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## **Aerospace — Self-locking nuts with maximum operating temperature greater than 425 °C — Procurement specification**

**iTeh STANDARD PREVIEW**

*Aéronautique et espace — Écrous à freinage interne dont la température maximale  
d'utilisation est supérieure à 425 °C — Spécification d'approvisionnement*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8641 was prepared by Technical Committee ISO/TC 20, *Aerospace and space vehicles*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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# Aerospace — Self-locking nuts with maximum operating temperature greater than 425 °C — Procurement specification

## 1 Scope and field of application

This International Standard specifies the requirements for metric self-locking nuts, with MJ thread, intended for use in aerospace construction at a maximum temperature greater than 425 °C.

This International Standard applies to self-locking nuts as defined above, provided that reference is made to this International Standard in the relevant definition document.

## 2 References

ISO 691, *Wrench and socket openings — Metric series — Tolerances for general use.*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*<sup>1)</sup>

ISO 3534, *Statistics — Vocabulary and symbols.*

ISO 5855-1, *Aerospace construction — MJ threads — Part 1: Basic profile.*

ISO 5855-2, *Aerospace construction — MJ threads — Part 2: Dimensions for bolts and nuts.*

ISO 7403, *Fasteners for aerospace construction — Spline drive wrenching configuration — Metric series.*

ISO 8642, *Aerospace — Self-locking nuts with maximum operating temperature greater than 425 °C — Test methods.*

ISO 8788, *Aerospace — Fasteners — Tolerances of form and position for nuts.*

## 3 Definitions

**3.1 definition document:** Document specifying all the requirements for nuts, i.e.

- metallurgical;

- geometrical and dimensional;
- functional (strength and temperature classes).

The definition document may be an International Standard, a national standard or an in-house standard or drawing.

**3.2 finished nut:** A nut ready for use, inclusive of any possible treatments and/or surface coatings, as specified in the definition document.

**3.3 batch:** A definite quantity of some commodity manufactured or produced under conditions which are presumed to be uniform.<sup>2)</sup>

For the purposes of this International Standard, a batch is a quantity of finished nuts, of the same type and same diameter, produced from a material obtained from the same melt, manufactured in the course of the same production cycle, following the same manufacturing route and having undergone all the relevant heat treatments and surface treatments.

**3.4 crack:** Rupture in the material which may extend in any direction and which may be intercrystalline or transcrystalline in character.

**3.5 seam:** Open surface defect resulting from some stripping of the metal.

**3.6 lap:** The folding over of unwelded metal that can arise when the material is formed (drawing) or in the finished product (pressing or forging).

**3.7 inclusions:** Non-metallic particles inherent from the material manufacturing process. These particles may exist either as discrete particles or as strings of particles extending longitudinally.

**3.8 critical defect:** A defect that, according to judgment and experience, is likely to result in hazardous or unsafe conditions for individuals using, maintaining or depending upon the considered product, or that is likely to prevent performance of the function of a major end item.<sup>2)</sup>

1) At present at the stage of draft. (Revision, in part, of ISO 2859 : 1974.)

2) Definition taken from ISO 3534. (ISO 3534 is currently being revised by ISO/TC 69, *Applications of statistical methods.*)

**3.9 major defect** : A defect, other than critical, that is likely to result in a failure or to reduce materially the usability of the considered product for its intended purpose.<sup>1)</sup>

**3.10 minor defect** : A defect that is not likely to reduce materially the usability of the considered product for its intended purpose, or that is a departure from established specifications having little bearing on the effective use or operation of this product.<sup>1)</sup>

**3.11 sampling plan** : A plan according to which one or more samples are taken in order to obtain information and possibly to reach a decision.<sup>1)</sup>

For the purposes of this International Standard, each sampling plan specifies the number of nuts to be inspected as a function of the size of the batch and the acceptance criteria [number of defective items acceptable —  $A_c$  (acceptance number)].<sup>2)</sup>

**3.12 simple random sampling** : The taking of  $n$  items from a population of  $N$  items in such a way that all possible combinations of  $n$  items have the same probability of being chosen.<sup>1)</sup>

**3.13 acceptable quality level (AQL)** : A quality level which in a sampling plan corresponds to a specified but relatively high probability of acceptance.

It is the maximum per cent defective (or the maximum number of defects per hundred units) that, for the purposes of sampling inspection, can be considered satisfactory as a process average.<sup>1)</sup>

**3.14 limiting quality (LQ)** : In a sampling plan, a quality level which corresponds to a specified and relatively low probability of acceptance. It is the limiting lot quality characteristic that the consumer is willing to accept with a low probability that a lot of this quality would occur.<sup>1)</sup>

For the purposes of this International Standard, the limiting quality quoted in table 13 corresponds to a customer's risk of 10 %.

**3.15 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 system being completely engaged with the bolt (minimum protrusion of two pitches, including the end chamfer).

**3.16 seating torque** : The tightening torque to be applied to the nut or bolt to introduce or to increase the axial load in the assembly.

**3.17 unseating torque** : The untightening torque to be applied to the nut or bolt to reduce or remove the axial load in the assembly.

**3.18 breakaway torque** : The torque required to start unscrewing the nut or bolt with respect to the associated part,

with the nut-locking device still fully engaged on the bolt, but after the axial load in the assembly has been removed by unscrewing half a turn followed by a halt in rotational movement.

**3.19 wrench torque** : The tightening and untightening torques which the driving feature of the nut shall withstand, repeatedly, without any permanent deformation which would prevent the appropriate wrench from being used and preclude re-use of the nut.

## 4 Certification and quality assurance

Certification and quality assurance will be the subject of a future International Standard.

The allocation of tests corresponding to the requirements of this International Standard is outlined in 4.1 and 4.2.

### 4.1 Qualification tests

#### 4.1.1 Purpose

The purpose of qualification tests is to ensure that the nut design and nut manufacturing conditions allow the nut to comply with the requirements of this International Standard.

#### 4.1.2 Test conditions

The qualification tests summarized in table 2 shall be carried out on each type and diameter of nut. Proposed changes in the source of procurement or in the manufacturing process shall be grounds for repeating qualification tests. 100 nuts selected from a single batch by simple random sampling shall be subjected to qualification tests.

The number of nuts to be subjected to each test as well as the test method(s) to be used are specified in table 1.

Each nut may be submitted to several tests.

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

The test programme may possibly be reduced or the qualification of a nut be granted without testing. This decision will be based on the results obtained on similar types and diameters of nuts, provided that the design and manufacturing conditions are identical.

### 4.2 Production acceptance tests

#### 4.2.1 Purpose

The purpose of production acceptance tests is to check, as simply as possible, using a method which is inexpensive and representative of actual conditions of use, with the uncertainty inherent in statistical sampling, that the nuts comprising a batch satisfy the requirements of this International Standard.

1) Definition taken from ISO 3534.

2) Supplementary information taken from ISO 2859/Add.1. (ISO 2859 and its addenda are currently being revised by ISO/TC 69.)

#### 4.2.2 Test conditions

Production acceptance tests are summarized in table 3. They shall be carried out on each batch. Table 1 specifies the test method(s) and sampling plan to be used for each test. Nuts from the batch to be tested shall be selected by simple random sampling.

Each nut may be submitted to several tests.

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

#### 4.2.3 Tightened inspection

Should a tightened inspection be deemed to be necessary, or in order to survey nuts that have not proved satisfactory in use, all or some of the qualification tests may also be carried out for production acceptance. In this case, the number of nuts to be tested is the same as that required for qualification tests.

#### 4.2.4 Rejection and re-test

Batches declared unacceptable shall be resubmitted for re-inspection only after all defective units have been removed and/or defects have been corrected.

Twice the normal sample size shall be used for re-inspecting or re-testing the attribute causing initial rejection. The same acceptance level shall be used.

## 5 Requirements

The requirements of this International Standard are given in table 1. These requirements complement the requirements of all standards or specifications referenced in the definition document of the nut.

NOTE — The attention of users of this International Standard is drawn to the fact that, in cases where no International Standard specifying the test method exists, the following tests or inspections require that the test method be subject to agreement between the vendor and the purchaser :

- spectrographic or spectroscopic analysis of the material (see 5.1.1);
- micrographic inspection of the material structure (see 5.1.2);
- fluoroscopic inspection of surface discontinuities (see 5.1.3);
- inspection by chemical reagent of the type of surface coating (see 5.2.2);
- tactile inspection or inspection using a profilometer for checking surface roughness (see 5.3.2).

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Table 1 – Technical requirements and test methods

Clause No.	Characteristic	Technical requirement	Inspection and test method	Test category	Number of nuts to be inspected
<b>5.1</b>	<b>Material</b>				
5.1.1	Type	The material shall be as specified in the definition document.	Spectrographic analysis or spectroscopic analysis (method subject to agreement between the vendor and the purchaser).	Qualification Production acceptance	3 Table 14, column B
5.1.2	Microstructure	Nuts shall be free from cracks.  Inclusions shall not be greater than the values specified in the material standard.  Nuts shall display no sign of overheating (nuts comprising ground parts) or of oxidation greater than 0,01 mm deep on machined areas and bearing surfaces and not deeper than 0,1 mm on non-machined areas.  Grain size, measured approximately at the geometrical centre of the half-section of the nut, shall be in accordance with the requirements of the material standard.	Micrographic inspection on a transverse section (method subject to agreement between the vendor and the purchaser).	Qualification Production acceptance	5 Table 14, column B
5.1.3	Surface discontinuities <sup>1)</sup>	The types of permissible surface discontinuities are given in the annex. The maximum depth allowed for these discontinuities is given in table 15.  Cracks are not permitted.	Fluoroscopic inspection (method subject to agreement between the vendor and the purchaser).  In the event of any doubt arising as to the nature of the defects detected, inspect defective nuts under low magnification after sectioning.	Qualification Production acceptance	5 Table 14, column B
5.1.4	Hardness	The hardness of the finished nuts shall be within the limits specified in the definition document of the nut or in the material standard.	See ISO 8642.	Qualification Production acceptance	5 Table 14, column B
<b>5.2</b>	<b>Surface coating</b>				
5.2.1	Presence	Surface coating shall be applied at the locations specified in the definition document.	Visual inspection.	Qualification Production acceptance	100 Tables 12 and 13
5.2.2	Type	Surface coating shall be as specified in the definition document.	Visual inspection or inspection by chemical reagent in case of doubt (method subject to agreement between the vendor and the purchaser).	Qualification Production acceptance	3 Table 14, column A
5.2.3	Thickness	The thickness of the surface coating shall be within the limits specified in the definition document.	Device for measuring the thickness of surface coatings.  In case of doubt, inspect defective nuts under low magnification after sectioning. <sup>2)</sup>	Qualification Production acceptance	5 Table 14, column A
5.2.4	Adhesion			Qualification Production acceptance	5 Table 14, column B
	a) Silver adhesion	There shall be no sign of blisters or exfoliation in use.	Maintain the nuts at a temperature of 550 °C during 4 h, then rapidly cool the nuts with compressed air (at a pressure of 0,3 to 0,4 MPa) by means of a nozzle, having a 1,5 mm diameter, held close to the surface of the nuts.		
	b) Molybdenum disulfide (MoS <sub>2</sub> ) adhesion	There shall be no sign of flaking, cracking or softening in use.	Maintain the nuts at a temperature of 260 °C for 3 h, then cool the nuts slowly to ambient temperature.		

1) Inspection to be carried out either before any surface coating is applied or after it has been removed.

2) This inspection may be carried out on nuts that have been subjected to micrographic inspection (see 5.1.2).



Table 1 (continued)

Clause No.	Characteristic	Technical requirement	Inspection and test method	Test category	Number of nuts to be inspected
<b>5.3</b>	<b>Surface condition</b>				
<b>5.3.1</b>	<b>Appearance</b>	Finished nuts shall be free from burrs and bumps.	Visual inspection.  In the event of any doubt arising as to the nature of the defects detected, inspect defective nuts under low magnification after sectioning.	Qualification  Production acceptance	100  Tables 12 and 13
<b>5.3.2</b>	<b>Surface roughness<sup>1)</sup></b>	The surface roughness of the nuts shall be as specified in the definition document.	Tactile inspection or inspection using a profilometer (method subject to agreement between the vendor and the purchaser).	Qualification	5
<b>5.4</b>	<b>Marking</b>	The nuts shall be marked as specified in the definition document.	Visual inspection.	Qualification  Production acceptance	100  Tables 12 and 13
<b>5.5</b>	<b>Dimensions</b>				
<b>5.5.1</b>	<b>General dimensions</b>	The dimensions and any deviations in form and position, measured at ambient temperature, shall be within the limits specified in the definition document.	Suitable limit gauges or measuring instruments.	Qualification  Production acceptance	20  Tables 12 and 13
<b>5.5.2</b>	<b>Thread</b>	The thread shall be in conformity with the definition document.  The threaded GO gauge shall be capable of being freely screwed for at least one and a half turns.  As regards nuts with a molybdenum disulfide dry-film lubrication, a bolt with standard threads shall be capable of being freely screwed for at least one and a half turns.	Threaded GO/NO-GO gauges.  Bolt with standard threads in accordance with ISO 5855.	Qualification  Production acceptance	20  Tables 12 and 13
<b>5.5.3</b>	<b>Wrench engagement<sup>2)</sup></b>	The deformation necessary to achieve internal locking shall not prevent a wrench from being used.  A female gauge, of identical form to the driving feature of the nut to be inspected, shall be capable of being freely installed over a length equal to the wrenching height specified in the definition document.	Female gauge satisfying the following dimensions :  a) Hexagonal and bi-hexagonal drive  Minimum tolerance specified in ISO 691.  b) Spline drive  Maximum material condition of female wrenching device in accordance with ISO 7403.	Qualification  Production acceptance	20  Tables 12 and 13
<b>5.5.4</b>	<b>Squareness of the bearing surface</b>	Any out-of-squareness of the bearing surface, relative to the thread, shall be within the limits specified in ISO 8788.	See ISO 8642.	Qualification  Production acceptance	20  Tables 12 and 13

1) Inspection to be carried either before any surface coating is applied or after it has been removed.

2) Test applicable only to wrench nuts.

Table 1 (continued)

Clause No.	Characteristic	Technical requirement	Inspection and test method	Test category	Number of nuts to be inspected
<b>5.6</b>	<b>Performance</b>				
<b>5.6.1</b>	<b>Axial load</b>	The finished nuts shall withstand the axial load specified for their tensile strength class, as laid down in the definition document.	See ISO 8642.	Qualification	8
	a) 80 % test	The nuts shall not display <ul style="list-style-type: none"> <li>— any cracks,</li> <li>— any permanent set,</li> <li>— any significant reduction in their locking torque.</li> </ul>	The load to be applied shall be as specified in table 4 of this International Standard.	Production acceptance	Table 14, column B
	b) 100 % test	The nuts shall not display <ul style="list-style-type: none"> <li>— any crack,</li> <li>— any fracture.</li> </ul> Permanent set and resultant effects (reduction or disappearance of the locking torque) are permissible.	The load to be applied shall be as specified in table 5 of this International Standard. <sup>1)</sup>		
<b>5.6.2</b>	<b>Wrenching feature<sup>2)</sup></b>	Finished nuts shall withstand the torque specified for the tensile strength class, as laid down in the definition document, and shall not display any crack or deformation preventing a standard socket spanner for being used.	See ISO 8642. The torque to be applied 15 times by alternately tightening and untightening shall be as specified in table 6.	Qualification	3
<b>5.6.3</b>	<b>Torque-out<sup>3)</sup></b>	The retention device in the body of the nut shall be capable of withstanding the torque arising during screwing, tightening, unscrewing and untightening, and the body of the nut shall not become detached from the plate, cage or gang channel. No crack or deformation shall be present which is likely to prevent the nut from being re-used.	See ISO 8642. The torque to be applied in both directions shall be as specified in table 8 of this International Standard.	Qualification	3
<b>5.6.4</b>	<b>Push-out<sup>4)</sup></b>	Finished nuts shall be capable of withstanding the axial load which may arise during screwing without any cracks appearing. Any deformation at the thread axis shall be less than 0,8 mm and shall not prevent a standard bolt being installed over at least one and a half turns.	See ISO 8642. The load to be applied shall be as specified in table 9 of this International Standard.	Qualification	3
<b>5.6.5</b>	<b>Locking</b>	The locking device shall enable <ul style="list-style-type: none"> <li>— the nuts to be re-used after several removal operations;</li> <li>— correct tensioning of the bolts when a normal tightening torque is applied and there shall be no risk of causing the bolts to fail under tension.</li> </ul> After the test has been completed, the thread of the bolts and nuts shall not display any signs of stripping, permanent deformation or seams likely to reduce the effectiveness of the threads. Furthermore, the bolt thread shall enable a new nut to be screwed up to the point where the locking device is engaged.			

1) In the case of qualification tests, before the load is applied, the nuts shall be exposed for 6 h to the maximum operating temperature specified in the definition document.

2) Test applicable only to wrench nuts.

3) Test applicable only to floating anchor nuts, gang channel nuts and fixed anchor nuts, produced in several parts and assembled by brazing or clinching.

4) Test applicable only to gang channel and anchor nuts, with the exception of corner nuts (see ISO 8642) and of reduced series single-lug nuts.

Table 1 (continued)

Clause No.	Characteristic	Technical requirement	Inspection and test method	Test category	Number of nuts to be inspected
5.6.5.1	Presence of locking element		Visual inspection.	Qualification Production acceptance	100 Tables 12 and 13
5.6.5.2	Inspection of locking torques at ambient temperature				
5.6.5.2.1	Over 15 cycles <sup>1)</sup>	The locking torques shall lie within the maximum and minimum values specified in table 10, columns 1 and 3.	See ISO 8642. The tightening torque to be applied shall be as specified in table 7 of this International Standard.	Qualification	8
5.6.5.2.2	Over one cycle	The locking torques shall be within the maximum and minimum values specified in table 10, columns 1 and 4.	See ISO 8642. The tightening torque to be applied shall be as specified in table 7 of this International Standard.	Production acceptance	Table 14, column A
5.6.5.3	Inspection of locking torques at ambient temperature, after exposure to the maximum operating temperature	After the maximum operating load of the associated bolt has been applied and after the nut has been exposed five times for 6 h ± 15 min to the maximum operating temperature, as specified in the definition document of the nut, to within ± 5 °C, the locking torques, measured after each cycle, the nut being cooled down slowly to ambient temperature, shall be within the values specified in table 10, columns 2 and 3.	See ISO 8642.	Qualification	8
5.6.5.4	Permanent set	The locking torques of finished nuts, measured at ambient temperature on a maximum threaded mandrel followed by a minimum threaded mandrel, shall lie within the maximum and minimum values specified in table 10, columns 1 and 3.	See ISO 8642.	Qualification	5
5.6.6	Vibration <sup>2)</sup>	The finished nuts shall be capable of absorbing, without failure, the energy imparted by vibrations, tremors, shocks, etc., that are likely to be experienced in operation without suffering any structural damage (cracks, fracture of the insert, expulsion of the locking element, fracture of threads, etc.) or any loss of their locking characteristics.	See ISO 8642. The tightening torque to be applied five times shall be as specified in table 11 of this International Standard. For half of the nuts (i.e. five) to be tested, before the tightening torque is applied for the first time, the nut shall be exposed to the maximum operating temperature specified in the definition document. The test shall be performed for a period of time equivalent to 30 000 cycles of vibration at 30 Hz. Rotation of the nut, relative to the bolt, less than or equal to 360° is permissible. Failure of the bolt shall not be considered as grounds for rejecting the nut.	Qualification	10
5.6.7	Swaging <sup>3)</sup>	The skirt of the finished clinch nuts shall be capable of being flared using a 60° conical tool to 1,1 times its original diameter without cracking or fracturing.	Visual inspection. In the event of any doubt arising as to the nature of the defects detected, inspect defective nuts under low magnification after sectioning.	Qualification Production acceptance	5 Table 14, column B

- 1) For nuts with dry-film lubrication, such as molybdenum disulfide, this test shall be carried out over five cycles in order to avoid any risk of binding.
- 2) Test applicable only to nuts having diameters of 5, 6, 7, 8, 10 and 12 mm. (See ISO 8642.)
- 3) Test applicable only to clinch nuts.