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**Aerospace — Nuts, plain or slotted  
(castellated) — Procurement specification**

*Aéronautique et espace — Écrous ordinaires ou à créneaux —  
Spécification d'approvisionnement*

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**Contents**

1 Scope ..... 1

2 Normative references ..... 1

3 Terms and definitions ..... 2

4 Quality assurance ..... 3

4.1 General ..... 3

4.1.1 Approval of manufacturers ..... 3

4.1.2 Qualification of nuts ..... 4

4.1.3 Production acceptance of nuts ..... 4

4.2 Qualification inspection and test conditions ..... 4

4.3 Production acceptance inspection and test conditions ..... 4

4.4 Use of "Statistical process control (SPC)" ..... 5

5 Technical requirements ..... 5

Annex A (normative) Types of permissible surface discontinuity ..... 17

Annex B (informative) Cross-sectional area formula ..... 18

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9139 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 4, *Aerospace fastener systems*.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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# Aerospace — Nuts, plain or slotted (castellated) — Procurement specification

## 1 Scope

This International Standard specifies the required characteristics for metric plain or slotted (castellated) nuts, with MJ threads according to ISO 5855-2, for use in aerospace construction.

It is applicable to nuts as defined above, provided that reference is made to this International Standard in the relevant definition document.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1463:1982, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*.  
<https://standards.itec.ai/catalog/standards/sist/56ceb536-485b-4250-a70f-37229fb648ed/iso-9139-1998>

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*.

ISO 3452:1984, *Non-destructive testing — Penetrant inspection — General principles*.

ISO 3887:1976, *Steel, non-alloy and low-alloy — Determination of depth of decarburization*.

ISO 4288:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*.

ISO 5855-2:1988, *Aerospace — MJ threads — Limit dimensions for bolts and nuts*.

ISO 7870:1993, *Control charts — General guide and introduction*.

ISO 7966:1993, *Acceptance control charts*.

ISO 8258:1991, *Shewhart control charts*.

ISO 8788:1987, *Aerospace — Fasteners — Tolerances of form and position for nuts*.

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing*.

ISO 9003:1994, *Quality systems — Model for quality assurance in final inspection and test*.

ISO 9140:1998, *Aerospace — Plain or slotted (castellated) nuts — Test methods*.

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO/TR 13425:1995, *Guide for selection of statistical methods in standardization and specification.*

### 3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

#### 3.1 definition document

document specifying all the requirements for nuts, i.e.:

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

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

#### 3.2 finished nut

nut ready for use, inclusive of any possible treatments and/or surface coatings, as specified in the definition document

#### 3.3 batch

definite quantity of some commodity manufactured or produced under conditions which are presumed to be uniform

NOTE 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 extension of the metal

#### 3.6 lap

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 originating from the material manufacturing process

NOTE These particles may be isolated or arranged in strings.

#### 3.8 critical defect

defect that, according to judgement 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

### 3.9 major defect

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

### 3.10 minor defect

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

### 3.11 sampling plan

plan according to which one or more samples are taken in order to obtain information and possibly reach a decision

NOTE 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 number [number of defective items acceptable (Ac)]<sup>1)</sup>.

### 3.12 simple random sampling

sampling 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

### 3.13 acceptable quality level AQL

maximum percent defective (or the maximum number of defects per hundred units) that, for purposes of sampling inspection, can be considered satisfactory as a process average

NOTE Variant: quality level which in a sampling plan corresponds to a specified but relatively high probability of acceptance.

### 3.14 limiting quality LQ

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⟨sampling plan⟩ quality level which corresponds to a specified and relatively low probability of acceptance

NOTE 1 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.

NOTE 2 For the purposes of this International Standard, the limiting quality given in Table 7 corresponds to a consumer's risk of 10 %.

## 4 Quality assurance

### 4.1 General

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1) Supplementary information taken from ISO 2859-1.

The purpose of these procedures is to ensure that a manufacturer has a quality system and the capability for continuous production of nuts complying with the specified quality requirements.

Approval of the manufacturer shall be granted by the Certification Authorities, or their appointed representative, who may be the prime contractor.

#### 4.1.2 Qualification of nuts

The purpose of qualification inspections and tests of nuts is to check that the design and manufacturing conditions of a nut allow it to satisfy the requirements of this International Standard.

The qualification is applicable to nuts of strength classes greater than or equal to 1 550 MPa and/or of temperature classes greater than or equal to 650 °C. It shall be granted by the Certification Authorities in the purchaser's country, or their appointed representative, who may be the prime contractor.

#### 4.1.3 Production acceptance of nuts

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

Production acceptance inspections and tests shall be carried out by the manufacturer, or under his responsibility.

The manufacturer is responsible for the quality of the nuts manufactured.

### 4.2 Qualification inspection and test conditions

Qualification inspections and tests (requirements, methods, numbers of nuts) are specified in Table 1. They shall be carried out on:

- each type and diameter of nut of strength classes greater than or equal to 1 550 MPa and/or of temperature classes greater than or equal to 650 °C;
- 75 nuts selected from a single inspection lot by simple random sampling.

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

The inspections and tests shall be repeated on any nut if the supplier or the manufacturing conditions have changed.

Qualification inspections and tests are summarized in Table 2.

### 4.3 Production acceptance inspection and test conditions

Production acceptance inspections and tests (requirements, methods, numbers of nuts) are specified in Table 1. They shall be carried out on each batch. Nuts from the batch to be tested shall be selected by simple random sampling.

Each nut may be submitted to several inspections or tests.

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

If a more stringent inspection is deemed necessary, all or part of the qualification inspections and tests may be performed during the production acceptance inspections and testing. This disposition applies to each nut, whatever its strength or temperature class. In this case, the number of nuts submitted to these inspections and tests is the same as that submitted for qualification inspections and tests.

Batches declared unacceptable after the production acceptance requirements shall be submitted for re-inspection only after all the defective units have been removed and/or defects have been corrected. In this case, the attribute(s) which caused the rejection shall be verified using a sample of twice the normal size with the same number of defective items acceptable.

Production acceptance inspections and tests are summarized in Table 2.

#### 4.4 Use of "Statistical process control (SPC)"

Where a characteristic is obtained by a controlled statistical process, the manufacturer has the possibility, in order to declare conformity of the characteristic, of refraining from the final systematic sampling provided for in this International Standard, if he is capable of **formally justifying** this choice by using ISO/TR 13425 and the standards quoted in it as a basis.

This justification will include the following phases:

- analysis of the product's key characteristics;
- analysis of the risks for each implemented process;
- determination of the parameters and/or characteristics to be respected under SPC;
- determination of the capabilities of each process;
- drawing up an inspection plan and integration in the manufacturing process;
- drawing up of routes and control charts (ISO 7966, ISO 7870, ISO 8258);
- use of control charts for data consolidation;
- determination of the audits to be run and the control to be carried out to ensure reliability of the device.

To be usable in production, this process should have been validated beforehand by the qualifying body, either during the qualification phase, or a posteriori according to the case, by analysing the justificatory file and the results of the qualification inspections such as provided for in clause 5.

## 5 Technical requirements

The technical requirements of this International Standard are given in Table 1.

They complement the requirements of all other standards or specifications referenced in the definition document of the nut.

**NOTE** The attention of the users of this International Standard is drawn to the fact that if there is no International Standard specifying the method to be used, a prior agreement is necessary between the user and the manufacturer with respect to the following inspections and tests:

- spectrographic analysis or spectroscopic analysis of the material (see 5.1.1);
- micrographic inspection of the structure of the material (see 5.1.2);
- inspection for carburization or decarburization (see 5.1.3);
- magnetoscopic inspection of surface for discontinuities (see 5.1.4);
- magnetic permeability inspection (see 5.1.6);
- inspection by chemical reagent to determine type of surface coating (see 5.2.2);
- tactile inspection or inspection using a profilometer to determine surface roughness (see 5.3.2).

Table 1 — Technical requirements

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.1	<b>Material</b>				
5.1.1	<b>Type</b>	The material shall be as specified in the definition document.	Spectrographic analysis or spectroscopic analysis (method to be agreed upon between the user and manufacturer).	Qualification <sup>a</sup>	3
5.1.2	<b>Microstructure</b>	Nuts shall be free from cracks. The inclusions shall not exceed the values when specified in the material standard.	Micrographic inspection of a transverse section (method to be agreed upon between the user and manufacturer)	Qualification <sup>a</sup>	5
5.1.3	<b>Carburization or decarburization<sup>b</sup></b>	No area of carburization and no area of total decarburization is permissible. An area of partial decarburization is permissible provided that the thickness over the area is less than or equal to 0,1 mm.	Microscopic examination (method to be agreed upon between the user and manufacturer) or Vickers microhardness measurement (using a 300 g load) in accordance with ISO 3887, or an equivalent method.	Qualification <sup>a</sup>	5
5.1.4	<b>Surface discontinuities<sup>c</sup></b>	The types of permissible surface discontinuity are given in annex A (normative). The maximum depth allowed for these discontinuities is given in Table 9.  Cracks are not permitted.	Magnetoscopic <sup>d</sup> (method to be agreed upon between the user and manufacturer) or penetrant inspection in accordance with ISO 3452.  In the event of any doubt arising as to the nature of the defects detected, inspect defective nuts at a magnification of × 10 after sectioning.	Qualification <sup>a</sup>	5
5.1.5	<b>Hardness</b>	The hardness of the finished nuts shall be within the limits specified in the definition document of the nut or the material standard.	See ISO 9140.	Qualification <sup>a</sup>	5
				Production acceptance	Table 8, column B
5.1.6	<b>Non-magnetism<sup>d</sup></b>	The magnetic permeability of the finished nuts shall be less than 2 (air = 1) in a magnetic field of 15 916 A/m.	Method to be agreed upon between the user and manufacturer	Qualification <sup>a</sup>	5

Table 1 (continued)

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.2	<b>Surface coating</b>				
5.2.1	<b>Presence</b>	Surface coating shall be applied at the locations specified in the definition document.	Visual examination	Qualification <sup>a</sup>	75
				Production acceptance	Tables 6 and 7
5.2.2	<b>Type <sup>e</sup></b>	Surface coating shall be as specified in the definition document.	Visual examination or inspection by chemical reagent in case of doubt (method to be agreed upon between the user and manufacturer)	Qualification <sup>a</sup>	3
				Production acceptance	Table 8, column A
5.2.3	<b>Thickness <sup>e</sup></b>	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 the event of any doubt, micrographic inspection in accordance with ISO 1463 <sup>f</sup> .	Qualification <sup>a</sup>	5
				Production acceptance	Table 8, column A
5.2.4	<b>Adhesion</b> <b>a) of molybdenum disulfide (MoS<sub>2</sub>)</b>  <b>b) of silver</b>	There shall be no sign of flaking, cracking or softening after test.	Heat the nuts to the maximum operating temperature specified in the definition document for 3 h, then cool the nuts slowly to ambient temperature.	Qualification <sup>a</sup>	5
		There shall be no sign of blisters or exfoliation after test.	Heat the nuts to the maximum operating temperature specified in the definition document for 4 h, then rapidly cool the nuts with compressed air (at a pressure of 0,3 MPa to 0,4 MPa) by means of a nozzle with a diameter of 1,5 mm held close to the surface of the nuts.		
5.2.5	<b>Corrosion resistance <sup>b</sup></b>	The surface coating specified in the definition document (protective treatment and, possibly, lubrication) shall ensure effective protection against corrosion.	Neutral salt spray (NSS) test in accordance with ISO 9227.  Exposure for 336 h without signs of iron rust.	Qualification <sup>a</sup>	8