INTERNATIONAL STANDARD

ISO 3506-2

First edition
1997-12-01

Mechanical properties of corrosion-resistant stainless-steel fasteners —

Part 2:
Nuts

Caractéristiques mécaniques des éléments de fixation en acier inoxydable résistant à la corrosion —

Partie 2: Écrous

Reference number
ISO 3506-2:1997(E)

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.

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 3506-2 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Sub-Committee SC 1, *Mechanical properties of fasteners*.

This first edition, together with ISO 3506-1 and ISO 3506-3, cancels and replaces ISO 3506:1979, which has been technically revised.

ISO 3506 consists of the following parts, under the general title *Mechanical properties of corrosion-resistant stainless-steel fasteners*.

— *Part 1: Bolts, screws and studs*

— *Part 2: Nuts*

— *Part 3: Set screws and similar fasteners not under tensile stress*

Annexes A to G of this part of ISO 3506 are for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Introduction

In the preparation of this part of ISO 3506 special attention has been given to the fundamentally different property characteristics of the stainless steel fastener grades compared with those of carbon steel and low-alloy steel fasteners. Austenitic stainless steels are strengthened only by cold working and consequently the components do not have as homogeneous a condition as hardened and tempered parts. These special features have been recognized in the elaboration of the property classes and the test procedures for mechanical properties.

This page intentionally left blank

Mechanical properties of corrosion-resistant stainless-steel fasteners —

Part 2:
Nuts

1 Scope

This part of ISO 3506 specifies the mechanical properties of nuts made of austenitic, martensitic and ferritic grades of corrosion-resistant stainless steels when tested over an ambient temperature range of 15 °C to 25 °C. Properties will vary at higher or lower temperatures.

It applies to nuts

— with nominal thread diameters (d) up to and including 39 mm;

— of triangular ISO metric threads with diameters (d) and pitches in accordance with ISO 68-1, ISO 261 and ISO 262;

— of any shape;

— with width across flats as specified in ISO 272;

— with nominal heights greater than or equal to 0,5 d.

It does not apply to nuts requiring properties such as

— locking abilities;

— weldability.

This part of ISO 3506 does not define corrosion or oxidation resistance in particular environments.

The aim of this part of ISO 3506 is a classification into property classes of corrosion resistant stainless steel fasteners. Some materials can be used at temperatures down to -200 °C, some can be used at temperatures up to +800 °C in air. Information on the influence of temperature on mechanical properties is found in annex D.

Corrosion and oxidation performances and mechanical properties for use at elevated or sub-zero temperatures must be the subject of agreement between user and manufacturer in each particular case. Annex E shows how the risk of intergranular corrosion at elevated temperatures depends on the carbon content.

All austenitic stainless steel fasteners are normally non-magnetic in the annealed condition; after cold working, some magnetic properties may be evident (see annex F).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 3506. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 3506 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 68-1:—[1], *ISO general purpose screw threads – Basic profile – Part 1: Metric screw threads.*

ISO 261:—[2], *ISO general purpose metric screw threads – General plan.*

ISO 262:—[3], *ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts.*

ISO 272:1982, *Fasteners – Hexagon products – Widths across flats.*

ISO 898-2:1992, *Mechanical properties of fasteners – Part 2: Nuts with specified proof load values – Coarse thread.*

ISO 898-6:1994, *Mechanical properties of fasteners – Part 6: Nuts with specified proof load values – Fine pitch thread.*

ISO 3651-1:—[4], *Determination of resistance to intergranular corrosion stainless steels – Part 1: Austenitic and ferritic-austenitic (duplex) stainless steels – Corrosion test in nitric acid medium by measurement of loss in mass (Huey test).*

ISO 3651-2:—[5], *Determination of resistance to intergranular corrosion stainless steels – Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels – Corrosion test in media containing sulfuric acid.*

ISO 6506:1981, *Metallic materials – Hardness test – Brinell test.*

ISO 6507-1:1997, *Metallic materials – Hardness test – Vickers test – Part 1: Test method.*

ISO 6508:1986, *Metallic materials – Hardness test – Rockwell test (scales A – B – C – D – E – F– G – H – K).*

3 Designation, marking and finish

3.1 Designation

The designation system for stainless steel grades and property classes for nuts is shown in figure 1. The designation of the material consists of two blocks which are separated by a hyphen. The first block designates the steel grade, the second block the property class.

The designation of the steel grade (first block) consists of the letters

A for austenitic steel or

C for martensitic steel or

F for ferritic steel

which indicate the group of steel and a digit which indicates a range of chemical compositions within this steel group.

The designation of the property class (second block) consists of 2 digits for nuts with the height $m \geqslant 0{,}8\,d$ (style 1) which indicates 1/10 of the stress under proof load and 3 digits for nuts with the height $0{,}5\,d \leqslant m < 0{,}8\,d$ (thin nuts), the first digit indicating that the nut has a reduced loadability and the following two digits 1/10 of the stress under proof load.

NOTE — For the definition of style 1 for nuts see ISO 898-2:1992, annex A.

1) To be published. (Revision of ISO 68:1973)
2) To be published. (Revision of ISO 261:1973
3) To be published. (Revision of ISO 262:1973)
4) To be published. (Revision of ISO 3651-1:1976)
5) To be published. (Revision of ISO 3651-2:1976)

Examples for the designation of material:

1) A2-70 indicates:

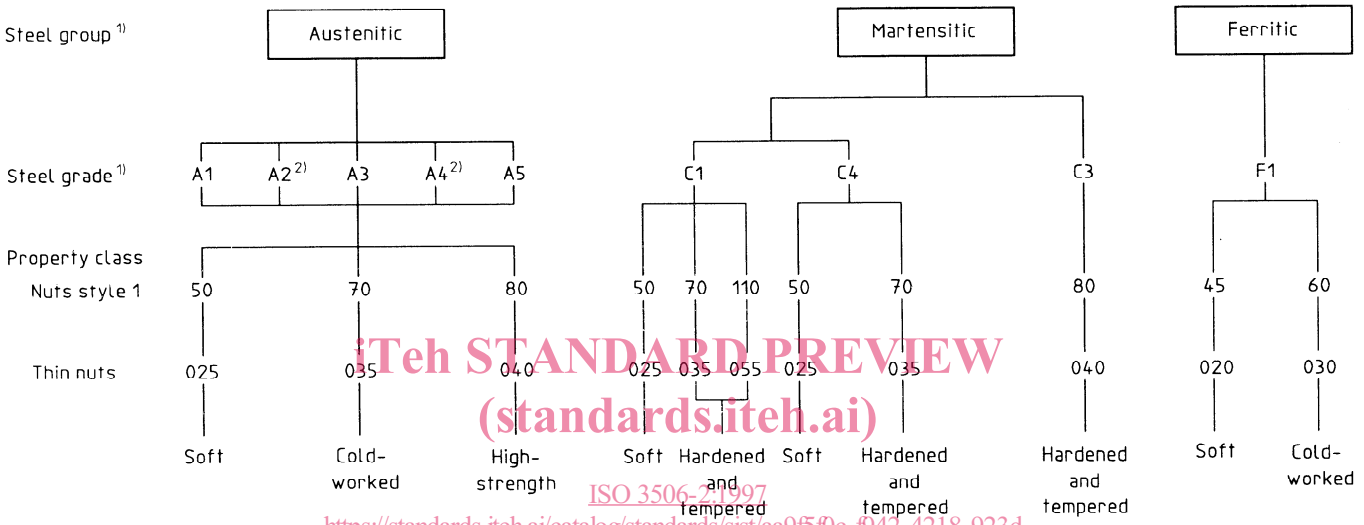
austenitic steel, cold worked, minimum 700 N/mm^2 (700 MPa) stress under proof load (nut of style 1).

2) C4-70 indicates:

martensitic steel, hardened and tempered, minimum 700 N/mm^2 (700 MPa) stress under proof load (nut of style 1).

3) A2-035 indicates:

austenitic steel, cold worked, minimum 350 N/mm^2 (350 MPa) stress under proof load (thin nut).



1) The steel groups and steel grades classified in figure 1 are described in annex A and specified by the chemical composition given in table 1.

2) Low carbon stainless steels with carbon content not exceeding 0,03 % may additionally be marked with an L.

EXAMPLE: A4L – 80

Figure 1 — Designation system for stainless steel grades and property classes for nuts

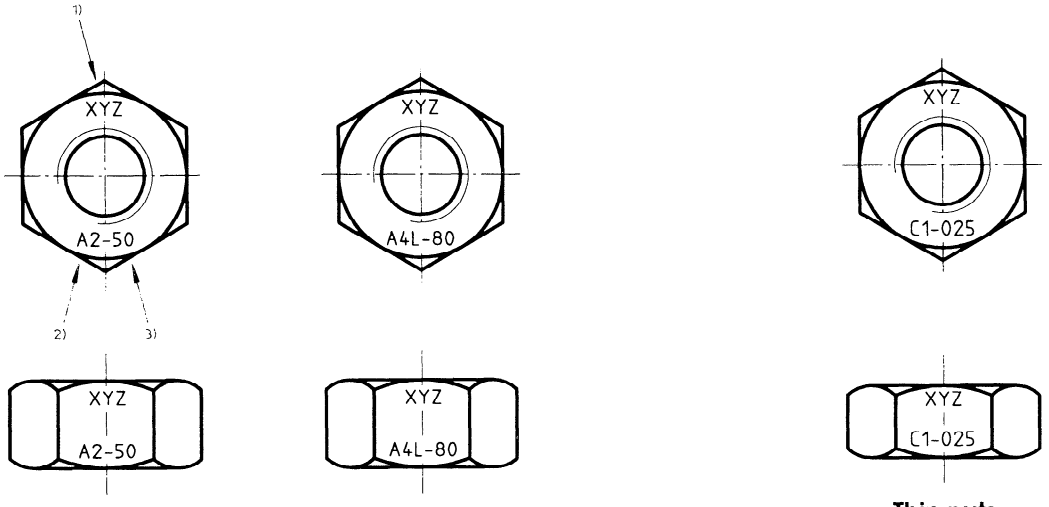
3.2 Marking

Only if all requirements in this part of ISO 3506 are met, parts shall be marked and/or described according to the designation system described in 3.1.

3.2.1 Nuts

Marking is mandatory on nuts with nominal thread diameters $d \geqslant 5$ mm and shall be marked with the steel grade and property class in accordance with 3.1, figure 1 and figure 2 and with the manufacturer's identification mark, provided this is possible for technical reasons. Marking of only one nut face is acceptable and shall be only by indentation when applied to the bearing surface of the nuts. Alternatively, marking on the side of the nuts is permissible.

When the marking is made with grooves (see figure 2) and the property class is not indicated, property class 50 or 025 will apply.



Nuts style 1

Thin nuts

1) manufacturer's identification mark
2) steel grade
3) property class

Marking with material designation and manufacturer's identification mark

s is the width across flats

Alternative groove marking (for A2 and A4 steel grades only)

NOTE — For marking of left-hand thread, see ISO 898-2.

Figure 2 — Marking of nuts

3.2.2 Packages

Marking with the designation and manufacturer's identification mark is mandatory on all packages of all sizes.

3.3 Finish

Unless otherwise specified, fasteners in accordance with this part of ISO 3506 shall be supplied clean and bright. For maximum corrosion resistance passivation is recommended.

4 Chemical composition

The chemical compositions of stainless steels suitable for fasteners in accordance with this part of ISO 3506 are given in table 1.

The final choice of chemical composition within the specified steel grade is at the discretion of the manufacturer unless by prior agreement between the purchaser and the manufacturer.

In applications where risk of intergranular corrosion is present, testing in accordance with ISO 3651-1 or ISO 3651-2 is recommended. In such cases, stabilized stainless steels A3 and A5 or stainless steels A2 and A4 with carbon content not exceeding 0,03 % are recommended.

Table 1 — Stainless steel grades - Chemical composition

Group	Grade	Chemical composition % (*m*/*m*)[1]									Notes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Austenitic	A1	0,12	1	6,5	0,2	0,15 to 0,35	16 to 19	0,7	5 to 10	1,75 to 2,25	2) 3) 4)
	A2	0,1	1	2	0,05	0,03	15 to 20	— [5]	8 to 19	4	7) 8)
	A3	0,08	1	2	0,045	0,03	17 to 19	— [5]	9 to 12	1	9)
	A4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	1	8) 10)
	A5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	9) 10)
Martensitic	C1	0,09 to 0,15	1	1	0,05	0,03	11,5 to 14	—	1	—	10)
	C3	0,17 to 0,25	1	1	0,04	0,03	16 to 18	—	1,5 to 2,5	—	
	C4	0,08 to 0,15	1	1,5	0,06	0,15 to 0,35	12 to 14	0,6	1	—	2) 10)
Ferritic	F1	0,12	1	1	0,04	0,03	15 to 18	— [6]	1	—	11) 12)

NOTES

1 A description of the groups and grades of stainless steels also entering into their specific properties and application is given in annex A.

2 Examples for stainless steels which are standardized in ISO 683-13 and in ISO 4954 are given in annexes B and C respectively.

1) Values are maximum unless otherwise indicated.

2) Sulfur may be replaced by selenium.

3) If the nickel content is below 8 %, the minimum manganese content must be 5 %.

4) There is no minimum limit to the copper content provided that the nickel content is greater than 8 %.

5) Molybdenum may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this must be stated at the time of ordering by the purchaser.

6) Molybdenum may be present at the discretion of the manufacturer.

7) If the chromium content is below 17 %, the minimum nickel content should be 12 %.

8) For austenitic stainless steels having a maximum carbon content of 0,03 %, nitrogen may be present to a maximum of 0,22 %.

9) Must contain titanium $\geq 5 \times C$ up to 0,8 % maximum for stabilization and be marked appropriately in accordance with this table, or must contain niobium (columbium) and/or tantalum $\geq 10 \times C$ up to 1,0 % maximum for stabilization and be marked appropriately in accordance with this table.

10) At the discretion of the manufacturer the carbon content may be higher where required to obtain the specified mechanical properties at larger diameters, but shall not exceed 0,12 % for austenitic steels.

11) May contain titanium $\geq 5 \times C$ up to 0,8 % maximum.

12) May contain niobium (columbium) and/or tantalum $\geq 10 \times C$ up to 1 % maximum.

5 Mechanical properties

The mechanical properties of nuts in accordance with this part of ISO 3506 shall conform to the values given in table 2 or 3.

For acceptance purposes the mechanical properties as given in this clause apply and shall be tested as follows:

– hardness test, according to 6.1 (only grades C1, C3 and C4, hardened and tempered);

– proof load test, according to 6.2.

Table 2 — Mechanical properties for nuts - Austenitic grades

Group	Grade	Property class		Range of thread diameter	Stress under proof load S_p min. N/mm²	
		Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	d mm	Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)
Austenitic	A1	50	025	≤ 39	500	250
	A2, A3	70	035	≤ 24 [1]	700	350
	A4, A5	80	040	≤ 24 [1]	800	400

1) For fasteners with nominal thread diameters $d > 24$ mm the mechanical properties shall be agreed upon between user and manufacturer and marked with grade and property class according to this table.

Table 3 — Mechanical properties for nuts - Martensitic and ferritic grades

Group	Grade	Property class		Stress under proof load S_p min. N/mm²		Hardness		
		Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	HB	HRC	HV
Martensitic	C1	50	025	500	250	147 to 209	—	155 to 220
		70	—	700	—	209 to 314	20 to 34	220 to 330
		110 [1]	055 [1]	1 100	550	—	36 to 45	350 to 440
	C3	80	040	800	400	228 to 323	21 to 35	240 to 340
	C4	50	—	500	—	147 to 209	—	155 to 220
		70	035	700	350	209 to 314	20 to 34	220 to 330
Ferritic	F1 [2]	45	020	450	200	128 to 209	—	135 to 220
		60	030	600	300	171 to 271	—	180 to 285

1) Hardened and tempered at a minimum tempering temperature of 275 °C.

2) Nominal thread diameter $d \leq 24$ mm.

6 Test methods

6.1 Hardness HB, HRC or HV

The hardness test shall be carried out in accordance with ISO 6506 (HB), ISO 6508 (HRC) or ISO 6507-1 (HV). In the case of doubt, the Vickers hardness test is decisive for acceptance.

The test procedure shall be as specified in ISO 898-2 and ISO 898-6.

The hardness values shall be within the limits given in table 3.

6.2 Proof load

The test procedure and criteria shall be in accordance with ISO 898-2 and ISO 898-6.

Annex A
(informative)

Description of the groups and grades of stainless steels

A.1 General

In ISO 3506-1, ISO 3506-2 and ISO 3506-3 reference is made to steel grades A1 to A5, C1 to C4 and F1 covering steels of the following groups:

Austenitic steel A1 to A5

Martensitic steel C1 to C4

Ferritic steel F1

In this annex the characteristics of the above mentioned steel groups and grades are described.

This annex also gives some information on the non-standardized steel group FA. Steels of this group have a ferritic-austenitic structure.

A.2 Steel group A (austenitic structure)

Five main grades of austenitic steels, A1 to A5, are included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. They cannot be hardened and are usually non-magnetic. In order to reduce the susceptibility to work hardening copper may be added to steel grades A1 to A5 as specified in table 1.

For non-stabilized steel grades A2 and A4 the following applies.

As chromic oxide makes steel resistant to corrosion, low carbon content is of great importance to non-stabilized steels. Due to the high affinity of chrome to carbon, chrome carbide is obtained instead of chromic oxide which is more likely at elevated temperature. (See annex E.)

For stabilized steel grades A3 and A5 the following applies.

The elements Ti, Nb or Ta affect the carbon and chromic oxide is produced to its full extent.

For offshore or similar applications, steels with Cr and Ni content at about 20 % and Mo at 4,5 % to 6,5 % are required.

When risk of corrosion is high experts should be consulted.

A.2.1 Steel grade A1

Steel grade A1 is especially designed for machining. Due to the high sulfur content the steels within this steel grade have lower resistance to corrosion than corresponding steels with normal sulfur content.

A.2.2 Steel grade A2

Steels of grade A2 are the most frequently used stainless steels. They are used for kitchen equipment and apparatus for the chemical industry. Steels within this grade are not suitable for use in non-oxidizing acid and agents with chloride content, i.e. swimming pools and sea water.

A.2.3 Steel grade A3

Steels of grade A3 are stabilized "stainless steels" with properties of steels in grade A2.

A.2.4 Steel grade A4

Steels of grade A4 are "acid proof steels", which are Mo alloyed and give considerably better resistance to corrosion. A4 is used to a great extent by the cellulose industry as this steel grade is developed for boiling sulfuric acid (thus