100X
Grain Size	3.7.2	Table XI, Col B	Microscopic examination with chart in ASTM E112
Flareability	3.9.10	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
Geometric Tolerances	3.2.1.2	Tables IX & X	Conventional measuring methods
Thread Size	3.2.3	Tables IX & X	Gaging methods per MA1566
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
Fluorescent Penetrant Inspection	3.8.1	Tables IX & X	Inspection per AMS 2645 & Appx. 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
Grain Size	3.7.2	5	Microscopic examination with chart in ASTM E112
Plating	3.5	5	Microscopic examination of sectioned nut
Axial Tensile Strength, As Received After 760°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 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 760°C Bake As Received	 3.9.6 3.9.7	 10 10	 Appendix F Appendix G
Accelerated Vibration Test, As Received After 760°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
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 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 Inspec.	3.8.1	All	Inspection per AMS 2645 & Appendix J

1/ Total number of samples for destructive tests equals 77; 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 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 & 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 not listed.

TABLE X. Sasmpling Data

Visual & Dimensional Characteristics
Sample Size (n), Acceptance Number (AC) & Limiting Quality (LQ) In Percent Defective
For AQL 0.4, 1.0, 2.5 & 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 150D00	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.

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:

MA1370 - 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.

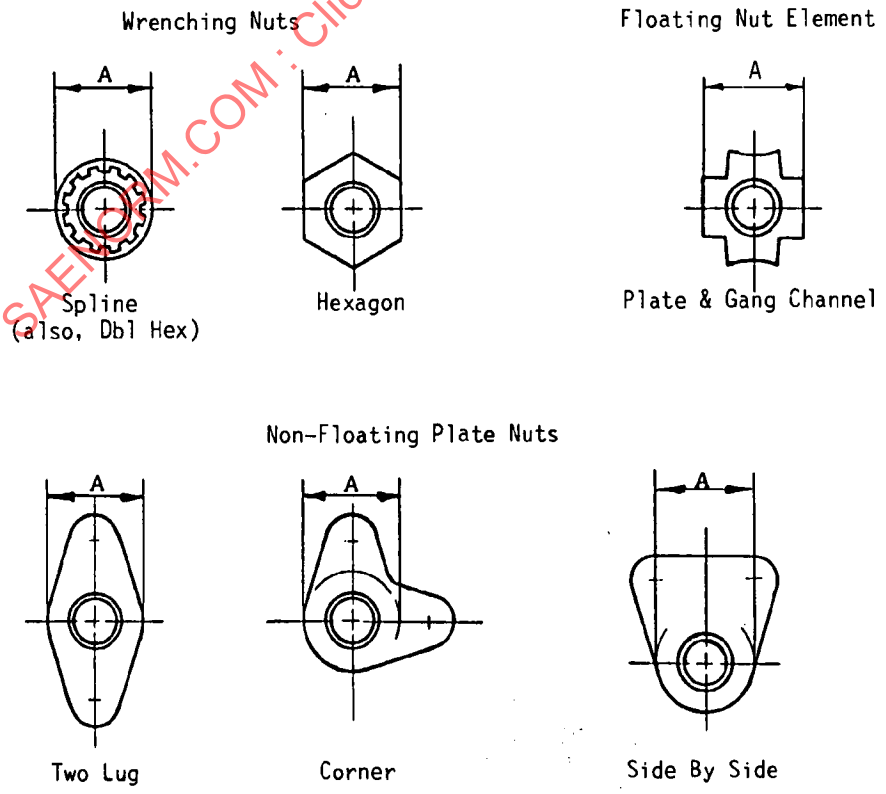


FIGURE A1. Bearing Surface Area "A" Under Perpendicularity Control For Various Types of Nuts

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 that 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:

MA1370 - Screw Threads - MJ Profile, Metric or ANSI B1.13M - 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 MA1370 or ANSI B1.13M tolerance class 4h6h.
b. Two wrenches conforming to MA1586; double hex sockets for double hex drive nuts and for hex drive nuts.
c. Square drive adaptor for socket wrenches.

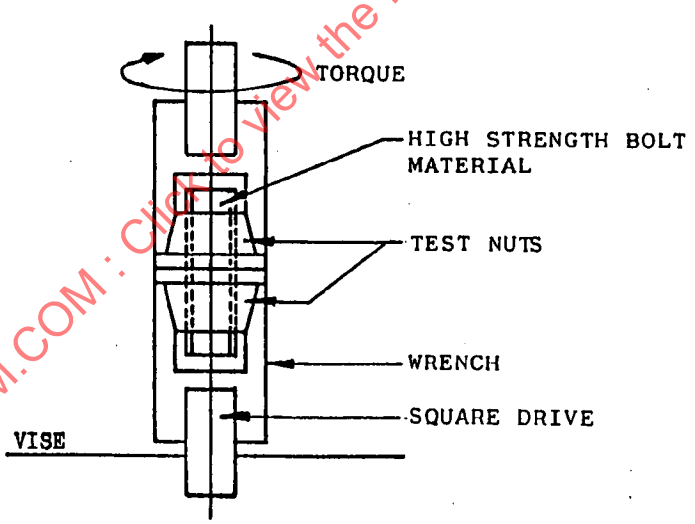


FIGURE B1. Wrench Torque Test Apparatus

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 requirement 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).

C1.2 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.

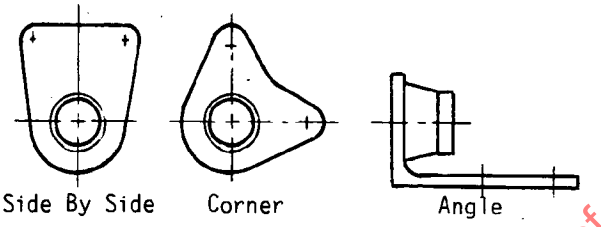


FIGURE C1. Types of Nuts Not Applicable to Push Out Test

C2. APPLICABLE DOCUMENTS:

MA1370 - 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 MA1370 tolerance class 4h6h.

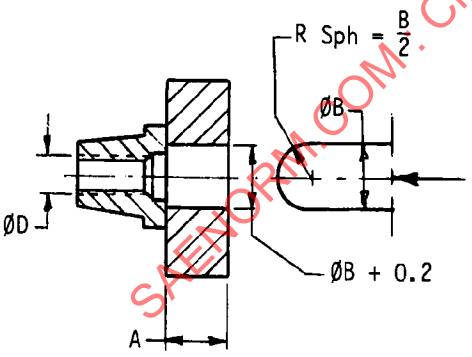


FIGURE C2. Push Out Test Apparatus

TABLE CI. 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

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.

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 or 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:

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

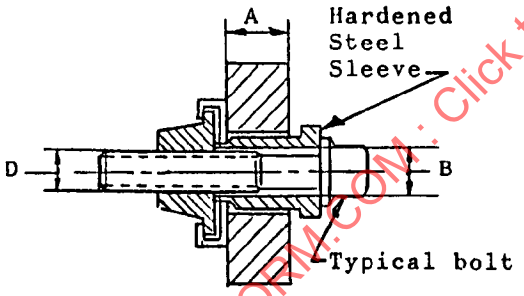


FIGURE D1 - Torque Out Test Apparatus

TABLE DI. 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

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:

MA1370 - 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).

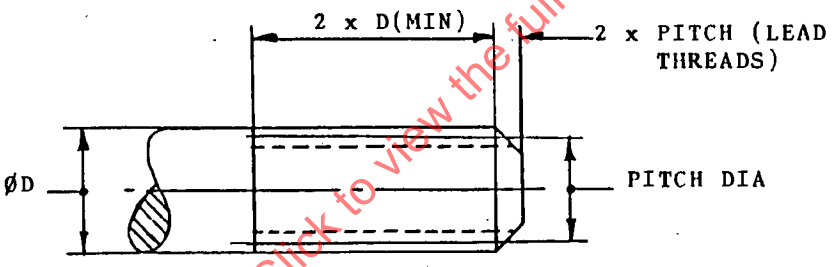


FIGURE E1. Maximum Mandrel

TABLE EI. Maximum Mandrel Pitch Diameter

Nom Thd Size	Pitch Dia, mm	
	Max	Min
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: MA1370 except pitch diameter shall be as specified in Table EI.

APPENDIX E

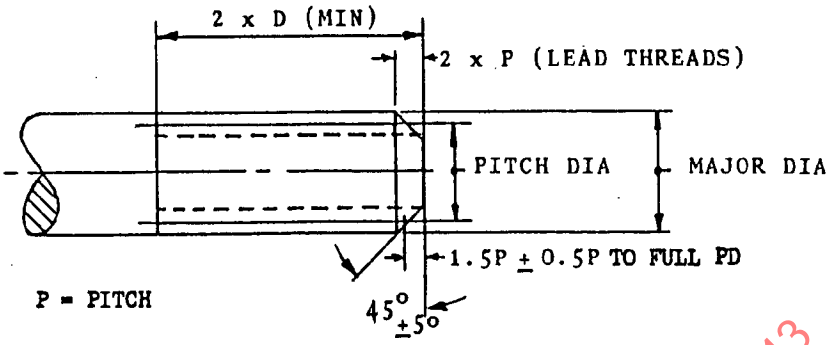


FIGURE E2. Minimum Mandrel

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		
MJ5 x 0.8	4.850	4.840	4.420	4.410	± 15	8
MJ6 x 1	5.820	5.810	5.279	5.269		
MJ7 x 1	6.820	6.810	6.279	6.269		
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: MA1370 except as otherwise specified in Table EII. 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 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 max mandrel until a min of three pitches protrude thru the top of nut. Record the max 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 thru 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 760°C 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 of 760°C baking under load for a specified number of cycles.

F2. APPLICABLE DOCUMENTS:

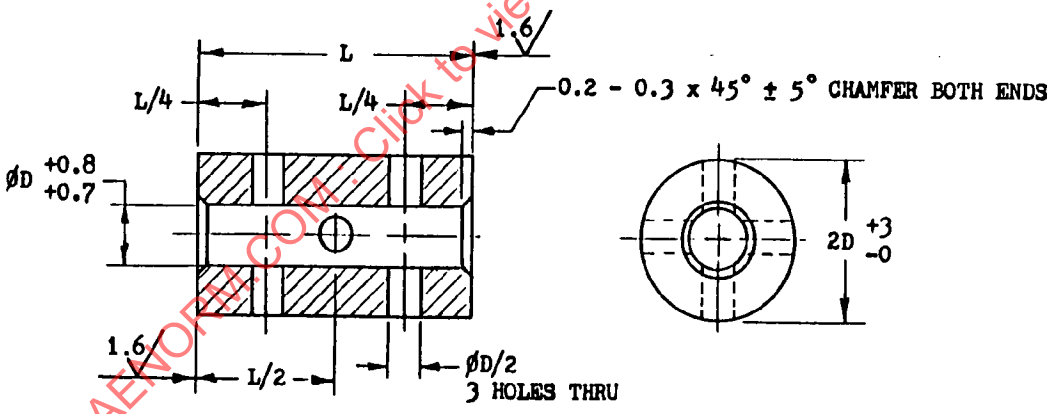
MA1370 - Screw Threads - MJ Profile, Metric
MA3378 - Bolts & Screws, UNS N07001, 760°C, 1210 MPa, 1065°C Solution Heat Treatment, Procurement Specification For, Metric
AMS 5707 - Nickel Alloy Bars and Forgings, UNS N07001
AMS 5709 - Nickel Alloy Bars and Forgings, UNS N07001
ANSI/ASME B46.1 - Surface Texture (Surface Roughness, Waviness, and Lay)

F3. APPARATUS:

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

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

F3.1.1 Spacer for nuts (except shank nuts): Material AMS 5707 or AMS 5709; dimensions Table FI.



D = nom dia of bolt
Dimensions in millimetres; surface roughness in micrometres, Ra.

FIGURE F1. Spacer for Nuts (Except Shank Nuts)

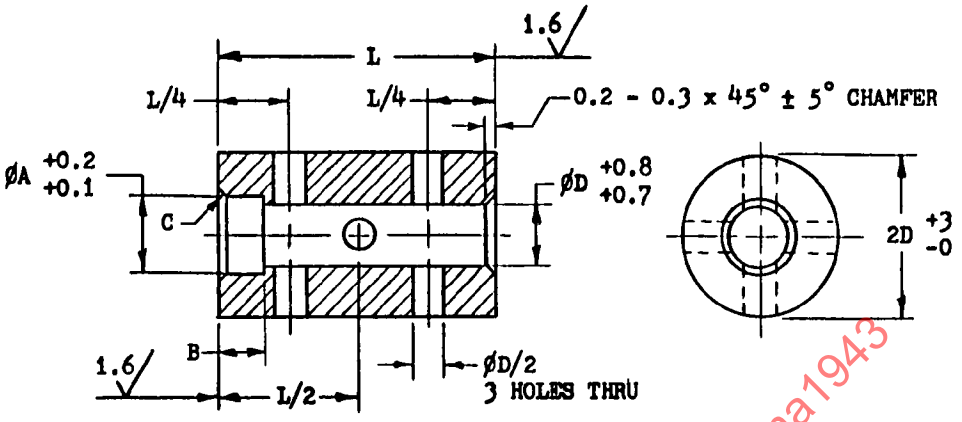
TABLE FI. Bolt & Spacer Length Dimensions and Bolt Elongation

Nom Thd Size	Bolt Length mm	Spacer Length mm	Required Bolt Elongation, mm	
			1	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 nuts formed from sheet stock.
2. Based on 0.002761 x L for nuts made from bar or forging.

APPENDIX F

F3.1.2 Spacer for shank (clinch) nuts: Material AMS 5707 or AMS 5709; Dimensions Table FI.



Dimensions in millimetres; surface roughness in micrometres, Ra.
A = max dia of nut shank uninstalled.
B = max length of nut shank + 1 mm.
C = 45° chamfer clearing max radius bearing face and shank of nut.
D = nom dia of bolt.

FIGURE F2. Spacer for Shank (Clinch) Nuts

F4. PROCEDURE:

F4.1 Lubricate the bolt and nut in accordance with this specification.

F4.2 Assemble the bolt thru the spacer and turn the nut so that the bolt protrudes thru the nut a minimum of three pitches (See Fig. F3), recording the maximum self locking torque.

F4.3 Load the assembly to the requirements of this specification and record the elongation and assembly torque.

F4.4 Leave the assembly in loaded condition for one hour; check and readjust to the required elongation if necessary.

F4.5 Heat the assembly in a furnace to the temperature and time stated in this specification.

F4.6 Remove the assembly from the furnace and allow to cool to room temperature.

F4.7 Loosen the nut by one-half turn and record breakloose torque.

F4.8 Remove the nut, first measuring and recording the breakaway and self locking torques.

F4.9 Repeat procedures F4.1 thru F4.8 for a further four cycles ensuring that the same nut, bolt and spacer are used.

F4.10 Repeat procedures F4.1 thru F4.9 for all nuts in the inspection sample.

Note: All nuts used for this test shall not be reused.

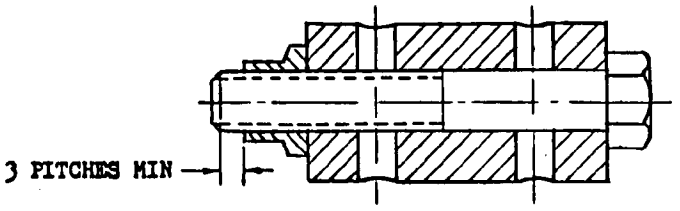


FIGURE F3. Heat Soak Test Assembly