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Second edition

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## Aerospace — Bolts — Test methods

*Aéronautique et espace — Vis — Méthodes d'essai*

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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.

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 documents 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://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*. ISO/PRF 7961

This second edition cancels and replaces the first edition (ISO 7961:1994), which has been technically revised.

The main changes compared to the previous edition are:

- modification of [Figures 3, 5 and 6](#) (corrected tolerances, further explanations added);
- modification of [Annex B](#);
- editorial adjustment.

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](http://www.iso.org/members.html).

# Aerospace — Bolts — Test methods

## 1 Scope

This document specifies test methods for bolts for aerospace constructions.

## 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 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

## 3 Terms and definitions

No terms and definitions are listed in this document.

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

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

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## 4 Tests

### 4.1 Tensile test at ambient temperature

#### 4.1.1 Apparatus

4.1.1.1 Test device (see [Figure 1](#)).

4.1.1.1.1 The test device shall be centred such that the stress at four equi-spaced points around the test sample is uniform within 1 %, or such that the coaxiality between the bolt and the clearance holes is less than or equal to 0,025 mm to ensure the application of the tensile load along the axis of the bolt.

Calibration requirements of the test device shall conform to ISO 7500-1 and [Annex A](#).

Other types of device may be used provided they respect the requirements of [Figure 3](#).

4.1.1.1.2 **Cups**, fixed or removable, in conformity with [Figure 3](#), which specifies only functional requirements.

4.1.1.1.3 **Test nut** (free-running or self-locking) or **threaded part** (assuming the role of a nut), of sufficient strength to guarantee bolt failure.

4.1.1.2 **Tapered spacer**, placed under the head during the test, when required by the procurement specification or definition document to evaluate the effect of angularity. The minimum clearance between the hole and the bolt shank shall be 0,13 mm. At least 90 % of the bolt bearing area shall be supported by

the spacer which shall have a diameter sufficient to support the width across the corners of the bolt. The tolerance on the hole diameter in the spacer shall be  $+0,08_0$  mm.

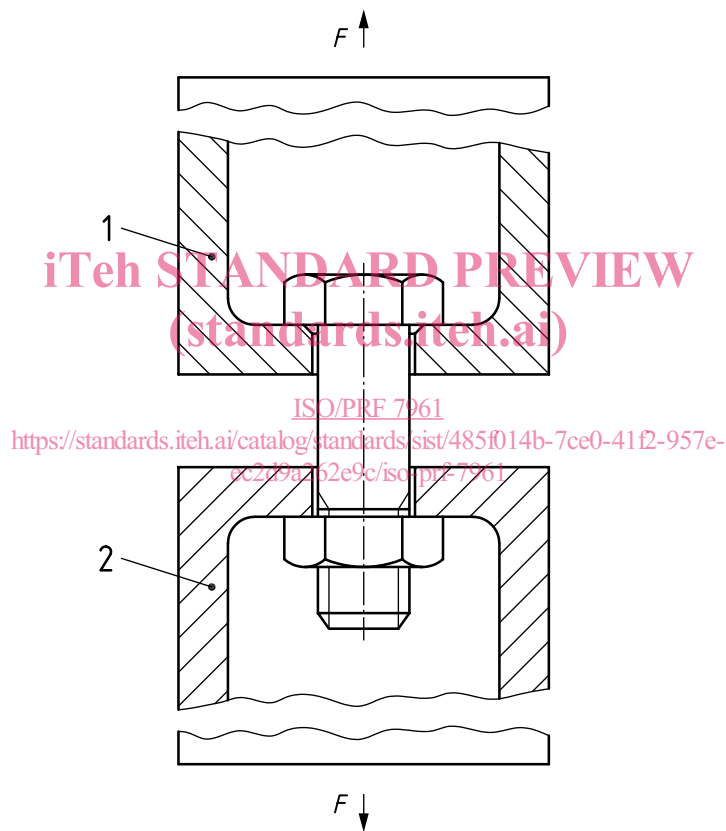
**4.1.1.3 Washers**, used under bolt heads or nuts only in the case outlined in [4.1.1.2](#).

**4.1.1.4 Tensile or compressive test machine**, depending on the fixture, capable of applying the test loads.

**4.1.2 Procedure**

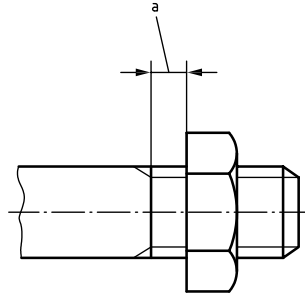
**4.1.2.1** Assemble the bolt in the test device ([4.1.1.1](#)) as shown in [Figure 1](#). Install the nut ([4.1.1.1.3](#)) as shown in [Figure 2](#). Place the complete assembly between the loading platens of the machine.

**4.1.2.2** Apply the load until the bolt breaks at the rate specified in [Table 1](#), in a controlled way.



- Key**
- 1 upper cup (see [Figure 3](#))
  - 2 lower cup (see [Figure 3](#))
  - F load

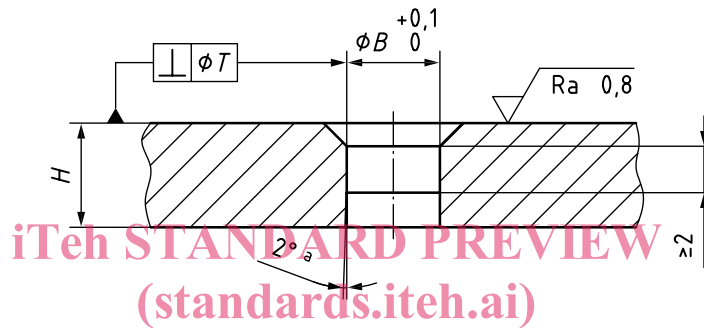
**Figure 1 — Tensile test — Test device**



a 2 complete threads min.

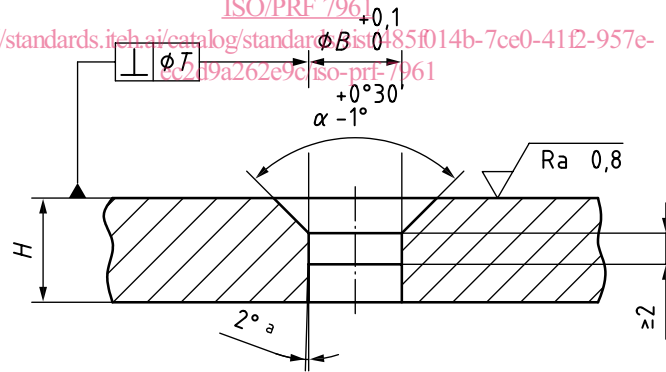
Figure 2 — Tensile test — Position of the nut in relation to the complete threads (shank side)

Dimensions in millimetres,  
Surface roughness in micrometres

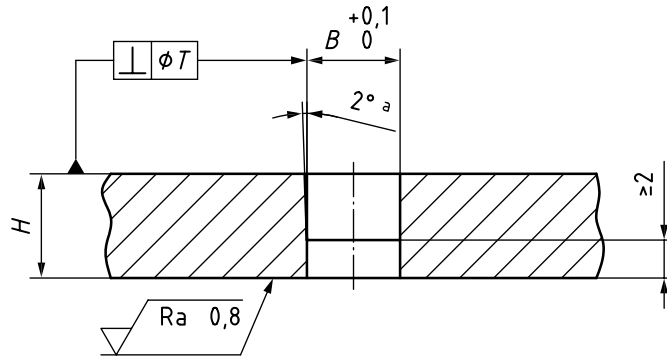


a) Upper cup for protruding head bolts

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b) Upper cup for flush head bolts



c) Lower cup

**Key**

$B$  nominal =  $D + 0,025$

$D$  = maximum diameter of bolt

$H$  ≥ nominal diameter of bolt

$T$  = perpendicularity tolerance corresponding to  $2^\circ$

$\alpha$  = nominal angle of countersunk head

break sharp edges

material: steel of hardness > 43 HRC

<sup>a</sup> Optional.

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NOTE Radius or chamfer compatible (compatible means radius or chamfer of upper cup equals to the maximum radius of the bolt plus 0,1 mm to 0,2 mm) with head to shank blend radius.

**Figure 3 — Tensile test — Upper and lower cup details**

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**Table 1 — Rates of load application — Tensile test**

Nominal shank diameter <sup>a</sup>	Rate kN/min	Nominal shank diameter <sup>a</sup>	Rate kN/min	Nominal shank diameter <sup>a</sup>	Rate kN/min
3	5	12	80	27	400
4	9	14	110	30	500
5	14	16	140	33	600
6	20	18	180	36	700
7	27	20	220	39	850
8	35	22	270		
10	55	24	320		

<sup>a</sup> For other shank diameters, bolts shall be tested at a loading rate, accurate to ±10 %, of 750 N per minute per 1 mm<sup>2</sup> of nominal shank cross-section.

**4.2 Double shear test**

**4.2.1 Apparatus**

See [Figures 4](#) and [5](#), the latter only defining functional requirements.

Totally enclosed top and bottom blades may be used as an alternative.

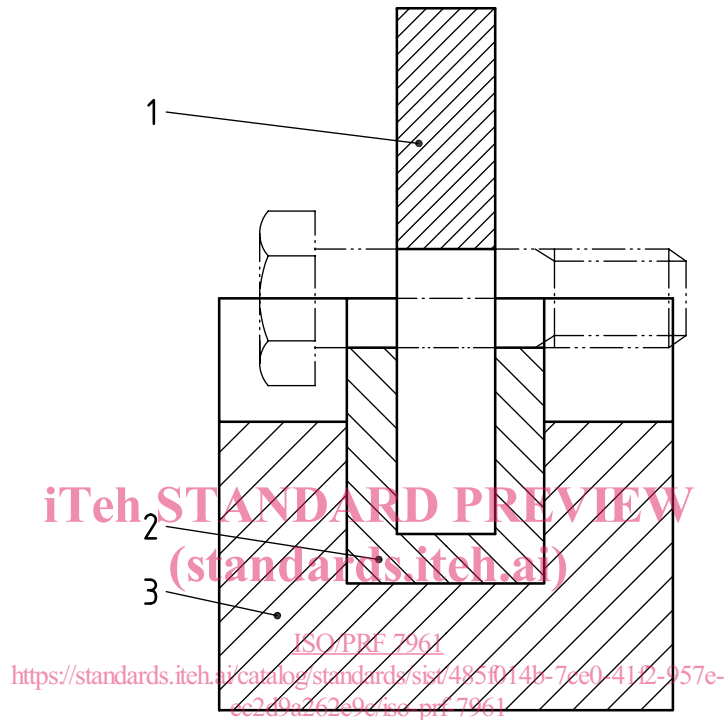


4.2.2 Procedure

4.2.2.1 Assemble the bolt into the lower part of the guillotine. The blend radius under the head and the threaded portion shall not be in contact with the lower part of the guillotine (see Figure 4).

4.2.2.2 Apply the load until the bolt breaks at the rate specified in Table 2, in a controlled way.

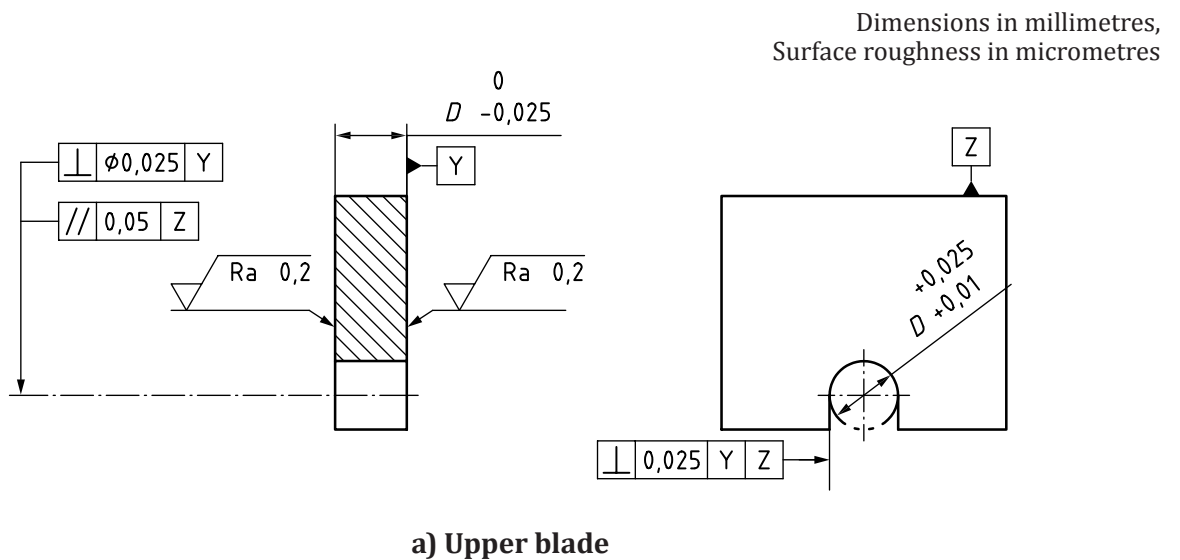
If this load is attained without breakage of the bolt, the test may be terminated.

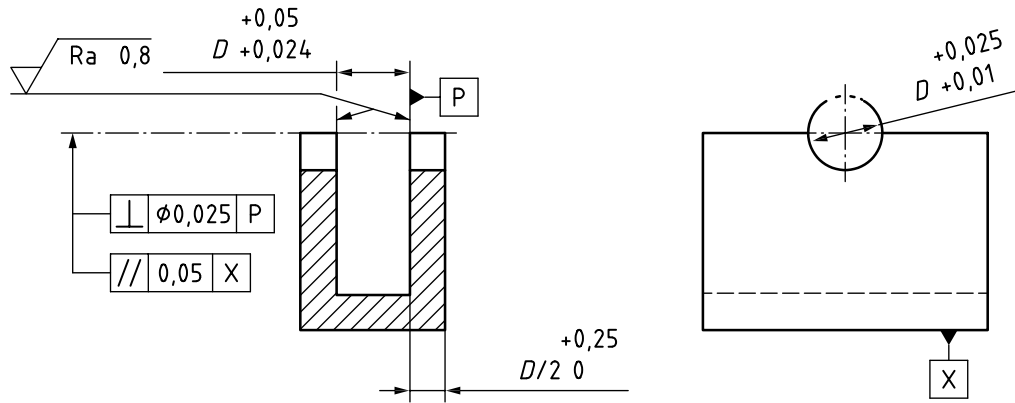


Key

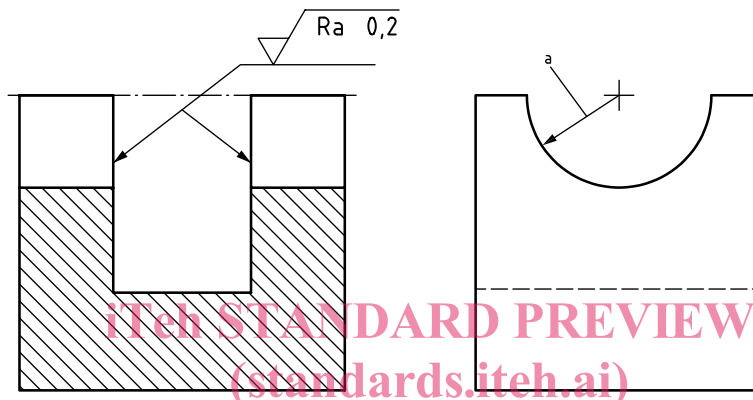
- 1 upper blade
- 2 lower blade
- 3 support block

Figure 4 — Double shear test — Test device





b) Lower blade



c) Support base

**Key**

$D$  = nominal diameter of the bolt

<sup>a</sup> Radius to clear head of test bolt.

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NOTE 1 Shear edges radius or break edge 0,13 max.

NOTE 2 Rework when edges reach a radius of or break edge of 0,25 max.

NOTE 3 Material: Steel of hardness 60 HRC to 62 HRC

**Figure 5 — Double shear test — Upper and lower blocks**

**Table 2 — Rates of load application — Double shear test**

Nominal shank diameter <sup>a</sup>	Rate kN/min	Nominal shank diameter <sup>a</sup>	Rate kN/min	Nominal shank diameter <sup>a</sup>	Rate kN/min
3	10	12	160	27	800
4	18	14	215	30	990
5	27	16	280	33	1 200
6	40	18	350	36	1 400
7	54	20	440	39	1 700
8	70	22	530		
10	110	24	630		

<sup>a</sup> For other shank diameters, bolts shall be tested at a loading rate, accurate to ±10 %, of 750 N per minute per 1 mm<sup>2</sup> of double the nominal shank cross-section.

## 4.3 Tension fatigue test

### 4.3.1 Apparatus

#### 4.3.1.1 Test device (see [Figure 1](#)).

**4.3.1.1.1** Universal joints and spherical seats shall not be used in the test column. The test device shall be centered such that the stress at four equi-spaced points around the test sample shall be uniform within 3 % of the mean stress value.

Calibration requirements of the test device shall conform to ISO 7500-1 and [Annex A](#).

Other types of device may be used provided they respect the requirements of [Figure 3](#).

Test bolts shall not be re-used.

**4.3.1.1.2 Cups**, fixed or removeable, in conformity with [Figure 3](#), which specifies only functional requirements.

**4.3.1.1.3 Test nut or threaded part** (assuming the role of a nut), with a height greater than or equal to  $0,8 D$  and of sufficient strength to ensure bolt breakage.

Test nuts or threaded parts may be re-used provided that it meets the dimensional requirements and has not been damaged by a previous test.

For referee purposes, only unused nuts or threaded parts shall be used.

**4.3.1.2 Load measuring system**, of an accuracy within  $\pm 2$  % of the applied maximum load.

**4.3.1.3 Automatic load maintaining system**.

**4.3.1.4 Fixtures**, designed to incorporate the features indicated in [Figure 3](#).

### 4.3.2 Procedure

#### 4.3.2.1 Installation

Test bolts shall be assembled so that a minimum of two and a maximum of three complete threads are exposed between the nut or threaded part ([4.3.1.1.3](#)) bearing face and incomplete threads on the shank side.

In the case of flush head bolts, the bearing between the bolt head and the loading cup in which it is to be tested shall be uniform.

There shall be no contact in the head-shank junction area.

#### 4.3.2.2 Test conditions

##### 4.3.2.2.1 Torque

There shall be no tensile stress due to torque or any other installation procedure.

##### 4.3.2.2.2 Load level

The fatigue test loads shall comply with the values specified in the procurement specification or definition document.