

Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 5: Special fasteners (also including fasteners from nickel alloys) for high temperature applications (ISO 3506-5:2022)

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

|   |   |
|---|---|
| <p>See Eesti standard EVS-EN ISO 3506-5:2023 sisaldab Euroopa standardi EN ISO 3506-5:2023 ingliskeelset teksti.</p> <p>Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas</p> <p>Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 01.11.2023.</p> <p>Standard on kättesaadav Eesti Standardimis- ja Akrediteerimiskeskusest.</p> | <p>This Estonian standard EVS-EN ISO 3506-5:2023 consists of the English text of the European standard EN ISO 3506-5:2023.</p> <p>This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.</p> <p>Date of Availability of the European standard is 01.11.2023.</p> <p>The standard is available from the Estonian Centre for Standardisation and Accreditation.</p> |
|---|---|

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 21.060.99

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele. Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis- ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis- ja Akrediteerimiskeskusega: Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation:

Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

ICS 21.060.99

English Version

## Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 5: Special fasteners (also including fasteners from nickel alloys) for high temperature applications (ISO 3506-5:2022)

Fixations - Caractéristiques mécaniques des fixations en acier inoxydable résistant à la corrosion - Partie 5: Fixations spéciales (incluant également les fixations en alliages de nickel) pour utilisation à hautes températures (ISO 3506-5:2022)

Verbindungselemente - Mechanische Eigenschaften von Verbindungselementen aus nichtrostenden Stählen - Teil 5: Spezielle Verbindungselemente (einschließlich Verbindungselemente aus Nickellegierungen) für Hochtemperaturanwendungen (ISO 3506-5:2022)

This European Standard was approved by CEN on 29 October 2023.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

## European foreword

The text of ISO 3506-5:2022 has been prepared by Technical Committee ISO/TC 2 "Fasteners" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 3506-5:2023 by Technical Committee CEN/TC 185 "Fasteners" the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2024, and conflicting national standards shall be withdrawn at the latest by May 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## Endorsement notice

The text of ISO 3506-5:2022 has been approved by CEN as EN ISO 3506-5:2023 without any modification.

# Contents

Page

|   |           |
|---|-----------|
| Foreword.....   | v         |
| Introduction.....   | vi        |
| <b>1 Scope.....</b>   | <b>1</b>  |
| <b>2 Normative references.....</b>  | <b>2</b>  |
| <b>3 Terms and definitions.....</b>   | <b>2</b>  |
| <b>4 Symbols.....</b>   | <b>4</b>  |
| <b>5 Designation system for fasteners made from stainless steels and nickel alloys.....</b>                         | <b>5</b>  |
| <b>6 Materials and manufacture.....</b>   | <b>5</b>  |
| 6.1 Chemical composition.....   | 5         |
| 6.2 Heat treatment for fasteners.....   | 7         |
| 6.3 Finish.....   | 8         |
| 6.4 Design of bolt/nut assemblies.....  | 9         |
| 6.5 Service temperatures for fasteners.....   | 10        |
| <b>7 Mechanical and physical properties.....</b>  | <b>10</b> |
| 7.1 Mechanical properties of bolts, screws and studs.....   | 10        |
| 7.2 Mechanical properties of nuts.....  | 14        |
| <b>8 Applicability of test methods and inspection.....</b>  | <b>15</b> |
| 8.1 Applicability of test methods.....  | 15        |
| 8.2 Manufacturer's inspection.....  | 16        |
| 8.3 Supplier's inspection.....  | 16        |
| 8.4 Purchaser's inspection.....   | 16        |
| 8.5 Delivery of test results.....   | 16        |
| <b>9 Test methods at ambient temperature.....</b>   | <b>17</b> |
| 9.1 Tensile test for bolts, screws and studs at ambient temperature.....  | 17        |
| 9.1.1 General.....  | 17        |
| 9.1.2 Applicability.....  | 17        |
| 9.1.3 Apparatus and testing device.....   | 17        |
| 9.1.4 General test procedure.....   | 18        |
| 9.1.5 Test procedure for the simultaneous determination of $R_{mf}$ , $R_{pf}$ and $A$ .....                        | 19        |
| 9.1.6 Reference test procedure for the determination of stress at 0,2 % non-proportional elongation, $R_{pf}$ ..... | 20        |
| 9.1.7 Alternative test procedure for the determination of elongation, $A$ .....                                     | 21        |
| 9.1.8 Test results and requirements for tensile strength, $R_{mf}$ .....  | 22        |
| 9.1.9 Test results and requirements for stress at 0,2 % non-proportional elongation, $R_{pf}$ .....                 | 23        |
| 9.1.10 Test results and requirements for elongation after fracture, $A$ .....                                       | 23        |
| 9.2 Hardness test for bolts, screws and studs.....  | 23        |
| 9.2.1 General.....  | 23        |
| 9.2.2 Test procedure.....   | 23        |
| 9.2.3 Test results and requirements for hardness.....   | 24        |
| 9.3 Proof load test for nuts.....   | 24        |
| 9.3.1 General.....  | 24        |
| 9.3.2 Applicability.....  | 24        |
| 9.3.3 Apparatus and testing device.....   | 24        |
| 9.3.4 Test procedure.....   | 25        |
| 9.3.5 Additional testing procedure for prevailing torque nuts.....  | 26        |
| 9.3.6 Test results and requirements for nut proof load.....   | 27        |
| 9.4 Hardness test for nuts.....   | 27        |
| 9.4.1 General.....  | 27        |
| 9.4.2 Test procedure.....   | 27        |
| 9.4.3 Test results and requirements for nut hardness.....   | 28        |

|  |  |           |
|--|--|-----------|
| <b>10</b>  | <b>Test methods at high temperature</b>                                | <b>28</b> |
| 10.1   | High temperature tensile test for bolts, screws, studs and nuts        | 28        |
| 10.1.1   | General  | 28        |
| 10.1.2   | Test apparatus   | 28        |
| 10.1.3   | Test procedure   | 29        |
| 10.1.4   | Test report  | 30        |
| 10.2   | High temperature stress rupture test for bolts, screws, studs and nuts | 31        |
| 10.2.1   | General  | 31        |
| 10.2.2   | Test apparatus and testing device                                      | 31        |
| 10.2.3   | Test procedure   | 32        |
| 10.2.4   | Test report  | 32        |
| 10.3   | Relaxation test for bolts, screws, studs and nuts                      | 33        |
| 10.3.1   | General  | 33        |
| 10.3.2   | Bolted joint models  | 33        |
| 10.3.3   | Test apparatus and measuring devices                                   | 34        |
| 10.3.4   | Test procedure   | 34        |
| 10.3.5   | Test results   | 35        |
| 10.3.6   | Test report  | 35        |
| 10.4   | Creep test   | 36        |
| <b>11</b>  | <b>Fastener marking and labelling</b>                                  | <b>36</b> |
| 11.1   | General requirements for marking                                       | 36        |
| 11.2   | Manufacturer's identification mark                                     | 37        |
| 11.3   | Marking on the fasteners   | 37        |
| 11.3.1   | Hexagon head bolts and screws and hexagon nuts                         | 37        |
| 11.3.2   | Hexagon socket and hexalobular socket bolts and screws                 | 38        |
| 11.3.3   | Other types of bolts, screws and nuts                                  | 38        |
| 11.3.4   | Studs (one-end and double-end studs)                                   | 38        |
| 11.3.5   | Fully threaded studs   | 38        |
| 11.3.6   | Left-hand thread marking   | 39        |
| 11.4   | Marking of the packages (labelling)                                    | 39        |
| <b>Annex A (informative) Tempering of martensitic stainless steels</b> |  | <b>40</b> |
| <b>Bibliography</b>  |  | <b>42</b> |

## 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 2, *Fasteners*.

A list of all parts in the ISO 3506 series can be found on the ISO website.

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).

## Introduction

The ISO 3506 series consists of the following parts, under the general title *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners*:

- *Part 1: Bolts, screws and studs with specified grades and property classes*
- *Part 2: Nuts with specified grades and property classes*
- *Part 3*<sup>1)</sup>: *Set screws and similar fasteners not under tensile stress*
- *Part 4*<sup>1)</sup>: *Tapping screws*
- *Part 5: Special fasteners (also including fasteners from nickel alloys) for high temperature applications*
- *Part 6: General rules for the selection of stainless steels and nickel alloys for fasteners*

Complementary detailed explanations about definitions of stainless steel grades and properties are specified in ISO 3506-6.

The properties of stainless steel and nickel alloy fasteners for high temperature applications result from the chemical composition of the material, from the heat treatment process and from the manufacturing process of the fasteners. Static or dynamic properties at room temperature like tensile strength, hardness or fatigue resistance are not sufficient enough to design fasteners for high temperature applications properly.

In fact, at high temperatures e.g. above 300 °C, additional phenomena occur, for instance:

- decrease in tensile properties and hardness,
- hot oxidation and scaling,
- stress relaxation,
- creep.

All these phenomena significantly affect the durability and service life of fasteners. Therefore:

- a proper choice of material grade is essential to avoid heavy hot oxidation,
- qualification of fasteners through dedicated tests should be performed.

Different tests are currently available to assess the behaviour of machined and standardized samples (see for example ASTM E292 or ASTM E328). In addition to these tests, this document specifies test methods on finished fasteners: these are useful when requiring results as representative as possible of the actual service conditions.

All fastener categories included in this document are heat-treated (see [Clause 6](#)). Heat treatment processing is crucial to reach mechanical properties and suitable microstructure that are essential to stand phenomena described above and to get adequate durability for the fasteners and the assembled bolted joints.

---

1) It is intended to revise ISO 3506-3 and ISO 3506-4 in the future in order to include the reference to ISO 3506-6.

# Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners —

## Part 5:

## Special fasteners (also including fasteners from nickel alloys) for high temperature applications

### 1 Scope

This document specifies the mechanical and physical properties of bolts, screws, studs and nuts, with coarse pitch thread and fine pitch thread, made of corrosion-resistant stainless steels (i.e. martensitic stainless steels and precipitation hardening austenitic stainless steels) and nickel alloys, intended for use at high temperatures up to 800 °C.

Tests in accordance with [Clause 9](#) are performed at the ambient temperature range of 10 °C to 35 °C, and other tests can be performed at higher temperatures, see [Clause 10](#).

NOTE Fasteners specified in this document are also suitable when used at low temperatures, typically down to -50 °C. For more information, see ISO 3506-6.

The term “fasteners” is used in this document when bolts, screws, studs and nuts are considered all together.

ISO 3506-6 provides general rules and additional technical information on suitable stainless steels and nickel alloys as well as their properties.

This document applies to fasteners:

- with ISO metric thread in accordance with ISO 68-1,
- with diameter/pitch combinations in accordance with ISO 261 and ISO 262,
- with coarse pitch thread M3 to M39, and fine pitch thread M8×1 to M39×3,
- with thread tolerances in accordance with ISO 965-1 and ISO 965-2, and
- of any shape but with full loadability.

Stainless steel and nickel alloy fastener symbols can be used for sizes outside the diameter limits of this document (i.e. for bolts, screws and studs with  $d < 3$  mm or  $d > 39$  mm and for nuts with  $D < 5$  mm or  $D > 39$  mm), provided that all applicable chemical, mechanical and physical requirements are met.

Fasteners with reduced loadability (i.e. thin nuts and bolts, screws and studs with head or unthreaded shank weaker than the threaded shank) are not dealt with in this document.

This document does not specify requirements for functional properties such as:

- torque/clamp force properties,
- shear strength,
- fatigue resistance,
- weldability,

or

- properties of bolted joints and fasteners in high temperature environment (see test methods at high temperature for fasteners in [Clause 10](#)).

## 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 1891-4, *Fasteners — Vocabulary — Part 4: Control, inspection, delivery, acceptance and quality*

ISO 3506-1, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs with specified grades and property classes*

ISO 3506-2, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 2: Nuts with specified grades and property classes*

ISO 3506-6, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 6: General rules for the selection of stainless steels and nickel alloys for fasteners*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 16228, *Fasteners — Types of inspection documents*

EN 10319-2, *Metallic materials — Tensile stress relaxation testing — Part 2: Procedure for bolted joint models*

## 3 Terms and definitions

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

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/>

### 3.1

#### **stainless steel**

steel with at least 10,5 % (mass fraction) of chromium (Cr) and maximum 1,2 % (mass fraction) of carbon (C)

[SOURCE: ISO 3506-1:2020, 3.5]