

TECHNICAL SPECIFICATION

No. TS128™

**"ALL-METAL" SELF-LOCKING NUTS (UNJ
THREADS) 1100 MPa (160,000 lbf/in²) MINIMUM
TENSILE STRENGTH AT ROOM TEMPERATURE.**



Aerospace Standards Part Qualification Program

A Program of SAE ITC

RATIONALE

8th issue of Technical Specification.
Updating the Technical Specification to the latest SAE ITC A4 TS Frame issue 5.
For full details of changes, refer to supplementary SAE ITC Amendment Record document TS128AR-8.

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Issued by: Technical Standards Committee (Aerospace)
SAE Industry Technologies Consortia (ITC)
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**SAE INDUSTRY TECHNOLOGIES CONSORTIA
AEROSPACE STANDARDS AND PART QUALIFICATION PROGRAM
FOREWORD**

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The legal obligations and copyright authority of all Aerospace Standards that were issued by the ADS Group Limited are therefore assigned / transferred to the SAE ITC.

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It is recommended that Technical Specification TS260, Metallic Materials List of Alternative Material Specifications and Standards Only Authorised for Use on Standard Parts, be consulted prior to manufacture of SAE ITC products. Selection of a material identified in TS260 as an alternative to those specified in the product standards requires Manufacturing Change Request (MCR) approval from the EATSC QMB.

Each Standard is a facsimile or electronic reproduction of a master drawing, and therefore, any outline view scales stated are not necessarily reproduced accurately. A Master Index of all SAE ITC Aerospace Standards is published separately on the SAE ITC website.

All references to Standards include reference to RS and TS publications.

Details of this and any further information can be obtained from the SAE ITC.

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1. SCOPE.

- 1.1 This Technical Specification details the requirements for all metal, self-locking nuts, with threads to ISO 3161 or SAE AS8879 and is based on SAE AS7251.
- 1.2 SAE ITC standards have been issued to provide dimensional control.
- 1.3 The heat treatment requirement for the product standards controlled by this specification is given in paragraph 6.3.2.
- 1.4 This specification establishes the requirements for all-metal, self-locking nuts, plate nuts, anchor nuts, shank nuts and gang channel nuts made of corrosion and heat resisting steel which will develop a minimum tensile strength of 1100 MPa (160,000 lbf/in²) at room temperature (20°C + 10°C).
- 1.5 The nut element shall be a self-contained 'all metal' unit including the self-locking device. The locking element shall not operate either by means of a separate movement from the installation nor depend upon pressure on the bearing surfaces for locking action.

2. NORMATIVE REFERENCES.

- 2.1 The following documents, in whole or in part, are normatively referenced in this Technical Specification & are indispensable for its application. For dated / revision listed references, only the issue cited applies. For undated / revision listed references, the latest issue of the referenced document (including any amendments) applies.

2.1.1 SAE Industry Technologies Consortia (ITC).

TS21	Manufacturing Specification for Bolts, 900MPa Tensile at Room Temperature.
TS48	Technical Specification for the Performance of Sockets and Ring Spanners.
TS200	Qualified Manufacturers for SAE ITC Aerospace Industry Standard Parts.
TS201	Method Change Approval for Qualified Parts listed in TS200.
TS202	Qualification Test Requirements & Procedures for Aerospace Industry Standard Parts.
RS610	Identification Marking of Parts & Assemblies.

2.1.2 British Standards Institution (BSI).

BS A4-1-2	Spec. for Test Pieces and Test Methods for Metallic Materials - Tensile Tests.
BS 1134 (ANSI: B46.1)	Assessment of surface texture.
BS A 358	MJ Threads: General Requirements & Limit Dimensions (Parts 1-3).
BS HR 650	Specification for High Expansion Heat-Resisting Steel Bar and Wire for Manufacture of Bolts, Studs, Setscrews and Nuts.

2.1.3 European Standards (CEN).

EN2002-2	Part 2: Metallic Materials – Test Methods - Tensile Testing at Elevated Temperature.
EN2786	Electrolytic Silver Plating of Fasteners.
EN2399	Heat-Resisting Steel – Bars for Forged Bolts.

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EN3639 High Resisting Alloy, Softened and Cold Worked – Wire for Forged Fasteners.

2.1.4 SAE International Standards.

AMS2411 Plating, Silver for High Temperature Applications.

AMS5732 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing and Rings.

AMS5737 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, and Tubing.

AMS7477 Procurement Specification for Bolts and Screws, Tensile Strength 130ksi.

AS1310 Definitions, Fastener Torque for Threaded Applications.

AS7251 Nuts, Self-Locking, Steel, Corrosion and Heat Resistant, High Strength.

AS8879 Screw Threads: UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter.

AS9100 Quality Management Systems - Requirements for Aviation, Space, and Defence Organizations.

AS9138 Statistical Product Acceptance Requirements.

2.1.5 UK Ministry of Defence Standards.

DEF STAN 91-98/2 Lubricating Oil: Gas Turbine Engines: Synthetic Type (DERD 2487) (OX-38).

DEF STAN 80-217 Corrosion Preventative Compound, Soft Film, Cold Application.

2.1.6 American National Standards Institute (ANSI).

ANSI B46.1 Assessment of Surface Texture.

2.1.7 ASTM International Standards.

ASTM E18 Standard Test Methods for Rockwell Hardness of Metallic Materials.

ASTM E92 Standard Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials.

ASTM E112 Standard Test Methods for Determining Average Grain Size.

2.1.8 USA Military Standards (MIL).

MIL-PRF-16173E Grade 2 Corrosion Preventive Compound.

2.1.9 International Standards (ISO).

ISO 3161 UNJ Threads: General Requirements and Limit Dimensions.

ISO 3452 Non-Destructive Testing – Penetrant Testing.

ISO 3453 Non-Destructive Testing – Liquid Penetrant Testing.

ISO 6507 Metallic Materials - Method for Vickers Hardness test.

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ISO 6508	Metallic Materials - Method for Rockwell Hardness test.
ISO 8642	Self-Locking Nuts with Maximum Operating temperature greater than 425°C – Test Methods.
ISO 9001	Quality Management Systems - Requirements.

3. DEFINITIONS & QUALITY REQUIREMENTS.

3.1 For the purpose of this specification, the following definitions apply:

3.1.1 Design Authority.

The Design Authority is the SAE ITC Technical Standards Committee (TSC).

3.1.2 Qualification Testing Authority.

In accordance with SAE ITC specification TS202 the qualification testing authority shall be the TSC or other body nominated by the TSC to carry out the testing.

3.2 Torque.

3.2.1 Breakaway Torque.

The torque required, to start unscrewing the nut or bolt. This is with respect to the associated part, with the nut-locking element still fully engaged on the bolt, as in paragraph 6.4.5, but after the axial load in the assembly has been removed by unscrewing half a turn followed by a halt in rotational movement.

3.2.2 Assembly Torque.

The torque necessary to provide a tensile load in the bolt.

3.2.3 Locking Torque (Self-Locking Torque).

The torque to be applied to the nut or bolt to maintain its movement of rotation in relation to the associated part, the assembly being under no axial load and the nut locking element being completely engaged with the bolt (minimum protrusion of two thread pitches, including the end chamfer).

3.3 Batch.

That group of nuts usually made from one cast of material and processed through the manufacturing cycle together.

3.4 Drawing.

This specifies all the requirements for the finished parts. In cases of dispute between the requirements of the drawing and this specification, the drawing shall take precedence.

4. QUALIFICATION & INSPECTION REQUIREMENTS.

4.1 Qualification.

A manufacturer seeking qualification shall submit to the Design Authority a minimum of 50 samples of each size and type of nut for which qualification is required. Nuts shall be selected

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from a single selection lot by a method defined in AS9138. The number of nuts to be subjected to each test as well as the methods to be used are given in Table 1. These tests are summarised in Table 4. The procedure to be followed is defined in SAE ITC specification TS202. The requirements of sample selection for qualification tests are defined in Table 5.

4.1.1 The testing programme may possibly be reduced. This decision will be made by the Design Authority, based on evidence and results of tests carried out on parts of a similar design, size and manufacturing condition.

4.1.2 Re-qualification may be called for from time to time at the discretion of the Design Authority.

If there is any proposed change in manufacturing source or method, the procedures specified in TS201 shall be initiated.

4.2 **Acceptance.**

4.2.1 **Purpose.**

The purpose of the acceptance tests is to check, as simply as possible, by a method representative of actual use conditions, with the uncertainty inherent to statistical sampling, that the nuts constituting the batch satisfy the requirements of this standard.

4.2.2 **Conditions.**

Acceptance tests are summarised in Table 4. They shall be performed on each batch. Table 1 specifies the test methods and sampling tables to be used for each test. Nuts from the batch to be tested shall be selected by a method defined in AS9138.

Each nut may be submitted to several tests.

The nuts subjected to destructive tests may be those on which non-destructive tests have been performed.

4.3 **Quality System Certification.**

4.3.1 **Purpose.**

The purpose of Quality System Certification is to ensure that the manufacturer has demonstrated the acceptability of their quality system and their ability for continuing production of parts to this standard to the required level of quality.

4.3.2 **Conditions.**

The requirements and procedures for quality systems shall be to the requirements of AS9100 and SAE ITC specification TS202.

4.4 **Inspection and Test Report.**

An inspection and test report showing actual numerical values shall be provided unless otherwise agreed by the Design Authority. Any reason for deviation from these presentation requirements shall be clearly recorded as part of the test report. This shall verify total compliance with product requirements. All deviations shall be considered for effect or applicability and a pass / fail criteria added.

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4.5 **Qualified Manufactures of Self-Locking Nuts.**

A list of nut manufacturers qualified to TS128 is contained in TS200.

<https://ts200.sae-itc.org/>

Note : Qualified manufacturers shall hold a certificate of qualification as evidence of their qualified status for a part.

5. **TEST EQUIPMENT.**

5.1 **Test Bolts.**

Test bolts for performance tests detailed in Table 1 shall conform to the requirements of Table 3.

5.2 **Test Lubrication.**

Bolt and mandrel threads shall be lubricated with oil conforming to DEF STAN 91-98 (DERD 2487) before each installation of the nut except for test 6.4.2 (wrench torque) and before removal where specifically stated.

5.3 **Test Fixtures.**

Details of test fixtures and mandrels are given in Figures A1 to E9 in the attached Appendices.

5.4 **Performance Tests.**

5.4.1 Nuts shall conform to all tests unless otherwise stated on the relevant drawing.

5.4.2 All tests shall be conducted on nuts produced by the declared manufacturing process. It shall be possible to assemble the nuts up to the locking feature using fingers and thumb only.

6. TECHNICAL REQUIREMENTS AND TEST METHODS.

See Table 1.

TABLE 1 - TECHNICAL REQUIREMENTS & TEST METHODS.

Clause	Characteristic	Requirement	Inspection and test method	Q/A 1)	Sample size
6.1	Material	Nut or nut elements - Corrosion and heat resisting steel to BS HR 650, EN2399, EN3639, AMS5732 or AMS5737. Floating nuts' cage material shall be as specified on the product standard or drawing. Heat treatment shall be as specified in paragraph 6.3.2.	As stated on the material specification.		
6.2	Dimensions, tolerances, of form and position, threads and quality			Q A	42 See Tables 11 thru 15
6.2.1	Dimensions	In accordance with the relevant nut drawing.	Standard gauging.		
6.2.2	Quality	Parts shall be uniform in quality and condition, clean, sound and free from fins, burrs, cracks and other imperfections detrimental to their performance. Parts shall also be free of tool marks except those resulting from producing the self-locking feature & these must blend smoothly without abrupt change and shall not affect the performance of the part.	Visual		
6.3	Manufacture	Nuts may be manufactured by machining or forming, dependent upon the material allowed by the product standard or the definition.	Whichever method is used shall be approved (see 6.3.1*).		
6.3.1	Forming	Formed nuts may be produced by a hot or cold forming process. If hot formed the forming temperature shall not exceed 1150°C & parts shall be air cooled or faster. The heating equipment used for forming shall ensure a consistent temperature throughout the batch*.	Whichever method is used shall be approved. *All processes and manufacturing equipment shall be approved by the qualification authority.		
6.3.2	Heat treatment	The heat treatment requirements for the product standard are quoted in Table 2. This takes precedence over any heat treatments quoted on the product standard.	The heat treatment equipment shall be approved (see 6.3.1*).		

1) Q = Qualification, A = Acceptance

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TABLE 1 - TECHNICAL REQUIREMENTS & TEST METHOD. (CONT.)

Clause	Characteristic	Requirement	Inspection and test method	Q/A 1)	Sample size
6.3.2 (cont.)	Heat treatment	The heat treatment medium or atmosphere shall not cause any surface contamination except that on unmachined surfaces, depth of oxide penetration to 0,025mm is permissible. Machined surfaces to be free from surface oxide. Any scale that will not be removed by subsequent machining shall be removed by abrasive blasting.	The equipment for abrasive blasting shall be approved (see 6.3.1*).		
6.3.3	Threads	Threads shall conform to ISO 3161 or AS8879 prior to the deformation of the self-locking feature. Except as noted in 6.3.4.1 (Insp. and Test Methods) there shall be no anti-seizure allowance on the nut thread to provide a clearance fit.	Threads shall be inspected using an approved, auditable quality control calibration system of gauging.		
6.3.3.1	Thread squareness	The bearing surface of the nut shall be square with the thread pitch diameter axis within the limits specified on the product standard or drawing. The squareness requirement shall apply to the complete bearing surface of the part (unless otherwise specified on the relevant definition), except that for non-floating plate nuts having a bearing surface exceeding 1,5 times the thread major diameter, the squareness requirement shall, unless otherwise specified by the product standard or definition, apply only to that portion of the bearing surface of the part contained within a diameter equal to 1,5 times the thread major diameter.	Nuts to be inspected shall be screwed onto at least three full threads of a threaded plug gauge. Squareness error is determined by a method agreed upon by purchaser and vendor. Plating or other coating may be stripped from bearing face if necessary to meet this requirement. Alternatively nuts prior to coating may be used. Multipiece floating plate nuts shall have the nut element removed from the retainer for checking thread squareness. Also see ISO 8642 test 3.2		See 6.2
6.3.3.2	Bearing face flatness	The bearing face of the nut shall be flat to concave within the limits specified on the product standard or definition.			See 6.2
6.3.3.3	Thread displacement	Threads in the locking region to be displaced using two (2) or more crimps, spaced equally around the circumference to enable the self-locking nut to meet the requirements of this specification. Any tool marks must blend smoothly without any abrupt changes, and shall not affect the performance of the part.	Thread displacement shall not prevent the nuts accepting wrenches of the types specified in 6.4.2.		See 6.2
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TABLE 1 - TECHNICAL REQUIREMENTS & TEST METHOD. (CONT.).

Clause	Characteristic	Requirement	Inspection and test method	Q/A 1)	Sample size
6.3.3.3 (cont.)	Thread displacement	The plated nut, or nuts not requiring plating, shall allow the plug gauge “GO” thread to enter a minimum of one & a half turns before engagement of the locking element for nuts having overall length of threaded portion of not less than 1,2 times the nominal thread diameter. Plated nuts having a shorter threaded portion shall allow “GO” thread plug gauge to enter a minimum of three quarters of a turn.	ISO 8642		
6.3.4	Surface texture	As specified on the relevant product standard prior to coating. There shall be no defects detrimental to the function of the part.	BS 1134 (ANSI B46.1)	Q	3
				A	See Tables 11 & 13
6.3.4.1	Surface coating	Unless otherwise specified on the relevant product standard, nuts shall be silver coated. On nuts with thread sizes of 0.2500” and larger, the coating thickness shall not be less than 0.0002” (5µm) when measured on the thread pitch dia. Coating thickness shall be measured on a micro-sectioned nut for process (batch) clearance and quality control. Nuts with thread sizes 0.1900” and smaller shall show complete coverage on the threads. Coating on other surfaces shall be 0.0003” to 0.0006” (8 – 15µm) thickness.	To EN2786, ISO 4521 or AMS2411. When silver-plating to AMS2411, adhesion testing shall be carried out on each batch/lot. Internal thread coating allowance shall be as specified in ISO 3161 or AS8879 unless otherwise specified on the relevant product standard.	Q	2
				A	See Tables 11 & 13
6.4	Mechanical properties	A test sample shall be selected from each diameter of bar, coil sheet or strip drawn from each cast and shall be heat treated together with a production batch of nuts.	The sample selected shall be sufficient to provide tensile and stress rupture test pieces. The test pieces shall meet the mechanical properties required by the material specification.		
6.4.1	Axial strength	Finished nuts shall withstand the minimum loads specified in Table 6.	See ISO 8642 test 3.3		
6.4.1.1	‘As received’	After the load specified in Table 6 has been applied the nut shall not display: - any cracks or fractures, - permanent set and any resultant effects are not permissible.		Q	4
				A	Tables 11 And 16

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TABLE 1 - TECHNICAL REQUIREMENTS & TEST METHOD. (CONT.)

Clause	Characteristic	Requirement	Inspection and test method	Q/A 1)	Sample size
6.4.1.2	'After 650°C bake'	Prior to testing, assemble the nuts on type 'A' test bolts with at least 2 threads protruding and bake for 6 to 16 hrs at 650°C±8°C and cooled in ambient air to ambient temp. Nuts that are designed to be flared at assembly shall be tested as in 6.4.1 except that the hole in the bearing plate shall be 0,10mm –0,20mm greater than the maximum allowable shank diameter. The bearing plate hole shall be chamfered sufficiently to clear the nut-bearing surface-to-shank maximum fillet radius.	After baking, the nuts are to be re-assembled on to a Type B test bolt (see Table 3) together with the bearing plates as specified in ISO 8642 test 3.3. The assembly shall then be tensile loaded in accordance with BS A4-1-2 or EN2002-2 (see Table 6). A new bolt shall be used for each tensile test.	Q	4
6.4.2	Wrench torque test	All wrenchable nuts shall, at ambient temperature, withstand 12 successive applications of the torque specified in Table 6 without any permanent damage to the wrenching feature in both the tightening and untightening direction. Bolts used shall be of sufficient length and use a bush as shown in Figure A1.	See ISO 8642 test 3.4. Socket type wrenches shall be in accordance with TS48. All nuts shall be cleaned to remove all trace of any lubricant, wax, or anti-seize coating and no engine oil shall be used on assembly.	Q	3
6.4.3	Accelerated vibration test	The nuts to be tested shall be installed on a type 'A' test bolt specified in Table 3 to a test torque specified in Table 6. The loaded nut assembly shall withstand 30,000 cycles of continuous vibration at 30 Hz with a total travel of 11,25mm, without cracking and without being capable of turning the nut by hand. Testing of nuts other than hexagon or double hexagon wrenching types shall be as agreed by the Design Authority. Relative motion between the assembled nut and bolt shall not be greater than 360 degrees. Reference marks shall be made on the nut and assembly to determine if any movement of the test nut on the test bolt takes place during the vibration test.	Ten test nuts for the nominal sizes listed in Table 6 shall be installed respectively on new type 'A' bolts with lengths in accordance with Table 7 on a test fixture as in Figure A1 and torque in accordance with Table 6. The nuts shall be conditioned as per 6.4.3.1 & 6.4.3.2 and finally they shall be assembled on the vibration test fixture (see Figure B1) using new bolts with lengths to Table B1 and torques to Table 6. Multipiece floating plate nuts shall have the nut element removed from the retainer for this test unless agreed otherwise by the Design Authority. Fixed anchor nuts may have the lugs removed.	Q	10

1) Q = Qualification, A = Acceptance

TABLE 1 - TECHNICAL REQUIREMENTS & TEST METHOD. (CONT.)

Clause	Characteristic	Requirement	Inspection and test method	Q/A 1)	Sample size
6.4.3.1	As received condition		The loaded nut assembly as specified in 6.4.3 shall then be dismantled and reassembled a further four times, using the same bolt to the specified torque values in Table 6. The final assembly shall then be vibration tested in accordance with 6.4.3. Nuts shall be assembled on new test bolts when installed on the vibration test rig.	Q	5
6.4.3.2	'After 650°C bake'		The nut shall be loaded as specified in 6.4.3 and soaked at 650°C ±8°C for 6 to 16 hrs ±15 min and cooled in ambient air to room temperature. The loaded nut assembly shall then be dismantled and reassembled a further four times, using the same bolt to the specified torque values in Table 6. The nuts shall then be assembled on the vibration test fixture & tested in accordance with 6.4.3. Nuts shall be assembled on new test bolts when installed on the vibration test rig.	Q	5
6.4.4	Permanent set test	Nuts shall not exceed the maximum permissible locking torque as specified in Tables 9/10 (Col.3) and shall be not less than the minimum specified in Tables 9/10 (Col.1). See Table A2 for max. mandrel dims. See Table A3 for min. mandrel dims.	Nuts shall be assembled on the maximum mandrel (see Fig. A2) so the mandrel projects not less than three turns. Then nuts shall be removed & assembled on the minimum mandrel (see Fig.A3).	Q	3
6.4.5.	Reusability test	<i>General: After testing, nut threads shall not show any indications of distortion, galling or scratches of such depth as to prevent reassembly of the nut freely, with the fingers, up to the self-locking device.</i>	Nuts shall be assembled on appropriate test bolts selected from Table 3. The tests shall be carried out so that an accurate, repeatable measure of torque will be obtained.		
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