INTERNATIONAL STANDARD

ISO 5858

Second edition
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Aerospace — Nuts, self-locking, with maximum operating temperature less than or equal to 425 °C — Procurement specification

Aéronautique et espace — Écrous à freinage interne dont la température maximale d'utilisation est inférieure ou égale 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. 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 5858 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 4, *Aerospace fastener systems.*

This second edition cancels and replaces the first edition (ISO 5858:1991), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Aerospace — Nuts, self-locking, with maximum operating temperature less than or equal to 425 °C — Procurement specification

1 Scope

This International Standard specifies the required characteristics for metric self-locking nuts, with MJ threads, for use in aerospace construction at a maximum temperature less than or equal to 425 °C.

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 691:1997, *Assembly tools for screws and nuts — Wrench and socket openings — Tolerances for general use.*

ISO 1463:1982, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method.*

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (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 5855-2:1999, *Aerospace — MJ threads — Part 2: Limit dimensions for bolts and nuts.*

ISO 7403:1998, *Aerospace — Spline drives — Wrenching configuration — Metric series.*

ISO 7481:—[1)], *Aerospace — Self-locking nuts with maximum operating temperature less than or equal to 425 °C — Test methods.*

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

ISO 7966:1993, *Acceptance control charts.*

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1) To be published. (Revision of ISO 7481:1984)

ISO 8258:1991, *Shewhart control charts.*

ISO 8788:—[2], *Aerospace — Nuts, metric — Tolerances of form and position.*

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

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

ISO/TR 13425:1995, *Guide for the 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, or 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)

2) To be published. (Revision of ISO 8788:1987)

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)][3].

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
acceptance quality limit
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
⟨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 12 corresponds to a consumer's risk of 10 %.

3) Supplementary information taken from ISO 2859-1.

3.15
self-locking torque
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 (two pitches minimum protrusion, including the end chamfer)

3.16
seating torque
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
untightening torque to be applied to the nut or bolt to reduce or remove the axial load in the assembly

3.18
breakaway torque
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
tightening and untightening torques which the driving feature of the nut has to withstand repeatedly without any permanent deformation which would prevent the appropriate wrench from being used or preclude re-use of the nut

4 Quality assurance

4.1 General

4.1.1 Manufacturer's approval

The manufacturer shall conform to the quality assurance and approval procedures defined by ISO 9002.

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 for a nut allow it to satisfy the requirements of this International Standard.

Qualification of the nuts 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;

— 100 nuts selected from a single batch 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 subjected 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. In this case, the number of nuts submitted is the same as that submitted for qualification inspections and tests.

Batches declared unacceptable after the production acceptance inspections and tests shall be submitted for re-inspection or testing 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 shall 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 for 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 for surface 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	**Material**				
5.1.1	**Type**	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 [a]	3
5.1.2	**Microstructure**	Nuts shall be free from cracks. The inclusions shall not exceed the values specified in the material standard, when specified therein.	Micrographic inspection of a transverse section (method to be agreed upon between the user and manufacturer).	Qualification [a]	5
5.1.3	**Carburization or decarburization** [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 [a]	5
5.1.4	**Surface discontinuities** [c]	The types of permissible surface discontinuity are given in normative annex A. The maximum depth allowed for these discontinuities is given in Table 14. Cracks are not permitted.	Magnetoscopic [b] (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 $\times 10$ after sectioning.	Qualification [a]	5
5.1.5	**Hardness**	The hardness of the finished nuts shall be within the limits specified in the definition document for the nut or in the material standard.	See ISO 7481.	Qualification [a] Production acceptance	5 Table 13, column B
5.1.6	**Non-magnetism** [d]	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 [a]	5

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.2	**Surface coating**				
5.2.1	**Presence**	Surface coating shall be applied at the locations specified in the definition document.	Visual examination.	Qualification [a]	100
				Production acceptance	Tables 11 and 12
5.2.2	**Type** [e]	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 [a]	3
				Production acceptance	Table 13, column A
5.2.3	**Thickness** [e]	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, micrographic inspection in accordance with ISO 1463 [f].	Qualification [a]	5
				Production acceptance	Table 13, column A
5.2.4	**Adhesion**			Qualification [a]	5
	a) of molybdenum disulfide (MoS_2)	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.		
	b) of silver	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	**Corrosion resistance** [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 corrosion.	Qualification [a]	8

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.3	**Surface condition**				
5.3.1	**Appearance**	Finished nuts shall be free from burrs and bumps.	Visual examination. 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 [a]	100
				Production acceptance	Tables 11 and 12
5.3.2	**Surface Roughness** [c]	The surface roughness of the nuts shall be as specified in the definition document.	See ISO 4288. Visual examination.	Qualification [a]	5
5.4	**Marking**	The nuts shall be marked as specified in the definition document.	Visual examination.	Qualification [a]	100
				Production acceptance	Tables 11 and 12
5.5	**Dimensions**				
5.5.1	**General dimensions**	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 [a]	20
				Production acceptance	Tables 11 and 12
5.5.2	**Thread**	The thread shall be in conformity with the definition document.		Qualification [a]	20
				Production acceptance	Tables 11and 12
		— Nuts with locking by plastic insert			
		The threaded GO gauge shall be capable of being freely screwed up to the locking device.	Threaded GO/NO GO gauges.		
		— All-metal self-locking nuts			
		The threaded GO gauge shall be capable of being freely screwed for at least one turn.	Threaded GO/NO GO gauges.		
		For nuts with molybdenum disulfide dry lubrication, a bolt with standard threads shall be capable of being freely screwed for at least one turn.	Bolt with standard threads in accordance with ISO 5855-2.		

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.5.3	**Wrench engagement** [g]	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 being 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 dimensional requirements: **a) Hexagonal and bihexagonal drive** Minimum tolerances specified in ISO 691. **b) Spline drive** Maximum material condition of female wrenching device in accordance with ISO 7403.	Qualification [a]	20
				Production acceptance	Tables 11 and 12
5.5.4	**Squareness of bearing surface**	Any out-of-squareness of the bearing surface, relative to the thread, shall be within the limits specified in ISO 8788.	See ISO 7481.	Qualification [a]	20
				Production acceptance	Tables 11 and 12
5.6	**Performance**				
5.6.1	**Axial load**	The finished nuts shall withstand the axial load specified for their tensile strength class, as laid down in the definition document.	See ISO 7481.	Qualification [a]	8
				Production acceptance	Table 13, column B
	a) 80 % test	The nuts shall not display: — any cracks; — any permanent set; — any significant reduction in their locking torque.	The load to be applied is specified in Table 3.		
	b) 100 % test	The nuts shall not display: — any cracks; — any fractures. Permanent set and resultant effects (reduction or dis-appearance of locking torque) are permissible.	The load to be applied is specified in Table 4 [h].		

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.6.2	**Wrenching feature** [i]	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 or spanner from being used.	See ISO 7481. The torque shall be as specified in Table 5 and shall be applied 15 times by alternately tightening and untightening the nut.	Qualification [a]	3
5.6.3	**Stress embrittlement** [j]	Heat treatment and surface treatment shall not cause any embrittlement that may prevent the nuts from withstanding continuously, without cracking or rupturing, the axial load specified for their tensile strength class, as laid down in the definition document.	See ISO 7481. The tightening torque applied shall be as specified in Table 6. The axial load shall be applied for 168 h.	Qualification [a]	3
5.6.4	**Torque-out** [k]	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 7481. The torque specified in Table 7 shall be applied in both directions.	Qualification [a]	3
5.6.5	**Non-rotation of captive washer**	During application of the seating torque, the washer shall not rotate on the bearing plate. The test is not applicable to nuts with a diameter < 4 mm. The test shall be carried out on one cycle only.	See ISO 7481. The squeeze torque applied shall be equal to $0{,}5 \times$ the value specified in Table 6. The seating torque applied shall be the torque specified in Table 6.	Qualification [a]	5

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.6.6	**Push-out** [l]	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 turn.	See ISO 7481. The load specified in Table 8 shall be applied.	Qualification [a]	3
5.6.7	**Locking**	The locking device shall enable: — the nuts to be re-used after several removal operations; — 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. 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.			
5.6.7.1	**Presence of locking element**		Visual examination	Qualification [a]	100
				Production acceptable	Tables 11 and 12

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.6.7.2	**Inspection of locking torque at ambient temperature**				
5.6.7.2.1	**Test over 15 cycles** [m]	The self-locking torque and breakaway torque shall lie within the maximum and minimum values specified in Table 9, columns a and d.	See ISO 7481. The tightening torque to be applied is specified in Table 6.	Qualification [a]	8
5.6.7.2.2	**Single-cycle test**	The self-locking torque and breakaway torque shall lie within the maximum and minimum values specified in Table 9, columns a and e.	See ISO 7481. The tightening torque to be applied is specified in Table 6.	Production acceptance	Table 13, column A
5.6.7.3	**Inspection of locking torques at ambient temperature, after exposure to maximum operating temperature**	After the nut has been exposed to the maximum operating temperature specified in the definition document for the nut, the locking torques, measured over three cycles, shall be within the maximum and minimum values specified in Table 9: — columns b and d for all-metal self-locking nuts; — columns c and d for nuts with locking by plastic insert.	See ISO 7481. The tightening torque to be applied is specified in Table 6.	Qualification [a]	8
5.6.7.4	**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 9, columns a and d.	See ISO 7481.	Qualification [a]	5

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.6.8	**Vibration** [n]	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 elements, fracture of threads, etc.) or any loss of their locking characteristics.	See ISO 7481. The tightening torque applied shall be equal to 0,5 × the value specified in Table 10. Half of the all-metal self-locking nuts to be tested (five) shall be exposed to the maximum operating temperature specified in the definition document before the tightening torque is applied for the first time. 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 [a]	10
5.6.9	**Sealing** [o]	Finished sealing nuts shall withstand a pressure of 0,35 MPa for 30 s without leakage.	Visual examination (method to be agreed upon between the user and manufacturer).	Qualification [a]	5
				Production acceptance	Tables 11 and 12
5.6.10	**Swaging** [p]	The shank of finished clinch nuts shall be capable of being flared using a 60° conical tool to 1,2 × its original diameter without cracking or fracturing.	Visual examination. In the event of any doubt as to the nature of the defects detected, inspect defective nuts at a magnification of ×10 after sectioning.	Qualification [a]	5
				Production acceptance	Table 13, column B
5.6.11	**Metallic cap**	The cap shall not separate from the nut when a bolt is gradually screwed up through the nut and penetrates the cap.	Visual examination	Qualification [a]	5
				Production acceptance	Table 13, column B

Table 1 *(continued)*

Subclause	Characteristic	Technical requirement	Inspection and test method	Test category	Sample size
5.7	**Delivery**				
5.7.1	**Packaging**	The nuts shall be packed so as to prevent damage and corrosion during handling, transportation and storage. Each primary package shall only contain nuts with the same part number and the same production lot number.	Visual examination	Qualification [a]	100 %
				Production acceptance	
5.7.2	**Labelling**	Each individual package shall have the manufacturer's name or trade mark, the complete part number, the quantity, the production lot number and the date of manufacture clearly shown on a label.	Visual examination	Qualification [a]	100 %
				Production acceptance	

[a] See clause 4 for applicability conditions.

[b] Inspections applicable only to nuts made of steel or steel alloy.

[c] Inspection to be carried out before coating of the surface or after removal of the surface coating.

[d] Inspection applicable only to nuts made of stainless steel.

[e] Inspection applicable only to electrolytic coatings (cadmium, silver, etc.).

[f] This inspection may be performed on nuts that have been subjected to the inspection of microstructure (see 5.1.2).

[g] Test applicable only to all-metal self-locking wrench nuts.

[h] For the qualification testing of all-metal self-locking nuts, the nuts shall be exposed for 6 h to the maximum operating temperature specified in the definition document before the load is applied.

[i] Test applicable only to wrench nuts.

[j] Test applicable only to nuts heat-treated to a hardness equal to or greater than 44 HRC.

[k] Test applicable only to floating-anchor nuts, gang channel nuts and fixed-anchor nuts, produced in several parts and assembled by brazing or clinching.

[l] Test applicable only to gang channel and anchor nuts, with the exception of corner nuts (see ISO 7481) and of reduced-series single-lug nuts.

[m] For all-metal self-locking nuts made of stainless steel with MoS_2-type dry-film lubrication, this test shall be carried out over five cycles in order to avoid any risk of seizing.

[n] Test applicable only to nuts of diameter 5 mm, 6 mm, 7 mm, 8 mm, 10 mm and 12 mm (see ISO 7481).

[o] Test applicable only to sealing nuts.

[p] Test applicable only to clinch nuts.

Table 2 — Summary of qualification and production acceptance inspections and tests

Characteristic	Qualification [a]	Production acceptance
	Subclause	
Material		
Type	5.1.1	
Microstructure	5.1.2	
Carburization or decarburization	5.1.3	
Surface discontinuities	5.1.4	
Hardness	5.1.5	5.1.5
Non-magnetism	5.1.6	
Surface coating		
Presence	5.2.1	5.2.1
Type	5.2.2	5.2.2
Thickness	5.2.3	5.2.3
Adhesion	5.2.4	
Corrosion resistance	5.2.5	
Surface condition		
Appearance	5.3.1	5.3.1
Roughness	5.3.2	
Marking	5.4	5.4
Dimensions		
General dimensions	5.5.1	5.5.1
Thread	5.5.2	5.5.2
Wrench engagement	5.5.3	5.5.3
Squareness of bearing surface	5.5.4	5.5.4
Performance		
Axial load	5.6.1	5.6.1
Wrenching feature	5.6.2	
Stress embrittlement	5.6.3	
Torque-out	5.6.4	
Non-rotation of captive washer	5.6.5	
Push-out	5.6.6	
Presence of locking element	5.6.7.1	5.6.7.1
Inspection of locking torque at ambient temperature		
— test over 15 cycles	5.6.7.2.1	
— single-cycle test		5.6.7.2.2
— after exposure to maximum operating temperature	5.6.7.3	
Permanent set	5.6.7.4	
Vibration	5.6.8	
Sealing	5.6.9	5.6.9
Swaging	5.6.10	5.6.10
Metallic cap	5.6.11	5.6.11
Delivery		
Packaging	5.7.1	5.7.1
Labelling	5.7.2	5.7.2

[a] See clause 4 for applicability conditions.

Table 3 — Loads to be applied in the 80 % axial-load test [see 5.6.1 a)]

Thread	Cross-sectional area, S, to be tested [a]	Load, F, [b] N					
		Tensile strength class, R_m, of the nut					
	mm^2	R_m = 450 MPa	R_m = 600 MPa	R_m = 900 MPa	R_m = 1 100 MPa	R_m = 1 250 MPa	R_m = 1 550 MPa
MJ3 × 0,5	5,439	2 000	2 600	3 900	4 800	5 400	6 700
MJ3,5 × 0,6	7,335	2 600	3 500	5 300	6 500	7 300	9 100
MJ4 × 0,7	9,517	3 400	4 600	6 900	8 400	9 500	11 800
MJ5 × 0,8	15,296	5 500	7 300	11 000	13 500	15 300	19 000
MJ6 × 1	21,753	7 800	10 400	15 700	19 100	21 800	27 000
MJ7 × 1	30,93	11 100	14 800	22 300	27 200	30 900	38 400
MJ8 × 1	41,682	15 000	20 000	30 000	36 700	41 700	51 700
MJ10 × 1,25	65,136	23 400	31 300	46 900	57 300	65 100	80 800
MJ12 × 1,25	97,128	35 000	46 600	69 900	85 500	97 100	120 400
MJ14 × 1,5	131,562	47 400	63 100	94 700	115 800	131 600	163 100
MJ16 × 1,5	175,613	63 200	84 300	126 400	154 500	175 600	217 800
MJ18 × 1,5	225,949	81 300	108 500	162 700	198 800	225 900	280 200
MJ20 × 1,5	282,571	101 700	135 600	203 500	248 700	282 600	350 400
MJ22 × 1,5	345,478	124 400	165 800	248 700	304 000	345 500	428 400
MJ24 × 2	401,68	144 600	192 800	289 200	353 500	401 700	498 100
MJ27 × 2	515,708	185 700	247 500	371 300	453 800	515 700	639 500
MJ30 × 2	643,877	231 800	309 100	463 600	566 600	643 900	798 400
MJ33 × 2	786,185	283 000	377 400	566 100	691 800	786 200	974 900
MJ36 × 2	942,632	339 300	452 500	678 700	829 500	942 600	1 168 900
MJ39 × 2	1 113,218	400 800	534 300	801 500	979 600	1 113 200	1 380 400

[a] See formula in informative annex B.

[b] Calculated using the formula: $F = R_m \times S \times 0,8$

Table 4 — Loads to be applied in the 100 % axial-load test [see 5.6.1 b)]

Thread	Cross-sectional area, S, to be tested [a]	Load, F, [b] N					
		Tensile strength class, R_m, of the nut					
	mm^2	R_m = 450 MPa	R_m = 600 MPa	R_m = 900 MPa	R_m = 1 100 MPa	R_m = 1 250 MPa	R_m = 1 550 MPa
MJ3 × 0,5	5,439	2 400	3 300	4 900	6 000	6 800	8 400
MJ3,5 × 0,6	7,335	3 300	4 400	6 600	8 100	9 200	11 400
MJ4 × 0,7	9,517	4 300	5 700	8 600	10 500	11 900	14 800
MJ5 × 0,8	15,296	6 900	9 200	13 800	16 800	19 100	23 700
MJ6 × 1	21,753	9 800	13 100	19 600	23 900	27 200	33 700
MJ7 × 1	30,93	13 900	18 600	27 800	34 000	38 700	47 900
MJ8 × 1	41,682	18 800	25 000	37 500	45 900	52 100	64 600
MJ10 × 1,25	65,136	29 300	39 100	58 600	71 600	81 400	101 000
MJ12 × 1,25	97,128	43 700	58 300	87 400	106 800	121 400	150 500
MJ14 × 1,5	131,562	59 200	78 900	118 400	144 700	164 500	203 900
MJ16 × 1,5	175,613	79 000	105 400	158 100	193 200	219 500	272 200
MJ18 × 1,5	225,949	101 700	135 600	203 400	248 500	282 400	350 200
MJ20 × 1,5	282,571	127 200	169 500	254 300	310 800	353 200	438 000
MJ22 × 1,5	345,478	155 500	207 300	310 900	380 000	431 800	535 500
MJ24 × 2	401,68	180 800	241 000	361 500	441 800	502 100	622 600
MJ27 × 2	515,708	232 100	309 400	464 100	567 300	644 600	799 300
MJ30 × 2	643,877	289 700	386 300	579 500	708 300	804 800	998 000
MJ33 × 2	786,185	353 800	471 700	707 600	864 800	982 700	1 218 600
MJ36 × 2	942,632	424 200	565 600	848 400	1 036 900	1 178 300	1 461 100
MJ39 × 2	1 113,218	500 900	667 900	1 001 900	1 224 500	1 391 500	1 725 500

[a] See formula in informative annex B.

[b] Calculated using the formula: $F = R_m \times S$

Table 5 — Torques to be applied for testing the wrenching feature (see 5.6.2)

Nominal thread diameter	Torque N·m					
	Tensile strength class of the nut					
mm	450 MPa	600 MPa	900 MPa	1 100 MPa	1 250 MPa	1 550 MPa
3	0,6	0,9	1,3	1,7	1,9	2,2
3,5	1	1,3	2	2,4	2,8	3,3
4	1,3	1,7	2,6	3,2	3,6	4,5
5	2,7	3,6	5,5	6,7	7,6	9,5
6	5,6	7,5	11,3	13,8	15,7	19,5
7	11	14,7	22	27	30,6	38
8	16,4	21,9	32,8	40	45,5	56,6
10	26	34,6	52	63,5	72	89,5
12	43	57	86	105	120	148
14	65	87	130	159	180	225
16	87	116	177	214	243	300
18	121	162	243	297	337	420
20	173	230	345	422	480	595
22	240	320	480	587	666	825
24	297	395	595	725	825	1 025
27	384	510	768	940	1 067	1 325
30	480	640	960	1 175	1 335	1 650
33	575	765	1 150	1 400	1 600	1 980
36	665	885	1 335	1 630	1 850	2 290
39	760	1 010	1 520	1 860	2 110	2 615

Table 6 — Tightening torques to be applied for the stress embrittlement test (see 5.6.3) **and for measuring locking torques** (see 5.6.7.2.1, 5.6.7.2.2 and 5.6.7.3)

Nominal thread diameter	Torque N·m Tensile strength class of the nut					
mm	450 MPa	600 MPa	900 MPa	1 100 MPa	1 250 MPa	1 550 MPa
3	0,5	0,7	1	1,2	1,4	1,7
3,5	0,7	1	1,5	1,8	2,1	2,5
4	1	1,3	2	2,4	2,8	3,4
5	1,9	2,6	3,9	4,7	5,4	6,7
6	4,5	6	9	11	12,5	15,5
7	8,1	10,8	16,4	20	22	28
8	11,9	15,8	23,7	29	33	41
10	21,6	28,6	43	53	60	74
12	36	48	72	88	100	125
14	48	64	97	118	135	167
16	63	84	126	154	175	217
18	85	113	170	208	236	293
20	130	173	260	318	360	448
22	177	236	355	434	493	611
24	220	293	440	538	610	758
27	287	383	575	703	800	990
30	355	473	710	868	986	1 225
33	430	575	860	1 050	1 200	1 490
36	500	665	1 000	1 225	1 390	1 725
39	570	760	1 140	1 400	1 585	1 970

Table 7 — Torques to be applied in the torque-out test (see 5.6.4)

Nominal thread diameter	Torque to be applied according to the material of the nut N·m	
	Nut made of steel, alloy steel or stainless steel	Nut comprising a cage or assembled with a gang channel made of aluminium alloy
3	3	2,4
3,5	4	3,2
4	6	4,8
5	9	7,2
6	13	10,4
7	18	14,4
8	23	18,4
10	38	30,4

Table 8 — Loads to be applied in the push-out test (see 5.6.6)

Nominal thread diameter mm	Load N
3	200
3,5	270
4	360
5	460
6	570
7	
8	
10	

Table 9 — Locking torques (see 5.6.7)

Nominal thread diameter mm	Locking torque N·m				
	max. [a]	max. [b]	max. [c]	min. [d]	min. [e]
3	0,75	1,5	1,12	0,1	0,2
3,5	0,9	1,8	1,35	0,11	0,22
4	1,2	2,4	1,8	0,15	0,3
5	2	4	3	0,25	0,5
6	3,2	6,4	4,8	0,35	0,7
7	4,6	9,2	6,9	0,5	1
8	6	12	9	0,7	1,4
10	9,5	19	14,25	1,2	2,4
12	15	30	22,5	1,8	3,6
14	22	44	33	2,6	5,2
16	33	66	49,5	3,7	7,4
18	44	88	66	4,9	9,8
20	50	100	75	6,3	12,6
22	65	130	97,5	7,5	15
24	75	150	112,5	9,3	18,6
27	95	190	142,5	11,4	22,8
30	110	220	165	14	28
33	120	240	180	16	32
36	136	272	204	19	38
39	157	314	235,5	21	42

[a] Maximum values for test at ambient temperature:
- over 15 cycles (see 5.6.7.2.1);
- single cycle (see 5.6.7.2.2);
- for permanent set (see 5.6.7.4).

[b] Maximum values for the test at ambient temperature after exposure to the maximum operating temperature for all-metal self-locking nuts (see 5.6.7.3).

[c] Maximum values for the test at ambient temperature after exposure to the maximum operating temperature for nuts with locking by plastic insert (see 5.6.7.3).

[d] Minimum values for the test at ambient temperature:
- over 15 cycles (see 5.6.7.2.1);
- after exposure to the maximum operating temperature (see 5.6.7.3);
- for permanent set (see 5.6.7.4).

[e] Minimum values for the single-cycle test at ambient temperature (see 5.6.7.2.2).

Table 10 — Tightening torques to be applied in the vibration test (see 5.6.8)

Nominal thread diameter mm	Torque N·m
5	4
6	6,4
7	9,2
8	12
10	19
12	30

Table 11 — Classification of visual and dimensional inspections

Category	Acceptance quality limit (AQL) [a]	Characteristics
Critical	1 %	Presence of locking element Thread size Appearance Presence of surface coating Sealing
Major	2,5 %	Dimensions affecting interchangeability: — overall height; — across flats; — diameter of flange; — length and width of plate; — diameter and position of rivet holes; — dimensions and position of counterbore. Marking
Minor	4 %	All other dimensions, and deviations in tolerances on shape or position

[a] The acceptance quality limit (AQL) specified in this table is used to select, from Table 12, the sampling plan to be applied according to the characteristics to be inspected and the batch size.

Table 12 — Sampling plans for visual and dimensional inspections and sealing test

Batch size	Sample size	Acceptance number (Ac) [a] and limiting quality (LQ) in accordance with the acceptance quality limit (AQL)					
		AQL 1 %		AQL 2,5 %		AQL 4 %	
		Ac	LQ_{10} %	Ac	LQ_{10} %	Ac	LQ_{10} %
2 to 8	2	↓	↓	↓	↓	↓	↓
9 to 15	3	↓	↓	↓	↓	0	53,6
16 to 25	5	↓	↓	0	36,9	↑	↑
26 to 50	8	↓	↓	↑	↑	↓	↓
51 to 90	13	0	16,2	↓	↓	1	26,8
91 to 150	20	↑	↑	1	18,1	2	24,5
151 to 280	32	↓	↓	2	15,8	3	19,7
281 to 500	50	1	7,56	3	12,9	5	17,8
501 to 1 200	80	2	6,52	5	11,3	7	14,3
1 201 to 3 200	125	3	5,27	7	9,24	10	12,1
3 201 to 10 000	200	5	4,59	10	7,60	14	9,91
10 001 to 35 000	315	7	3,71	14	6,33	21	8,84
35 001 to 150 000	500	10	3,06	21	5,60	↑	↑
⩾ 150 001	800	14	2,51	↑	↑	↑	↑

↑ Use sampling plan above.

↓ Use sampling plan below.

NOTE The data given in this table are based on single sampling plans for a normal inspection, as specified in ISO 2859-1:1999, Tables 2-A and 6-A. A 100 % inspection should be performed when the sample size is as large as or larger than the batch size.

Other sampling plans specified in ISO 2859-1 may be used (double or multiple sampling), but these shall be chosen in such a way as to ensure an equivalent quality level.

As regards those manufacturers who carry out an inspection during the manufacturing process (inspection on a machine and/or inspection between operations), the sampling plan for the final inspection shall be compiled in such a way that the overall inspection plan will guarantee an equivalent quality level.

[a] See 3.11.

Table 13 — Sampling plans for the inspection of mechanical and metallurgical characteristics

Batch size	Sample size		Acceptance number [a] (Ac)
	Non-destructive tests A	Destructive tests B	
⩽ 500	8	3	0
501 to 3 200	13	5	0
3 201 to 35 000	20	5	0
⩾ 35 001	32	8	0

[a] See 3.11.

Table 14 — Maximum depth of permissible surface discontinuities (see 5.1.4)

Dimensions in millimetres

Nominal thread diameter	Depth [a]
3	0,1
3,5	0,12
4	
5	
6	0,13
7	
8	0,15
10	
12	0,2
14	0,22
16	0,25
18	
20	
22	
24	0,3
27	
30	
33	
36	
39	

[a] These values do not apply to unmachined surfaces of semi-products for machined nuts for which 0,04 mm per 1,6 mm of diameter or across flats of semi-product is permissible.

EXAMPLE

For a hexagonal nut manufactured from bars with an across-flat dimension of 8 mm, the maximum depth of permissible surface discontinuities, in millimetres, will be:

$$0{,}04 \times \frac{8}{1{,}6} = 0{,}2$$

Annex A
(normative)

Types of permissible surface discontinuity (see 5.1.4)

The following surface discontinuities are permissible:

— laps or seams produced in the drawing process and seams produced in the machining process (a);

— laps produced in the stamping process (b);

— seams produced in the clinching process (c);

— marks caused by the forming tool used to ensure internal locking (d).

The location and appearance of these discontinuities are illustrated in Figure A.1.

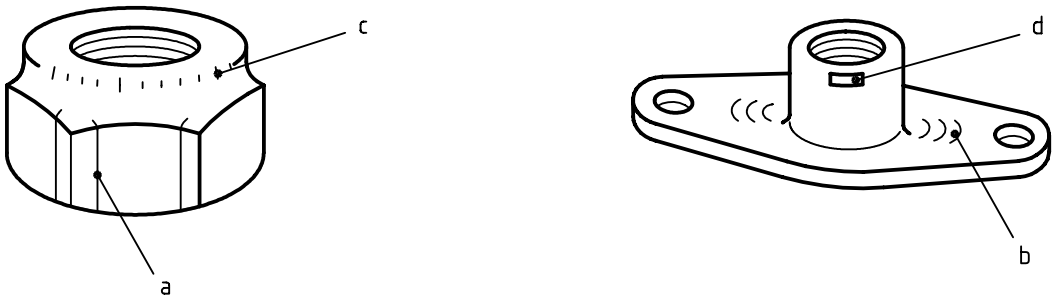

Figure A.1

These discontinuities shall not

— result in any abrupt change in area;

— be located within the self-locking zone (apart from c or d);

— be deeper than those values specified in Table 14.

Annex B
(informative)

Cross-sectional area formula (see Tables 3 and 4)

The cross-sectional area taken into consideration to calculate the axial load to be applied to a nut is the same as that of the bolt with an identical diameter and pitch.

The formula for this cross-sectional area is the following:

$$S = \frac{\pi}{4}\left(d_3\right)^2\left[2 - \left(\frac{d_3}{d_2}\right)^2\right]$$

where

S is the cross-sectional area, in square millimetres (mm^2);

d_2 is the maximum thread flank diameter of the bolt in accordance with ISO 5855-2, in millimetres (mm);

d_3 is the maximum root diameter of the bolt in accordance with ISO 5855-2, in millimetres (mm).

ICS 49.030.30

Price based on 26 pages