
**Aerospace — Nuts, self-locking, with
maximum operating temperature
less than or equal to 425 °C — Test
methods**

*Aéronautique et espace — Erous à freinage interne dont la
température maximale d'utilisation est inférieure ou égale à 425 °C
— Méthodes de contrôle et d'essai*

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Contents

	Page
Foreword.....	iv
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Inspections and tests.....	1
4.1 Hardness test.....	1
4.1.1 Procedure.....	1
4.1.2 Method.....	2
4.2 Bearing surface squareness test.....	2
4.2.1 Test device.....	2
4.2.2 Method.....	3
4.3 Axial load test.....	4
4.3.1 Test device.....	4
4.3.2 Method.....	4
4.4 Wrenching feature test.....	6
4.4.1 General.....	6
4.4.2 Test device.....	6
4.4.3 Method.....	7
4.5 Stress embrittlement test.....	7
4.5.1 General.....	7
4.5.2 Test device.....	7
4.5.3 Method.....	7
4.6 Torque-out test.....	8
4.6.1 General.....	8
4.6.2 Test device.....	9
4.6.3 Method.....	9
4.7 Test of no rotation of the captive washer.....	9
4.7.1 General.....	9
4.7.2 Test device.....	10
4.7.3 Method.....	10
4.8 Push-out test.....	10
4.8.1 General.....	10
4.8.2 Test device.....	10
4.8.3 Method.....	11
4.9 Self-locking torque at ambient temperature.....	12
4.9.1 Test device.....	12
4.9.2 Method.....	12
4.10 Self-locking torque at ambient temperature after heat soak at maximum operating temperature.....	14
4.10.1 Test device.....	14
4.10.2 Method.....	14
4.11 Permanent set test.....	15
4.11.1 General.....	15
4.11.2 Test device.....	15
4.11.3 Method.....	15
4.12 Vibration test.....	16
4.12.1 General.....	16
4.12.2 Test device.....	16
4.12.3 Method.....	18

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 7481:2000), which has been technically revised.

The main changes are as follows:

- normative references have been updated and changed to undated;
- [Table 4](#) title error corrected;
- [Table 5](#) has been corrected;
- the footnote in [Table 5](#) has been added;
- the document has been editorially updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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

1 Scope

This document specifies test methods for metric self-locking nuts with MJ threads intended for use in aerospace construction at maximum operating temperatures less than or equal to 425 °C. It describes the test device and the method for each test.

It applies to self-locking nuts as defined above, provided that the relevant documents (dimensional standard, drawing, procurement specification, etc.) refer to this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

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

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Inspections and tests

4.1 Hardness test

4.1.1 Procedure

The choice depends on the configuration of the nut and available equipment. The authorized procedures shall meet the following requirements:

- Rockwell hardness in accordance with ISO 6508-1;
- Vickers hardness HV 5 to HV 100 in accordance with ISO 6507-1;
- Rockwell superficial hardness in accordance with ISO 6508-1;

— microhardness.

4.1.2 Method

This test shall be carried out at ambient temperature.

The measurement zone (bearing surface, across flats, underside of anchor nut lugs, etc.) shall correspond to the following conditions:

- a) thickness at least equal to 10 times the penetration depth;
- b) parallelism with respect to bearing surface not greater than 3°.

Should this not be possible, carry out this test on a cut section after moulding the nut into thermosetting resin.

Remove all possible coating (protection, lubrication, paint, etc.) in the measurement zone. Align the bearing surface to obtain the required relationship. These two operations shall not generate any heat liable to modify the characteristics of the material constituting the nut being tested.

Carry out the test and then check conformity with the requirements of the dimensional standard or drawing.

Nuts subjected to this test shall not be used again.

4.2 Bearing surface squareness test

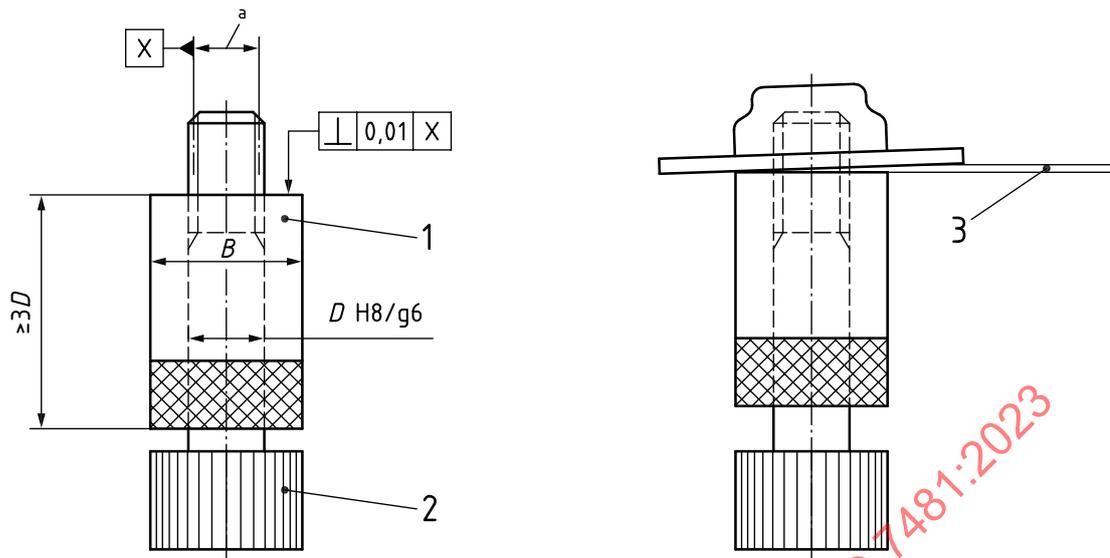
4.2.1 Test device

The test device is illustrated in [Figure 1](#).

The test device shall include the following elements:

- a) a threaded mandrel with end in accordance with ISO 5855-2, with the exception of the pitch diameter, which shall be in accordance with the values specified in [Table 5](#) for the maximum mandrel;
- b) a collar sliding on the plain portion of the threaded mandrel whose external diameter B is at least equal to reference dimension A for type I, II and V nuts in [Figure 2](#) and equal to reference dimension A for type III and IV nuts in [Figure 2](#);
- c) an appropriate feeler gauge.

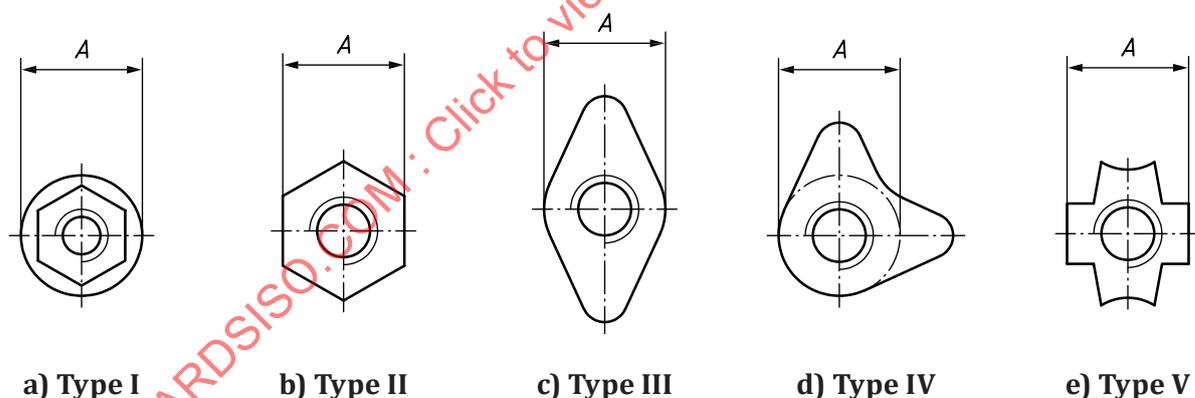
For clinch nuts, the sliding collar shall have a counterbore to accommodate the shank.



Key

- 1 sliding collar
- 2 threaded mandrel
- 3 feeler gauge
- ^a Pitch diameter.

Figure 1 — Test device bearing surface squareness



NOTE Types I and II are wrench nuts and clinch nuts. Types III and IV are fixed anchor nuts. Type V are floating anchor nuts and gang channel nuts.

Figure 2 — Types of internally threaded fasteners

4.2.2 Method

The test shall be carried out at ambient temperature.

For floating nuts, extract the nut from the cage or channel.

Lubricate the mandrel and nut (or threaded part) threads as stated in [Table 1](#) (if necessary). Screw, with or without a wrench, the threaded mandrel into the nut or threaded part up to a minimum engagement of three turns.

Move the collar into contact with the bearing surface.

Evaluate the out-of-squareness by means of a feeler gauge whose thickness corresponds to the permissible squareness error permitted by the dimensional standard, the drawing or the procurement specification.

4.3 Axial load test

4.3.1 Test device

The test device is illustrated in [Figure 3](#).

The test device includes the following elements:

- a) a bearing plate in steel, heat-treated to a hardness ≥ 40 HRC;
- b) a conical washer (for testing countersunk nuts);
- c) a bolt with characteristics as follows:
 - 1) threads: in accordance with ISO 5855-2;
 - 2) tensile strength class: greater than that of the nut under test;
 - 3) material and coating: no specific requirement.

4.3.2 Method

4.3.2.1 General

The axial load is transmitted to the nut by the bolt, the nut resting on the bearing plate. For countersunk nuts, a conical washer is interposed.

4.3.2.2 80 % test

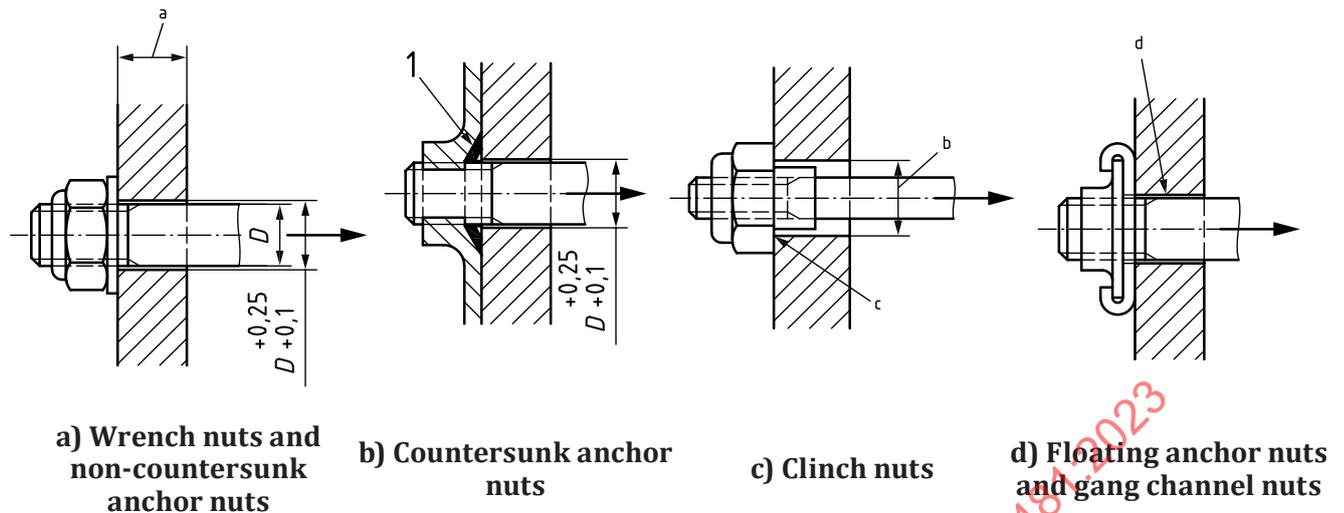
This test shall be carried out at ambient temperature.

Lubricate the bolt and nut threads as stated in [Table 1](#) (if necessary). Assemble the bearing plate and, if used in conjunction with the nut, the conical washer onto the bolt. Assemble the nut and measure the locking torque when the protrusion is two pitches minimum (including chamfer).

Position the assembly on the tensile machine. Apply the load slowly and progressively. Reduce the load slowly and progressively when the value quoted in the procurement specification has been reached.

Remove the assembly from the tensile machine. Unscrew the nut a half-turn and cease movement, then again unscrew and measure the breakaway torque.

Remove the nut, then submit it to a visual examination and, if necessary, an examination at a magnification of $\times 10$ after sectioning, to check conformity with the requirements of the procurement specification.



Key

- 1 washer to fit countersink
- a Thickness $\geq D$.
- b Maximum shank diameter $\begin{matrix} +0,25 \\ +0,10 \end{matrix}$.
- c Chamfer to suit the nut radius.
- d The hole shall allow the specified float.

Figure 3 — Test set-up axial load test

Table 1 — Test bolt and lubrication, example

Locking	Nut to be tested		Test bolt		Additional lubrication
	Material	Coating	Material	Coating	
Plastic insert	Any	Any	Alloy steel	Cadmium	None
Metallic	Steel or alloy steel	Any	Alloy steel	Cadmium	None
	Stainless steel	Silver or MoS ₂	Stainless steel	None	Synthetic oil
		None	Stainless steel	Silver	

4.3.2.3 100 % test

This test shall be carried out at ambient temperature.

If the test includes a heat soak, then heat the nut and maintain it at the temperature quoted in the procurement specification. Take the nut from the oven and allow it to cool slowly to ambient temperature, then proceed as follows.

Lubricate the bolt and nut threads as specified in [Table 1](#) (if necessary), assemble the bearing plate and, if required, the conical washer, onto the bolt. Assemble the nut with a protrusion of two bolt pitches minimum (including chamfer).

Position the assembly on the tensile machine and apply the load slowly and progressively. Reduce the load slowly and progressively when the value quoted in the procurement specification has been reached.

Remove the assembly from the tensile machine. Remove the nut, then submit it to a visual examination and, if necessary, an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.

4.4 Wrenching feature test

4.4.1 General

This test applies only to wrenchable nuts.

4.4.2 Test device

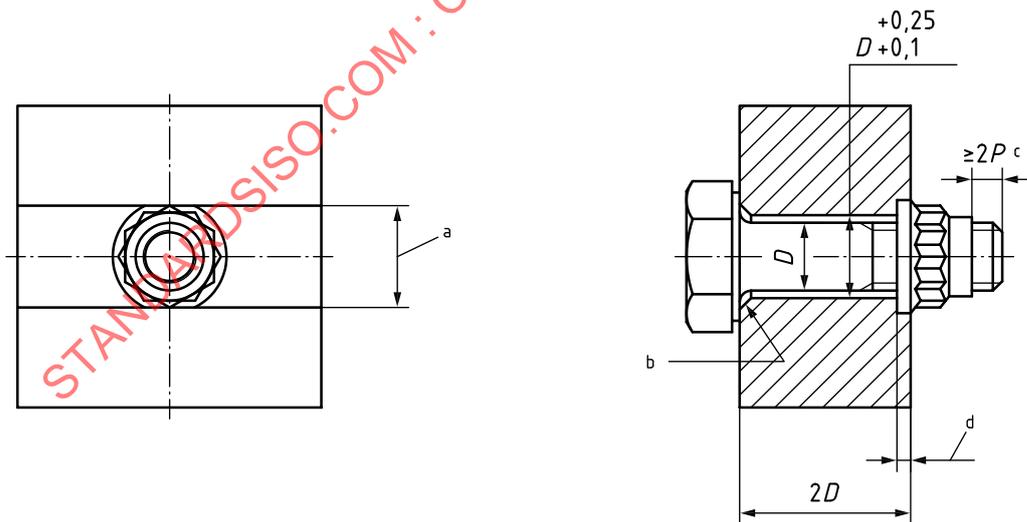
The test device is illustrated in [Figure 4](#).

The test device includes the following elements:

- a) a block of steel, heat-treated to a hardness of ≥ 40 HRC;
- b) a bolt with characteristics as follows:
 - 1) threads: in accordance with ISO 5855-2;
 - 2) tensile strength class: no specific requirement;
 - 3) material and coating: no specific requirement.

NOTE Any other device which prevents the rotation of the nut and allows the specified torque to be applied is acceptable. For instance:

- nut welded on a block of the same material, the assembly being heat-treated to the correct level;
- nuts mounted in counter-rotation on a threaded rod of strength class appropriate to hold the required torques without deformation;
- nut mounted on a bolt of strength class appropriate to hold the required torques without deformation as a spacer is placed between the nut and the bolt head.



- a Width of slot equal to diameter of circle circumscribing the wrenching feature.
- b Chamfer to suit underhead radius.
- c Including chamfer, where P is the pitch.
- d Depth of slot equal to flange height of nut under test.

Figure 4 — Test set-up for wrenching feature test

4.4.3 Method

This test shall be carried out at ambient temperature.

Make two flats on the flange of the nut so that it has a clearance of 0,05 mm to 0,1 mm inside the slot, then lubricate the bolt and nut threads as specified in [Table 1](#) (if necessary). Insert the modified nut into the slot. Assemble the bolt and moderately tighten it, then assemble the block into a vice.

Repeat the following operations the number of times specified in the procurement specification:

Apply the torque to the nut, in a tightening movement, as quoted in the procurement specification, with the aid of a socket wrench with an opening tolerance in accordance with ISO 691 or ISO 7403. Remove, then replace the socket wrench. Apply the same torque to the nut in an untightening direction.

Finally, dismantle the assembly, then submit the nut to a visual examination and, if necessary, to an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.

4.5 Stress embrittlement test

4.5.1 General

This test applies only to nuts heat-treated to a hardness ≥ 44 HRC, unless otherwise stated in the procurement specification or definition document.

4.5.2 Test device

The test device is illustrated in [Figure 5](#).

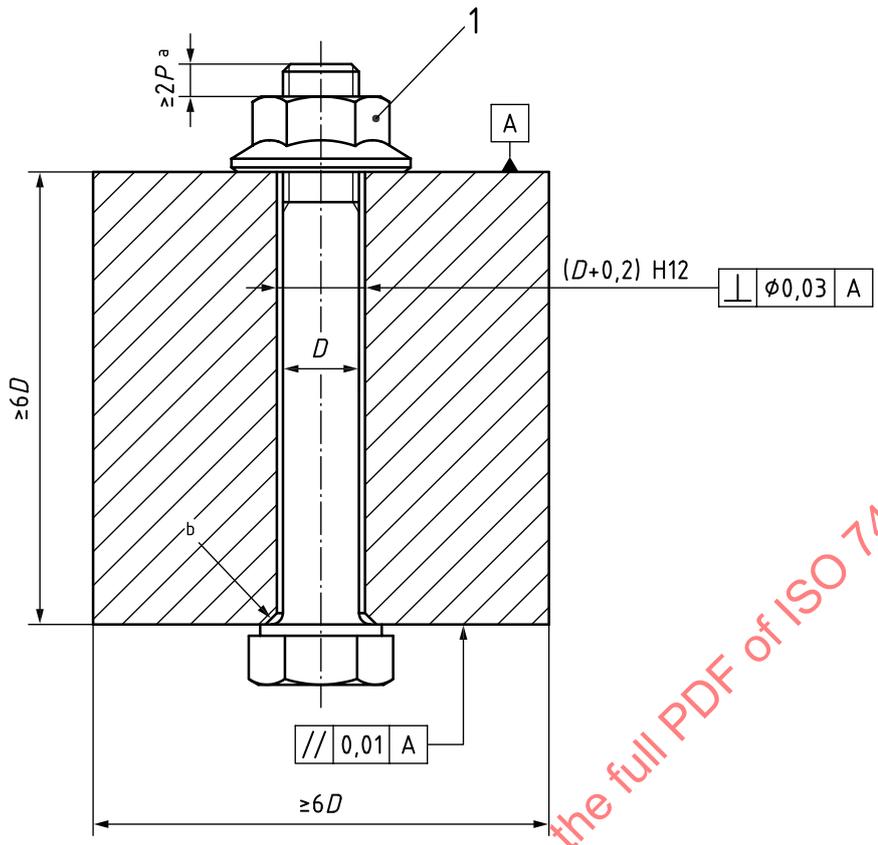
The test device includes the following elements:

- a) a block with parallel faces in steel, heat-treated to a hardness ≥ 40 HRC;
- b) a bolt with the following characteristics:
 - 1) thread: in accordance with ISO 5855-2;
 - 2) tensile strength requirement greater than that of the nut under test;
 - 3) material and coating: no specific requirement.

4.5.3 Method

This test shall be carried out at ambient temperature.

Hold the bolt by the head, lubricate the bolt and nut threads as specified in [Table 1](#) (if necessary), assemble the block and assemble the nut to be tested.



Key

- 1 nut under test
- a Including chamfer, where P is the pitch.
- b Chamfer to suit underhead radius.

Figure 5 — Test set-up for stress embrittlement test

Tighten the nut to the torque quoted in the procurement specification with the aid of a socket wrench in accordance with ISO 691 or ISO 7403. Keep the nut under axial tension for the period quoted in the procurement specification.

At the end of this period, dismantle the assembly, then submit the nut to a visual examination and, if necessary, to an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.

4.6 Torque-out test

4.6.1 General

This test applies only to nuts made from more than one part, either by design (floating anchor nuts or gang channel nuts) or by the needs of manufacture (fixed anchor nuts whose body is assembled to the baseplate by brazing or clinching).

It aims to check that the retention device can resist rotation of the threaded portion during tightening and untightening.

4.6.2 Test device

The test device is illustrated in [Figure 6](#) and its dimensions are given in [Table 2](#). The test device includes the following elements:

- a) a fixing plate;
- b) a shouldered mandrel threaded in accordance with ISO 5855-2 (a shouldered sleeve mounted on a bolt may also be used);
- c) a locknut threaded in accordance with ISO 5855-2;
- d) rivets or bolts to fix the nut (no specific requirement).

4.6.3 Method

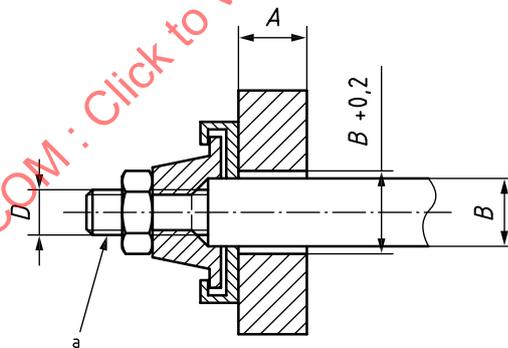
This test shall be carried out at ambient temperature.

Attach the nut or portion of channel to be tested on the plate by means of rivets or bolts. Lubricate the mandrel and nut threads as specified in [Table 1](#) (if necessary). Screw in the mandrel so that the shoulder contacts the body of the nut (on bearing surface or bottom of counterbore). Apply the torque to the nut, in a tightening movement, as quoted in the procurement specification.

Assemble the locknut and apply to it the same torque in the reverse direction.

Dismantle the assembly, then submit the nut as well as the cage or the channel to a visual examination and, if necessary, to an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.



- a Threaded length: $\approx 3D$.

Figure 6 — Test set-up for torque-out test

4.7 Test of no rotation of the captive washer

4.7.1 General

This test applies only to nuts with captive washer.

Table 2 — Dimensions of the device for torque-out test

Dimensions in millimetres

<i>D</i>	3	3,5	4	5	6	7	8	10
<i>A</i> min.	6	6	8	8	8	14	14	14
$B_{-0,05}^0$	3,4	3,9	4,4	5,5	6,5	7,5	8,5	10,5

4.7.2 Test device

The test device includes the following elements:

- a) a bearing plate in usual sheet (light alloy with anodizing, $Ra \leq 0,8 \mu\text{m}$ on the nut side), minimum thickness 2 mm;
- b) a spacer in steel (to compensate the bolt shank length excess);
- c) a bolt with characteristics as follows:
 - 1) threads: in accordance with ISO 5855-2;
 - 2) tensile strength class: at least equal to that of the nut to be tested;
 - 3) length between $1,5D$ and $3D$.

4.7.3 Method

The test shall be carried out at ambient temperature.

Apply the installation torque to the nut to be tested as quoted in the procurement specification. Mark the washer position and apply a seating torque double to the torque applied for squeeze torque to the nut to be tested.

The bearing plate shall be replaced for each test.

The test bolt may be reused several times if its threads do not have seams or traces of wear or seizing. During application of the seating torque, the washer shall not rotate on the bearing plate.

4.8 Push-out test

4.8.1 General

This test applies only to gang channel nuts and anchor nuts, with the exception of corner nuts shown in [Figure 7](#) and reduced series single lug nuts.

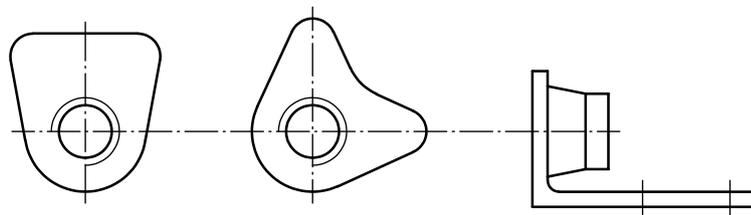
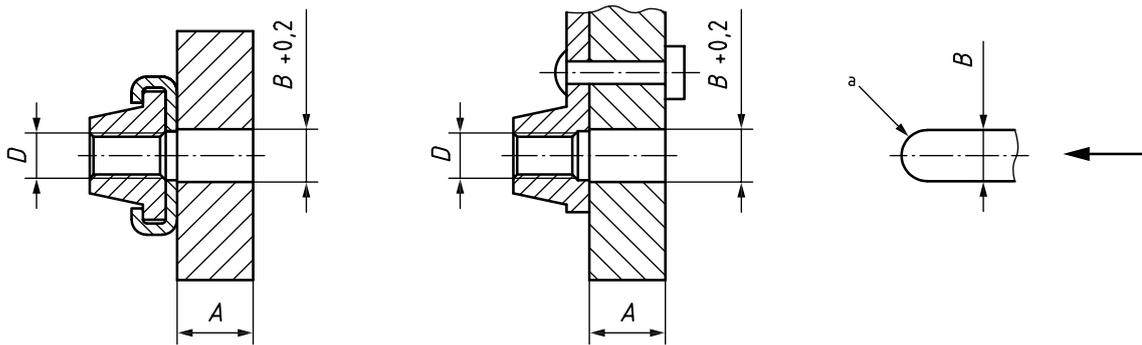


Figure 7 — Plate nuts, corner type

4.8.2 Test device

The test device is illustrated in [Figure 8](#) and its dimensions are given in [Table 3](#).



a Sphere with diameter B .

Figure 8 — Test device for push-out test

Table 3 — Dimensions of the device for push-out test

Dimensions in millimetres

D	3	3,5	4	5	6	7	8	10
A min.	6	6	8	8	8	14	14	14
$B_{-0,05}^0$	3,4	3,9	4,4	5,5	6,5	7,5	8,5	10,5

The test device includes the following elements:

- a) a fixing plate;
- b) a push rod with spherical end;
- c) a bolt with the following characteristics:
 - 1) thread: in accordance with ISO 5855-2;
 - 2) tensile strength class: no specific requirement;
 - 3) material coating: no specific requirement;
- d) rivets or bolts to fix the nut (no specific requirement).

4.8.3 Method

This test shall be carried out at ambient temperature.

Attach the nut or the portion of channel to be inspected onto the plate by means of rivets or bolts. Apply the axial load quoted in the procurement specification using the rod with the spherical end.

Ensure that any permanent deformation is not greater than the value allowed in the procurement specification using an appropriate feeler gauge.

Try to screw a standard bolt manually into the nut, even if deformed, as far as the locking device.

Dismantle, then subject the nut as well as the cage and the channel to a visual examination and, if necessary, examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.

4.9 Self-locking torque at ambient temperature

4.9.1 Test device

The test device is illustrated in [Figure 9](#).

The test device includes the following elements:

- a) a steel spacer heat treated to a hardness ≥ 40 HRC (this may be a cylindrical sleeve or a block with parallel faces pierced with a series of holes);
- b) a bolt with the following characteristics:
 - 1) for the single cycle test:
 - i) thread: in accordance with ISO 5855-2, with the exception of the pitch diameter, whose minimum and maximum dimensions are given in [Table 4](#);
 - ii) tensile strength class: greater than or equal to that of the nut under test;
 - iii) material: non-coated alloy steel;
 - 2) for the multiple cycle test:
 - i) thread: in accordance with ISO 5855-2;
 - ii) tensile strength class: identical to that of the nut under test;
 - iii) material and coating: in accordance with [Table 1](#).

4.9.2 Method

4.9.2.1 General

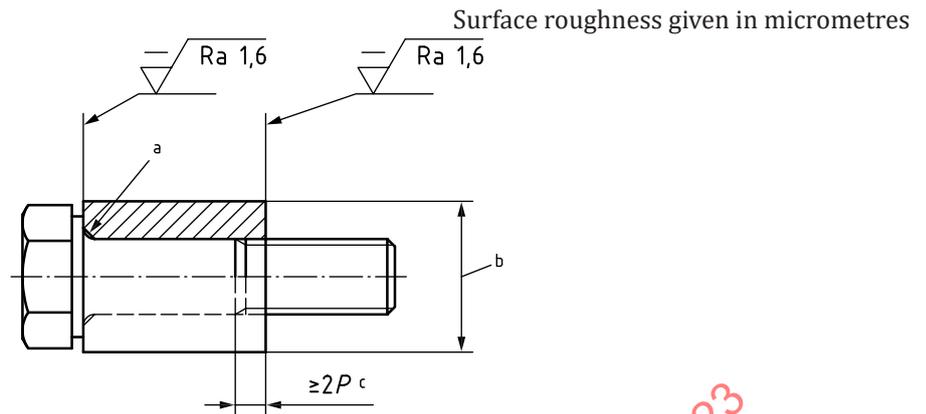
This test shall be carried out at ambient temperature. During the test, the nut temperature shall not exceed 45 °C.

4.9.2.2 Single cycle test

Lubricate the nut and bolt threads as stated in [Table 1](#) (if necessary), then assemble the nut to the bolt after having added the spacer. Measure the self-locking torque when the protrusion is two pitches minimum (including chamfer). Apply the seating torque quoted in the procurement specification.

Remove the load by unscrewing a half turn and cease movement. Again, unscrew and measure the breakaway torque.

Dismantle the assembly, then submit the bolt and nut to a visual examination and, if necessary, to an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.



- a Chamfer to suit underhead radius.
- b > bearing surface of nut.
- c P is the pitch.

Figure 9 — Test set-up for self-locking torque test

Table 4 — Bolt dimensions for self-locking torque at ambient temperature (single cycle test)

Dimensions in millimetres

Thread $d \times P$	Pitch diameter d_2	
	max.	min.
3 × 0,5	2,651	2,627
3,5 × 0,6	3,084	3,057
4 × 0,7	3,517	3,489
5 × 0,8	4,45	4,42
6 × 1	5,315	5,279
7 × 1	6,315	6,279
8 × 1	7,315	7,279
10 × 1,25	9,151	9,113
12 × 1,25	11,146	11,103
14 × 1,5	12,981	12,936
16 × 1,5	14,981	14,936
18 × 1,5	16,981	16,936
20 × 1,5	18,981	18,936
22 × 1,5	20,981	20,936
24 × 2	22,648	22,595
27 × 2	25,648	25,595
30 × 2	28,648	28,595
33 × 2	31,648	31,595
36 × 2	34,648	34,595
39 × 2	37,648	37,595

4.9.2.3 Multiple cycle test

Proceed as stated in [4.9.2.2](#), repeating the cycle on the same bolt the number of times specified in the procurement specification, and measure the self-locking torque under the same conditions as the first assembly and at each disassembly. The first assembly shall be carried out on a new bolt. Each disassembly shall be sufficient to entirely disengage the nut locking device.

Nuts subjected to this test shall not be used again.

4.10 Self-locking torque at ambient temperature after heat soak at maximum operating temperature

4.10.1 Test device

The test device consists of:

- a) the same spacer as for test [4.9](#) (see [Figure 9](#));
- b) a bolt with the following characteristics:
 - 1) thread: in accordance with ISO 5855-2;
 - 2) tensile strength class: identical to that of the nut under test;
 - 3) material and coating: in accordance with [Table 1](#).

4.10.2 Method

This test shall be carried out at ambient temperature.

Lubricate the nut and bolt threads as stated in [Table 1](#) (if necessary), then assemble the nut to the bolt after having positioned the spacer. Measure the self-locking torque when the protrusion is two pitches minimum (including chamfer). Apply the seating torque quoted in the procurement specification.

Heat the assembly to the maximum operating temperature quoted in the dimensional standard or drawing of the nut ± 5 °C and maintain it at this temperature for the following period:

- nuts locked by plastic ring: 3 h \pm 15 min.;
- all metal self-locking nuts: 6 h \pm 15 min.

Remove the assembly from the oven and allow it to cool slowly to ambient temperature.

Remove the load by unscrewing a half turn and cease movement. Begin again to unscrew and measure the breakaway torque.

Remove the nut.

Repeat the cycle the number of times stated in the procurement specification and measure the self-locking torque at each cycle under the same conditions.

Dismantle, then submit the bolt and nut to a visual examination and, if necessary, to an examination at a magnification of $\times 10$ after sectioning to check conformity with the requirements of the procurement specification.

Nuts subjected to this test shall not be used again.

4.11 Permanent set test

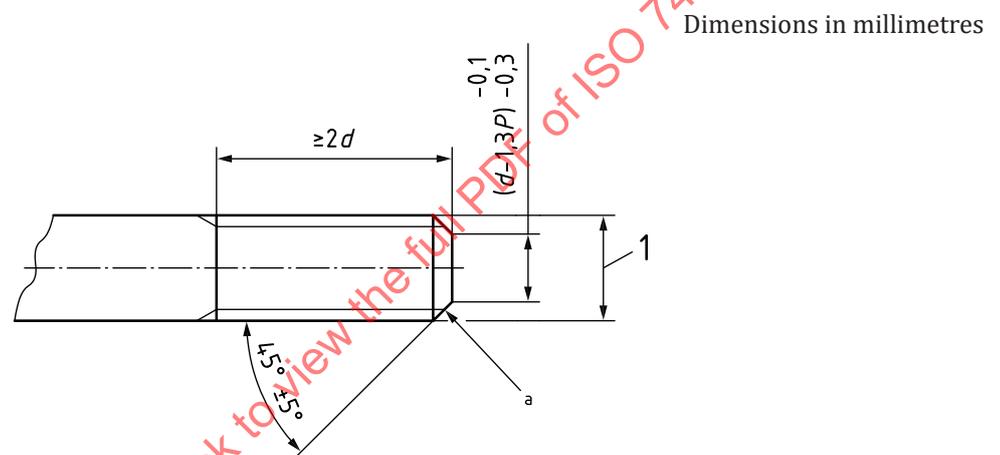
4.11.1 General

This test details the method for checking the thread possibility of reuse of self-locking nuts on bolts whose thread is at the tolerance limit.

4.11.2 Test device

The test device consists of a maximum and minimum threaded mandrel, in accordance with [Figure 10](#), whose characteristics are as follows:

- threads: in accordance with ISO 5855-2, with the exception of the pitch diameter and tolerances that shall be in accordance with the values stated in [Table 5](#);
- material: steel heat-treated to a hardness ≥ 39 HRC.



Key

- 1 thread
 a Remove sharp edges if thread is machined.

Figure 10 — Mandrel for permanent set test

This test may also be carried out with a bolt of tensile strength class equal to or greater than that of the nut to be tested on the condition that the pitch diameter is inside the tolerance given in [Table 5](#). However, in cases of dispute, only the results obtained with the mandrels in steel, heat-treated, shall be taken into consideration.

4.11.3 Method

This test shall be carried out at ambient temperature.

Check that the mandrel dimensions are within the limits given in [Table 5](#) and that their threads have not been damaged.

Lubricate the nut threads and the maximum mandrel threads as stated in [Table 1](#) (if necessary). Assemble the nut to the maximum mandrel and measure the locking torque when the protrusion is two pitches minimum (including chamfer), then unscrew the nut.

Lubricate the nut threads and the minimum mandrel threads as stated in [Table 1](#) (if necessary). Assemble the nut to the minimum mandrel with a protrusion of two pitches minimum (including chamfer), then measure the breakaway torque in the unscrewing direction.