Aerospace Industries Association

NATIONAL AEROSPACE STANDARD

FED SUP CLASS

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
1000 WILSON BOULEVARD
ARLINGTON, VA 22209

1. SCOPE

1.1 This specification covers the requirements for high quality, self-locking nuts, used at temperatures up to 800°F, in conjunction with bolts and screws having Class 3A threads. These nuts are divided into classifications depending upon materials and room temperature axial tensile strength ratings as follows:

Class	Minimum Axial Tensile strength	Material
I	125,000 PSI	Alloy or Carbon Steel
IA	125,000 PSI	Corrosion Resistant Alloy
II	160,000 PSI	Alloy Steel
IIA	160,000 PSI	Corrosion Resistant Alloy
III	180,000 PSI	Alloy Steel
IIIA	180,000 PSI	Corrosion Resistant Alloy
IV	80,000 PSI	Alloy or Carbon Steel
IVA	80,000 PSI	Corrosion Resistant Alloy
V	220,000 PSI	Alloy Steel
VA	220,000 PSI	Corrosion Resistant Alloy

2. APPLICABLE DOCUMENTS

2.1 Specifications

Federal

GGG-W-641	Wrench, Socket (And Sockets, Handles, and Attachments for Socket Wrenches, Hand)

Industry

NAS 3356	Lubricant Coatings, Suitability of Self-Locking Nuts

LIST OF CURRENT SHEETS

SHEET NO.	1	2	3	4	5	6	7	8	9	10
REVISION	6	5	5	5	3	3	3	3	3	3
SHEET NO.	11	12	13	14	15	16	17	18	19	
REVISION	3	3	3	3	3	3	3	new	new	

(6) *completely revised*

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CUSTODIAN **NATIONAL AEROSPACE STANDARDS COMMITTEE**

THIRD ANGLE PROJECTION

PROCUREMENT SPECIFICATION
NONE

NUTS, SELF-LOCKING, 450°F AND 800°F, HIGH QUALITY

CLASSIFICATION
SPECIFICATION

NAS3350

2.2 Standards

Military

Industry SAE

AEROSPACE MATERIAL SPECIFICATIONS (AMS)

AMS-QQ-P-35	Passivation Treatment for Corrosion Resistant Steels
AMS-QQ-P-416	Plating, Cadmium (Electroplated)
AMS 2410	Plating, Silver, Nickel Strike, High Bake
AMS 2750	Pyrometry
AMS 5662	Nickel Alloy, Corrosion and Heat Resistant, Bars, Forgings, and Rings
AMS 5731	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings
AMS 5732	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings
AMS 5734	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings
AMS 5737	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings and Tubing
AMS 5853	Steel, Corrosion and Heat Resistant, Bars and Wire
AMS 5962	Nickel Alloy, Corrosion and Heat Resistant, Bars and Wire
AMS 6304	Low-Alloy Steel, Heat Resistant, Bars, Forgings and Tubing
AMS 6322	Steel Bars, Forgings and Rings
AMS 6348	Steel Bars, Normalized
AMS 6349	Steel Bars, Normalized
AMS 6415	Steel Bars, Forgings and Tubing
AMS 6448	Steel Bars, Forging and Tubing
AMS 6487	Steel Bars and Forgings

AMERICAN SOCIETY FOR QUALITY

ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes

AMERICAN SOCIETY FOR TESTING MATERIALS SPECIFICATIONS

ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Product
ASTM E112	Standard Test Methods for Determining Average Grain Size
ASTM E140	Standard Hardness Conversion Tables for Metals
ASTM E1417	Standard Practice for Liquid Penetrant Inspection
ASTM E1444	Standard Practice for Magnetic Particle Inspection
ASTM G44	Practice for Evaluating Stress Corrosion Cracking Resistance of Metals and Alloys by Alternate Immersion in 3.5% Sodium Chloride Solution

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME B 46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

NATIONAL AEROSPACE STANDARD COMMITTEE

NAS 3351	Stud and Mandrel Test Fixture – Self-Locking Nuts
NAS 3352	Fixture – Stress Embrittlement Test – Self-Locking Nuts
NAS 3353	Fixture – Bearing Surface Squareness Test – Self-Locking Nuts
NAS 3354	Fixture – Vibration Test – Self-Locking Nuts
NASM 1312	Fasteners, Test Methods

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SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AS 5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting Procurement Specification
AS 3071	Acceptance Criteria – Magnetic Particle, FPI and Contrast Dye Penetrant Inspection
AS 8879	Screw Thread, Controlled Radius With Increased Minor Diameter, General Inspection for

3. REQUIREMENTS

3.1 Design – The nut design shall conform to the applicable part drawing.

3.2 Materials – As specified on the applicable part drawing

3.3 Construction – The nut shall be a self-contained, all-metal unit including the self-locking device. The locking device shall be of prevailing torque type and shall not depend upon pressure on the bearing surface for locking action. For wrenchable nuts, dimension across flats and corners shall be applicable prior to incorporation of the locking feature. Finished wrenchable nuts shall have free engagement with sockets conforming to GGG-W-641, Type II, Class 2.

3.3.1 Threads - Threads shall conform to AS 8879, Class 3B, unless otherwise specified. Threads in the locking region may be displaced in any manner that provides self-locking nuts meeting the requirements of this specification.

3.3.2 Finish – The finish shall be in accordance with the requirements of the applicable drawing except for the following:

CLASS I, II, III, IV and V: Nuts cadmium plated per AMS-QQ-P-416 shall be baked after plating at 375°F +/- 25°F for 23 hours minimum within 4 hours of plating when the nut hardness is 33 HRC and higher. For nuts with a hardness of 32 or lower no baking is required.

CLASS IA, IIA, IIIA, IVA and VA: Both plated and unplated nuts shall be salt spray tested. Nuts to be plated shall be salt spray tested prior to plating. Salt spray test shall be conducted in accordance with MIL-STD-1312, Test 1 (document NASM1312). The test duration shall be 2 hours as per AMS-QQ-P-35. Minor indications of corrosion products due to free iron on the non-bearing surfaces of the nut or originating in permissible laps per Table 8 are acceptable after salt spray testing.

3.3.3 Lubrication

3.3.3.1 Solid (dry) film lubricant – When required by applicable standard drawing, nuts shall be coated with a lubricant classified as dry film. Lubricant so specified shall meet the requirements of NAS 3356, "Suitability of Lubricant Coatings". The lubricant shall not be changed without requalification of the nut.
If the lubricant is in accordance with AS5272, no testing of the lubricant is required. Nickel and/or copper plate as a pretreatment for the application of solid (dry) film lubricant is optional.

3.3.3.2 Soluble Lubricant – When required by the applicable standard drawing, nuts shall be coated with a lubricant classified as non-dry film such as cetyl alcohol or wax.
Nuts may be provided with a wax type coating that will prevent nut-bolt seizure at initial installation provided such treatment is applicable to all production nuts of the same part number.

(5) *Completely Revised*

3.3.4 Workmanship - Workmanship shall be consistent with the type of product, finish, and class of thread fit specified. Sharp edges shall be broken; hanging burrs and slivers which might become dislodged in service or which interfere with thread fit shall be removed.

3.4 Performance - The nuts furnished under this specification shall be a product capable of passing the tests as specified in paragraph 4, "Quality Assurance Provisions". Unless otherwise specified, test bolts shall be in accordance paragraph 7, "Test Bolts". All tests shall be conducted in accordance with MIL-STD-1312 except as noted.

3.4.1 Acceptance Tests – The Acceptance tests consist of the tests specified in 3.4.1.1 through 3.4.1.12 which may be applied to any or all lots by the purchaser. Manufacturer shall use sufficient in-process controls, which include tests of unfinished parts, and/or inspection of product to assure conformance to the requirements of this specification. Tests of unfinished parts shall not be invalidated by subsequent operations.

3.4.1.1 Examination of Product: Check for
(1) Visual Presence of Locking Configuration
(2) Finish
(3) Loose or Hanging Burrs
(4) Dimensional Characteristics
(5) Product Identification as applicable on Part Drawing

3.4.1.2 Thread Fit – Thread gaging shall be performed after plating in accordance with the applicable thread specification except that the nut with locking device incorporated but without lubricant shall allow the go plug gage members to enter the threaded element ½ of one turn minimum. When parts are received with lubricant which prevents the use of standard gages, the nut shall permit free rotational (finger torqued) Class 3A threaded bolt engagement of at least ¾ turn.

3.4.1.3 Axial Tensile Strength – Static tensile tests shall be conducted in accordance with MIL-STD-1312, Test 8. The nut shall support the axial tensile strength load listed in Table 4, without rupture. Bolt failure below rated axial strength is not cause for rejection. Such failure shall not constitute a valid test; a new sample nut shall be tested using a higher strength bolt. Failure due to nut splitting is not acceptable.

3.4.1.4 Discontinuities – Thread Sizes .1900-32 and Larger Only. For alloy steel nuts the presence of discontinuities such as laps, seams and inclusions shall be determined by magnetic particle inspection per ASTM E1444. The nuts shall be magnetically inspected circularly only. The magnetic field shall be normal to the longitudinal axis of the nut.

For corrosion resistant material nuts, the presence of discontinuities such as laps, seams and inclusions shall be determined by penetrant inspection per ASTM E1417. Penetrant inspect CRES nuts prior to, or with plating or lubrication removed.

Magnetic or penetrant indications in themselves shall not be cause for rejection. The specific nuts that show indications may be sectioned and measured microscopically for conformance to Table 8. Nuts shall not be marked as an indication of magnetic or penetrant inspection.

Non-Ratable Discontinuities: Any discontinuity that is not a crack, regardless of location, with a depth of .0005 in. or less, is considered a non-ratable discontinuity and shall not be cause for rejection.

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3.4.1.5 Stress Embrittlement – Class III and V only. Nuts shall be installed on a standard test bolt as specified in paragraph 7 in a steel test fixture in accordance with NAS 3352, and torqued to the assembly torque test values in Table 3. Unless otherwise specified, the test bolt shall be clean and dry and the nut in "as received" condition. Test procedure shall be in accordance with MIL-STD-1312, Test 14. The nuts shall be torqued until the bolt elongates the amount specified in Table 5. The assemblies shall then be baked at 450°F +25°F/-0°F, for 96 hours, and air cooled to room temperature.

After removing the nuts, their bearing surfaces shall be polished and examined at 10X to 50X magnification for cracks. The presence of cracks found in any nut shall be cause for rejection of the entire lot.

3.4.1.6 Bearing Surface Squareness – The nut, or nut element of an assembly, shall be turned on a fixture per NAS 3353. At least one full thread must penetrate the nut locking device. Use a feeler gage to determine the maximum gap under the nut at the outside circumference of the bearing surface. Bearing surface squareness shall conform to the requirements of Table 9.

3.4.1.7 Surface Texture – Surface texture of the bearing surface of wrenchable nuts shall be 63 microinches maximum per ANSI / ASME B46.1

3.4.1.8 Torque Effectivity, Room Temperature – For these tests, installation shall be considered complete when the bolt end has protruded through three full turns after being flush with the top of the nut.

THREAD SIZES 0.0860-56 THROUGH 0.1640-32: Nuts shall be installed and removed one time on standard test bolts as specified in Paragraph 7. Maximum locking torque and breakaway torque shall be recorded. Of the first cycle specimens, the nut with the highest locking torque and the nut with the lowest breakaway torque shall be selected and 14 additional unseated cycles, or the number of cycles specified in the part standard, shall be run. The maximum installation and breakaway torques on seventh and fifteenth cycles shall be recorded. For nuts with less than 15 cycles requirement, torque values for the first, middle and last cycles shall be recorded.

THREAD SIZES 0.1900-32 THROUGH 0.6250-18: Nuts shall be installed and removed one time on standard test bolts as specified on Paragraph 7 and bushing per NAS 3352. The nuts shall be seated to the assembly torques of Table 3. Maximum locking torque and breakaway torque shall be recorded for the first cycle. Of the first cycle test specimens, the nut with the highest locking torque and the nut with the lowest breakaway torque shall be selected and tested for 14 additional unseated installation and removal cycles or the number of cycles specified in the part standard. The maximum installation and breakaway torques shall be recorded for the seventh and fifteenth cycles. For nuts with less than 15 cycles requirement, torque values for the first, middle and last cycles shall be recorded. All values shall be within limits of Table 1, columns 1 and 3.

THREAD SIZES 0.7500-16 and LARGER: The total number of reuse cycles shall be 5 or as specified on the part standard. Otherwise, the test procedure shall be as described above for thread sizes 0.1900-32 through 0.6250-18.

At the conclusion of the test, the nuts and bolts used in the test shall be examined for damage to the threads. Noticeable distortion, thread peel, galling or scratches shall be cause for rejection. The threads on the bolt shall remain in serviceable condition and permit the installation of a new nut freely with fingers up to self-locking element.

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3.4.1.9 Surface Hardness – (Class III and V only) Surface hardness shall apply to nuts in sizes 0.2500-28 and larger, except hardness may be omitted if nuts pass tensile test and have satisfactory microhardness. Individual hardness readings shall be within the limits specified on the applicable standard. Hardness test shall be performed on a flat surface prior to plating or with plating removed. Tested parts may be used for destructive tests but may not be used for production. Hardness conversion between scales shall be in accordance with ASTM E140 or ASTM A370.

3.4.1.10 Microhardness – (Class III and V only) Microhardness test of the cross section of nuts shall be used to check for correct heat treatment, excessive decarburization, or recarburization. Test procedure shall be in accordance with MIL-STD-1312, Test 6. Microhardness readings with a 500 or 1000 gram load shall be taken on a cross section of nuts. Two readings shall be taken at .005 from the external surface of the nut, and two readings shall be taken at the center of the thickest section. Microhardness readings shall not be taken adjacent to the exterior wrenching surface of nuts machined from hexagon or bar stock. Hardness readings at the core and the surfaces specified shall be as shown in the applicable nut drawing. Total carburization is limited to a depth of .001. Partial decarburization or recarburization shall not exceed a depth of .003. Hardness conversion between scales shall be in accordance with ASTM E140 or ASTM A370.

3.4.1.11 Untempered Martensite and Transformed Structure – (Class III and V only, sizes 0.500-20 and larger)
Lubricant and plating shall be stripped. Bearing surface shall be metallographically polished, etched, and examined at 10X to 100X. No cracks are allowed. Nuts shall be rejected if untempered martensite and/or transformed structure are present on the outside circumference of the thread chamfer on the bearing surface.

3.4.1.12 Microstructure – (Class IA, IIA, III, IIIA, IVA, V and VA only) Nuts shall be sectioned through thread axis, etched and examined at 6X or greater. Grains in Class III and V nuts shall have microstructure of tempered martensite. For Class IA, IIA, IIIA, IVA and VA nuts the grain size may vary and exhibit duplex structure according to section thickness and / or deformation but shall exhibit no grains coarser than ASTM No. 1, as determined by comparison of the specimen with the chart in ASTM E112. Material shall be free of bursts and voids. Alloy segregation that adversely affects mechanical or physical properties is not allowed.

3.4.2 Qualification Tests – Qualification tests shall consist of all Acceptance Tests and the tests listed in the following paragraphs. Test samples shall be of the same material and manufactured by the same method as production parts. Required test sample quantities are listed in Table 7. All qualification parts shall meet the minimum requirements of the applicable tests.

The nut manufacturer shall be responsible for conducting qualification tests and furnishing part drawings, certified test reports and test samples (if required by purchaser). The purchaser may perform qualification tests at any time.

Requalification will be required in the event any change is made in the material, heat treatment, finish, lubrication, or significant design characteristics.

3.4.2.1 Axial Strength After Baking – The nuts shall be assembled on a standard test bolt as specified in paragraph 7, baked for six hours at 450°F +/- 25°F or 800°F +/- 25°F, whichever is applicable. The nut shall then be air cooled to room temperature and axial tensile strength test conducted in accordance with MIL-STD-1312, Test 8. The nuts shall support the axial tensile loads listed in Table 4 without rupture. Failure of the bolt below rated axial strength of the nut shall not be cause for rejection of the nut. Such failure shall not constitute a valid test; a new sample nut shall be tested using higher strength bolt.

3.4.2.2 Wrench Torque – This requirement shall apply to wrenchable type nuts only. The nut shall be installed on a standard test bolt, as specified in paragraph 7, with a steel test fixture in accordance with NAS 3352, and torqued to the wrench-torque test values in Table 2. This test shall be repeated for a total of 15 cycles, or the number of reuse cycles specified on the part standard. Wrenches shall be of the socket type having openings in accordance with Specification GGG-W-641, Type II, Class 2. Deformation of the wrenching surfaces shall not be of sufficient magnitude to prevent proper application and removal of the nut with the wrench, or free engagement of the wrench with the nut. Wrench failure below requirements of this specification shall not be cause for rejection of the nut. Such failure shall not constitute a valid test; a new nut sample shall be tested.

3.4.2.3 Push-Out - This test is applicable to gang channels and plate nuts except right-angle type nuts. The nuts shall be attached or riveted to a rigid steel plate. The screw or clamping head diameter shall not exceed 1½ times the rivet hole diameter. The rivet hole size and location in gang channels shall be the same as equivalent thread size two-lug floating plate nuts. The bolt hole in the plate shall be located concentric with the nominal position of the thread in the nut within 0.010 inch. The push-out stud or device shall be provided with a hemispherical end of a diameter equal to the nominal thread diameter plus 0.030 inches minimum. The push-out load of Table 1, Column 6 shall be applied evenly to the nut on a line perpendicular to the mounting plane of the nut.

The nut shall withstand the above test without a resulting permanent deformation of more than .030 inches when measured at the thread centerline between the test plate and the nut base. There shall be no cracks in the nut or nut retainer.

3.4.2.4 Torque-Out - This test is applicable to floating plate nuts, retained non-floating plate nuts, and gang channel nuts. Nuts from the Push-out test may be used for this test. The nut shall be attached or riveted to a rigid steel plate as in paragraph 3.4.2.3, and subjected to the torque-out values in Table 1, Column 5, in the clockwise or tightening direction. The diameter of the torque stud shall have a maximum diameteral clearance of 0.010 inch in the test plate. The Torque stud shall be provided with a shoulder to seat against the base of the nut or shall incorporate a suitable bushing to accomplish this. Reverse loading may be accomplished by the addition of a check nut. An easy-out tool may be used in place of the torque stud to apply torque. This test is to be performed with no axial load on the seat of the nut.

The nut assembly shall withstand the above test without rupture.

3.4.2.5 Torque Effectivity, 450°F or 800°F - The nuts tested in paragraph 3.4.1.8 shall be installed on a new standard test bolt as specified in paragraph 7 checking maximum locking torque at room temperature during installation cycle. The assemblies shall be baked for one hour at the applicable test temperature (450°F +/-25°F or 800°F +/- 25°F) and shall be tested at this temperature for minimum breakaway torque.

Room temperature locking torque shall not exceed the values shown in Table 1, column 1. The minimum breakaway torque at the applicable test temperature (450°F +/- 25°F or 800°F +/-25°F) shall conform to the requirements of Table 1, Column 3.

3.4.2.6 Accelerated Environmental Reusability - (Sizes: 0.1900-32 through 0.6250-18) The nut shall be installed on a standard test bolt as specified in paragraph 7 with a steel test fixture in accordance with NAS 3352 and torqued to the assembly torque in Table 3. The assembly shall then be baked for six hours at the applicable test temperature (450°F +/- 25°F or 800°F +/- 25°F) and air cooled to room temperature. The nut shall be backed off one-half turn and then checked for minimum breakaway torque. The nut shall be removed from the test bolt. The complete test cycle shall be repeated three additional times using the same nut and bolt.

For nuts with thread sizes 0.7500-16 and larger and for solid (dry) film coated (without cadmium plating undercoat) nuts, this test shall be run for a total of 3 cycles.

The torques shall be in accordance with the values of Table 1, Columns 2 and 3.

3.4.2.7 Accelerated Vibration - (Thread Sizes: 0.1900-32 through 0.6250-18 only) The nuts shall be installed on a standard test bolt as specified in paragraph 7, in fixtures in accordance with MIL-STD-1312, Test 7. The assembly torque values shall be as listed in Table 1, Column 4. The nuts shall then be removed and reinstalled to this torque four additional times. In case of solid (dry) film (without cadmium plating undercoat) lubricant coated nuts a total of 3 cycles shall be run. After the completion of the last reuse cycle, the nuts shall be vibrated in accordance with MIL-STD-1312, Test 7 procedure. An additional five assembled specimens shall be vibrated at room temperature after baking in the assembled condition at the applicable test temperature (450°F +/- 25°F or 800°F +/- 25° F) for six hours, and running the additional cycles at room temperature per the preceding procedure. The test shall be run for 30,000 cycles except that it shall be stopped prior to the completion of the 30,000 cycles in the event a nut becomes disassembled from a bolt. Upon completion of the test, the relative rotation between each nut and bolt shall be measured. The nut shall be examined under 10X magnification for cracks or broken segments.

The relative rotation between any nut and bolt shall not exceed 360 degrees. The nuts shall not have developed any cracks nor broken segments.

3.4.2.8 Stress Corrosion - (Class III and V only) Nuts shall be assembled on a standard test bolt, as specified in paragraph 7, with a steel test fixture in accordance with NAS 3352. Stress corrosion test shall be conducted in accordance with MIL-STD-1312, Test 9.

Nuts shall be free from cracks after 500 hours alternate immersion. After removing the nut, its bearing surface shall be polished and examined at 10X to 50X magnification. Equipment, solution and test method shall be per ASTM G44.

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4. QUALITY ASSURANCE PROVISIONS

The manufacturer is responsible for performance of the product in accordance with this specification.

4.1 Acceptance Tests

4.1.1 Tests

a. Examination of Product
b. Thread Fit
c. Axial Tensile Strength
d. Discontinuities
e. Stress Embrittlement (Class III, and V only)
f. Bearing Surface Squareness
g. Surface Texture
h. Torque Effectivity – Room Temperature
j. Surface Hardness (Class III and V only)
k. Microhardness (Class III and V only)
m. Untempered Martinsite and Transformed Structure (Class III and V only)
n. Microstructure (Class IA, IIA, III, IIIA, IVA, V, VA only)

4.1.2 Sampling - Sample nuts shall be selected at random from each lot as specified below.

4.1.2.1 Lot – A lot shall consist of finished nuts which are of the same type and diameter, fabricated by the same process, heat treated and processed in the same manner, and produced as one continuous run or part thereof.

4.1.2.2 Product Characteristics: The following characteristics shall be inspected:

Major A	(1) Self-locking feature missing
Major B	(1) Thread fit (2) Bearing surface squareness (3) Surface finish, plating or surface treatment (4) Rivet hole location and alignment (plate nuts only) (5) Height of nut
Major C	(1) Dimensions of wrenching element (wrenchable nuts only) (2) Loose or hanging burrs (3) All other dimensional characteristics not covered above

4.1.2.3 Sampling Plan 1 –Sample sizes for inspection of product characteristics shown in paragraph 4.1.2.2 shall be in accordance with ANSI/ASQC Z1.4, as follows:

Major A	Inspection Level S-4
Major B	Inspection Level S-3
Major C	Inspection Level S-2

Acceptance=0 Rejection=1

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4.1.2.4 Sampling Plan 2 – For axial tensile strength test, surface hardness test, microhardness test, untempered martensite and transformed structure test and microstructure test, the samples shall be selected in accordance with the following:

Lot Size	Sample Size	Acceptance Number
Under 10,000	5	0
10,001 to 50,000	10	0
50,001 to 100,000	15	0
Over 100,000	27	0

4.1.2.5 Sampling Plan 3 – For the torque effectivity sample size shall be 10, and for stress embrittlement test, the sample size shall be 6, for each lot and the acceptance number is 0.

5. PREPARATION FOR DELIVERY

5.1 Packaging – Packaging shall be in accordance with regular commercial practices or as specifies in the purchase order.

5.2 Marking – Products supplied under this specification shall be in packages marked with the manufacturer's and NAS standard part number, and the work order, lot number or job number under which these parts were manufactured.

5.3 Quality Control Records – Quality Control records pertaining to the specific work order, lot number, or job number shall be available for inspection by the purchaser.

5.4 Packing – Packages shall be packed to meet commercial handling requirements.

6. NOTES

6.1 Definitions

6.1.1 Installed – A nut is considered installed when a minimum of two threads plus the chamfer of the male thread member extend beyond the top of the nut.

6.1.2 Removal Cycle – The removal cycle shall be considered complete when the locking device is disengaged.

6.1.3 Crack – A crack is a clean break passing through the grain or grain boundary without inclusion of foreign element.

6.1.4 Minimum Breakaway Torque – The minimum breakaway torque is that torque required to start nut or bolt rotation from a fixed position during a removal cycle with no load on the base of the nut.

6.1.5 Maximum Locking Torque – The maximum locking torque is the highest self-locking torque encountered during installation or removal with no load on the base of the nut, measured during the third complete turn of the nut after the top of the nut is flush with the end of the bolt.

7. TEST BOLTS

Test bolts specified below are for referee purposes. Bolts or threaded studs having similar characteristics may be used for routine testing. Screws, bolts, studs or threaded mandrels with rolled threads per AS8879, Class 3A with major diameters as tabulated in Table 10 may be used. Thread dimensions shall be met after plating. Bolt types for specific tests shall be selected per Table 6.

TYPE	TYPICAL TEST BOLT MATERIALS	FINISH	STRENGTH LEVEL (KSI)
A	AMS 6322 (UNS G87400), AMS 6349 (UNS G41400), AMS 6348 (UNS G41300)	Cadmium plate	125 - 145
B	AMS6304 (UNS K14675), AMS 6322 (UNS G87400), AMS 6415 (UNS G43406)	Cadmium plate	160 – 180
C	AMS 6322 (UNS G87400), AMS 6349 (UNS G41400), AMS 6448 (UNS G61500)	Cadmium plate	180 – 200
D	AMS 6487 (UNS T20811)	Cadmium plate	220 – 240
E	AMS 5731 (UNS S66286), AMS 5732 (UNS S66286), AMS 5734 (UNS S66286), AMS 5853 (UNS K66286)	Passivated, bare	160 – 180
F	AMS 5662 (UNS N07718), AMS 5962 (UNS N07718)	Passivated, bare	180 – 240

Cadmium plate per AMS-QQ-P-416, Type II, Class 2
Passivated per AMS-QQ-P-35

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TABLE 1 – TORQUE VALUES (lb-in)

SIZE	(1) Max. Locking Torque Room Temp.	(2) Max. Locking Torque After Bake	(3) Minimum Breakaway	(4) Assembly Torque Vibration	(5) Torque-Out Minimum	(6) Push-Out Minimum (lb)
0.0860-56	2.5	5	0.2	--	10	20
0.1120-40	5	10	0.5	--	20	40
0.1380-32	10	20	1.0	--	30	60
0.1640-32	15	30	1.5	--	45	80
0.1900-32	18	36	2.0	36	60	100
0.2500-28	30	60	3.5	60	100	125
0.3125-24	60	120	6.5	120	160	125
0.3750-24	80	160	9.5	160	240	125
0.4375-20	100	200	14	200	350	125
0.5000-20	150	300	18	300	450	125
0.5625-18	200	400	24	400	600	125
0.6250-18	300	600	32	600	900	125
0.7500-16	400	800	50	--	--	--
0.8750-14	600	1,200	70	--	--	--
1.0000-12	800	1,600	90	--	--	--
1.1250-12	900	1,800	117	--	--	--
1.2500-12	1,000	2,000	143	--	--	--
1.3750-12	1,100	2,200	165	--	--	--
1.5000-12	1,250	2,500	195	--	--	--
1.7500-12	1,450	2,900	245	--	--	--
2.0000-12	1,700	3,400	300	--	--	--

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TABLE 2 – WRENCH TORQUES (lb-in)

SIZE	Class I, IA (125 KSI)	Class II, IIA (160 KSI)	Class III, IIIA (180 KSI)	Class IV, IVA (80 KSI)	Class V, VA (220 KSI)
0.0860-56	5	6	--	4	--
0.1120-40	9	10	--	6	--
0.1380-32	18	20	--	11	--
0.1640-32	27	30	--	16	--
0.1900-32	50	60	70	35	85
0.2500-28	125	150	170	85	210
0.3125-24	280	330	370	185	450
0.3750-24	430	530	600	300	730
0.4375-20	650	825	880	440	1,100
0.5000-20	900	1,125	1,225	615	1,400
0.5625-18	1,200	1,550	1,700	850	2,000
0.6250-18	1,500	2,000	2,200	1,100	2,600
0.7500-16	2,500	3,300	3,800	1,900	4,400
0.8750-14	4,300	5,200	6,200	3,100	7,200
1.0000-12	6,000	7,000	8,500	4,250	10,300
1.1250-12	7,600	9,000	11,000	5,500	13,000
1.2500-12	9,500	11,000	13,500	6,750	16,000
1.3750-12	11,000	13,000	15,000	8,000	19,000
1.5000-12	13,000	15,000	18,000	9,000	22,000
1.7500-12	16,000	18,000	23,000	11,000	27,000
2.0000-12	20,000	23,000	28,000	14,000	34,000

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TABLE 3 – ASSEMBLY TORQUES (lb-in)

SIZE	Class I, IA (125 KSI)	Class II, IIA (160 KSI)	Class III, IIIA (180 KSI)	Class IV, IVA (80 KSI)	Class V, VA (220 KSI)
0.1900-32	37	45	63	26	76
0.2500-28	94	110	150	64	190
0.3125-24	210	250	330	139	400
0.3750-24	320	390	540	220	665
0.4375-24	490	620	790	330	1,000
0.5000-20	670	840	1,100	460	1,260
0.5625-18	900	1,160	1,530	640	1,800
0.6250-18	1,120	1,500	2,000	820	2,350
0.7500-16	1,880	2,500	3,400	1,420	4,000
0.8750-14	3,220	3,900	5,600	2,320	6,500
1.0000-12	4,500	5,250	7,700	3,180	9,300
1.1250-12	5,700	6,750	10,000	4,120	11,700
1.2500-12	7,120	8,250	12,200	5,050	14,400
1.3750-12	8,600	9,750	14,400	6,200	17,000
1.5000-12	10,000	11,250	16,200	7,500	19,800
1.7500-12	13,000	14,250	20,000	10,000	24,000
2.0000-12	16,000	17,250	25,000	12,500	31,000

TABLE 4 – AXIAL TENSILE STRENGTH (lb.)

SIZE	Class I, IA (125 KSI)	Class II, IIA (160 KSI)	Class III, IIIA (180 KSI)	Class IV, IVA (80 KSI)	Class V, VA (220 KSI)
0.0860-56	375	480	--	240	--
0.1120-40	875	1,120	--	560	--
0.1380-32	1,250	1,600	--	800	--
0.1640-32	2,000	2,500	--	1,280	--
0.1900-32	2,825	3,620	4,070	1,810	4,970
0.2500-28	5,060	6,470	7,270	3,235	8,870
0.3125-24	8,000	10,200	11,500	5,100	14,100
0.3750-24	11,900	15,200	17,100	7,600	20,900
0.4375-20	16,100	20,600	23,200	10,300	28,300
0.5000-20	21,450	27,500	30,900	13,750	37,800
0.5625-18	27,250	34,800	39,200	17,400	47,900
0.6250-18	34,050	43,600	49,100	21,800	59,900
0.7500-16	49,300	63,200	71,000	31,600	86,900
0.8750-14	67,400	86,300	97,000	43,150	119,000
1.0000-12	88,000	112,000	126,000	56,000	155,000
1.1250-12	112,000	144,000	162,000	72,000	198,000
1.2500-12	140,900	180,000	202,000	90,000	247,000
1.3750-12	171,000	219,000	246,000	109,000	301,000
1.5000-12	205,000	263,000	296,000	131,000	361,000
1.7500-12	282,000	361,000	407,000	180,000	497,000
2.0000-12	372,000	476,000	535,000	238,000	654,000

Axial tensile strength values calculated from formula:

$T = 1{,}000 \times Ftu \times A$

Where T = Tensile strength of nut (lb.)
Ftu = Minimum ultimate tensile strength rating of nut (KSI)
A = Stress area at maximum pitch diameter of AS 8879, Class 3A thread (sq. in.)

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TABLE 5 – BOLT ELONGATION

SIZE	Nominal Grip Length of Bolt	Class I, IA (125 KSI)	Class II, IIA (160 KSI)	Class III, IIIA (180 KSI)	Class IV, IVA (80 KSI)	Class V, VA (220 KSI)
0.1900-32	2.00	0.0039	0.0049	0.0055	0.0024	0.0070
0.2500-28	2.00	0.0041	0.0052	0.0058	0.0025	0.0073
0.3125-24	2.00	0.0042	0.0053	0.0060	0.0026	0.0076
0.3750-24	2.00	0.0043	0.0056	0.0063	0.0027	0.0080
0.4375-24	2.50	0.0052	0.0068	0.0076	0.0032	0.0096
0.5000-20	2.50	0.0054	0.0071	0.0080	0.0036	0.0101
0.5625-18	2.50	0.0055	0.0073	0.0082	0.0034	0.0103
0.6250-18	2.75	0.0060	0.0081	0.0091	0.0037	0.0114
0.7500-16	2.75	0.0062	0.0084	0.0095	0.0038	0.0122
0.8750-14	2.75	0.0063	0.0088	0.0099	0.0039	0.0126
1.0000-12	3.00	0.0069	0.0096	0.0108	0.0041	0.0138
1.1250-12	3.00	0.0072	0.0100	0.0112	0.0044	0.0144
1.2500-12	3.00	0.0074	0.0103	0.0116	0.0046	0.0149
1.3750-12	3.00	--	0.0106	0.0119	--	0.0154
1.5000-12	3.00	--	0.0109	0.0123	--	0.0159
1.7500-12	4.00	--	--	--	--	0.0206
2.0000-12	4.00	--	--	--	--	0.0220

Stress embrittlement test (para. 3.4.1.5)

Test Method: MIL-STD-1312, Test 14, other bolt grips are permissible.

Elongation shall be calculated per the following extension formula:

$$d = [F \{X+0.75Z+ Y(R/S)^2-Y\}] / E$$

Where d = desired extension (inches)
E = modulus of elasticity of bolt material at room temperature
F = desired stress at bolt root area (psi)*
X = fixture length (inches)
Z = nut thread length (inches)
S = bolt maximum grip diameter (inches)
Y = bolt nominal grip length (inches)
R = bolt basic thread minor diameter (inches)*

* If stress is specified at area other than thread minor diameter, use value for R relative to diameter at that area. If load is specified, divide load by thread minor diameter area of bolt to determine F.

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TABLE 6 – BOLT TYPES USED IN TESTS

TEST	Para.	NUT CLASS I (125 KSI)	IA (125 KSI)	II (160 KSI)	IIA (160 KSI)	III (180 KSI)	IIIA (180 KSI)	IV (80 KSI)	IVA (80 KSI)	V (220 KSI)	VA (220 KSI)
Axial Tensile Strength	3.4.1.3	B	B	C	C	C/D	C/D	B	B	D	D
Stress Embrittlement	3.4.1.5	B	--	B/C	--	C/D	--	A	--	D	--
Torque Effectivity	3.4.1.8	B	E	B/C	E	B/C	E	B	E	D	F
Axial Tensile Strength – After Bake	3.4.2.1	B	B	C	F	C/D	F	B	E	D	D*
Wrench Torque	3.4.2.2	B	E	C	E	C/D	C/D	B	E	D	D
Torque Effectivity – 450F or 800F	3.4.2.5	B	E	B/C	E	B/C	E	B	E	D	F
Accelerated Environmental Reusability	3.4.2.6	B	E	B/C	E	B/C	E	B	E	D	F
Vibration	3.4.2.7	B	E	B	E	C/D	E	B	E	D	F
Stress Corrosion	3.4.2.8	--	--	--	--	C/D	--	--	--	D	--

* Nuts shall be baked on "F" type bolts and tensile tested on "D" type bolts.

TABLE 7 – QUALIFICATION TEST PLAN

CHARACTERISTIC	Para.	NUT CLASS I (125 KSI)	IA (125 KSI)	II (160 KSI)	IIA (160 KSI)	III (180 KSI)	IIIA (180 KSI)	IV (80 KSI)	IVA (80 KSI)	V (220 KSI)	VA (220 KSI)
Examination of Product	3.4.1.1	All	All	All	All	All	All	All	All	All	All
Thread Fit	3.4.1.2	All	All	All	All	All	All	All	All	All	All
Axial Tensile Strength	3.4.1.3	3	3	3	3	3	3	3	3	3	3
Axial tensile Strength – After Bake	3.4.2.1	3	3	3	3	3	3	3	3	3	3
Discontinuities	3.4.1.4	All	All	All	All	All	All	All	All	All	All
Stress Embrittlement	3.4.1.5	--	--	10	--	10	--	--	--	10	--
Bearing Surface Squareness	3.4.1.6	3	3	3	3	3	3	3	3	3	3
Surface Texture	3.4.1.7	3	3	3	3	3	3	3	3	3	3
Torque Effectivity – Room Temp.	3.4.1.8	10	10	10	10	10	10	10	10	10	10
Torque Effectivity – 450F or 800F	3.4.2.5	10	10	10	10	10	10	10	10	10	10
Wrench Torque	3.4.2.2	3	3	3	3	3	3	3	3	3	3
Push-out	3.4.2.3	3	3	3	3	3	3	3	3	3	3
Torque-out	3.4.2.4	3	3	3	3	3	3	3	3	3	3
Accelerated Environmental Reusability	3.4.2.6	10	10	10	10	10	10	10	10	10	10
Vibration – Room temperature	3.4.2.7	5	5	5	5	5	5	5	5	5	5
Vibration – After Bake	3.4.2.7	5	5	5	5	5	5	5	5	5	5
Hardness	3.4.1.9	--	--	--	--	6	--	--	--	6	--
Micohardness	3.4.1.10	--	--	--	--	6	--	--	--	6	--
Untempered Martensite and Transformed Structure	3.4.1.11	--	--	--	--	6	--	--	--	6	--
Microstructure	3.4.1.12	--	6	--	6	6	6	--	6	6	6
Stress Corrosion	3.4.2.8	--	--	--	--	6	--	--	--	6	--

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③ *Completely Revised*

TABLE 8 – DISCONTINUITIES LIMITS, MAXIMUM (in.)

SIZE	LIMITS	SIZE	LIMITS
0.0860-56	--	0.6250-18	0.010
0.1120-40	--	0.7500-16	0.010
0.1380-32	--	0.8750-14	0.010
0.1640-32	--	1.0000-12	0.011
0.1900-32	0.005	1.1250-12	0.011
0.2500-28	0.005	1.2500-12	0.012
0.3125-24	0.006	1.3750-12	0.012
0.3750-24	0.006	1.5000-12	0.012
0.4375-20	0.007	1.7500-12	0.012
0.5000-20	0.008	2.0000-12	0.012
0.5625-18	0.009		

Note: Discontinuities as described are not applicable to the retainers of multi-piece nuts.

TABLE 9 – BEARING SURFACE SQUARENESS REQUIREMENTS

W (in.)	A Max. (in.)		
	Class I, IA, IV, IVA	Class II, IIA, III, IIIA	Class V, VA
Under 0.46	0.006	0.003	0.003
0.47 – 0.63	0.008	0.004	0.003
0.64 – 0.94	0.010	0.005	0.003
0.95 – 1.13	0.012	0.006	0.004
1.14 – 1.23	--	0.007	0.004
1.24 – 1.44	--	0.008	0.005
1.45 – 1.63	--	0.009	0.006
1.64 – 1.83	--	0.010	0.006
1.84 – 2.02	--	0.011	0.007
2.03 – 2.22	--	0.012	0.007
2.23 – 2.42	--	0.013	0.008
2.43 – 2.82	--	0.015	0.008
2.83 – 3.20	--	0.017	0.011
3.21 – 3.41	--	--	0.013

Note: For application of the values tabulated, refer to NAS 3353 which describes method of measurement.

TABLE 10 – TEST BOLT THREAD MAJOR DIAMETERS

SIZE	BOLT TYPES (See Para. 7)			
	B & E		A,C,D & F	
	Max.	Min.	Max.	Min.
0.0860-56	0.086	0.081	0.086	0.081
0.1120-40	0.112	0.106	0.112	0.106
0.1380-32	0.138	0.132	0.138	0.132
0.1640-32	0.164	0.158	0.164	0.158
0.1900-32	0.187	0.184	0.190	0.184
0.2500-28	0.247	0.244	0.250	0.244
0.3125-24	0.310	0.306	0.312	0.306
0.3750-24	0.372	0.368	0.375	0.368
0.4375-20	0.435	0.430	0.437	0.430
0.5000-20	0.497	0.492	0.500	0.492
0.5625-18	0.559	0.554	0.562	0.554
0.6250-18	0.623	0.617	0.625	0.617
0.7500-16	0.747	0.741	0.750	0.741
0.8750-14	0.872	0.865	0.875	0.865
1.0000-12	0.996	0.989	1.000	0.989
1.1250-12	1.121	1.114	1.125	1.114
1.2500-12	1.246	1.239	1.250	1.239
1.3750-12	1.371	1.364	1.375	1.364
1.5000-12	1.496	1.489	1.500	1.489
1.7500-12	1.746	1.739	1.750	1.739
2.0000-12	1.996	1.989	2.000	1.989

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