INTERNATIONAL STANDARD

ISO 3506-2

Second edition
2009-11-15

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 3506-2:2009(E)

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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 2.

The main task of technical committees is to prepare International Standards. 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.

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.

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

This second edition cancels and replaces the first edition (ISO 3506-2:1997), 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*

— *Part 4: Tapping screws*

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. Ferritic and austenitic stainless steels are strengthened only by cold working and consequently, the components do not have as homogeneous local material properties 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. The latter differ from the carbon steel and low-alloy steel fastener test procedures with regard to the measurement of the stress at 0,2 % permanent strain (yield stress) and ductility (total elongation after fracture).

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 steel grades of corrosion-resistant stainless steels, when tested over an ambient temperature range of 10 °C to 35 °C. Properties vary at higher or lower temperatures.

This part of ISO 3506 applies to nuts:

— with nominal thread diameter $D \leqslant 39$ mm;

— of triangular ISO metric threads with diameters 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 $m \geqslant 0{,}5D$.

It does not apply to nuts requiring properties such as

— locking abilities, and

— weldability.

NOTE The designation system of this part of ISO 3506 can be used for sizes outside the limits given in this clause (e.g. $D > 39$ mm), provided that all applicable mechanical and physical requirements of the property classes are met.

This part of ISO 3506 does not define corrosion or oxidation resistance in particular environments. However, some information on materials for particular environments is given in Annex D. Regarding definitions of corrosion and corrosion resistance, see ISO 8044.

The aim of this part of ISO 3506 is the classification of corrosion-resistant stainless steel nuts into property classes. 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 E.

Corrosion and oxidation performances and mechanical properties for use at elevated or sub-zero temperatures can be agreed on between the user and the manufacturer in each particular case. Annex F 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 can be evident (see Annex G).

2 Normative references

The following referenced documents are indispensable for the application 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 68-1, *ISO general purpose screw threads — Basic profile — Part 1: Metric screw threads*

ISO 261, *ISO general purpose metric screw threads — General plan*

ISO 262, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts*

ISO 272, *Fasteners — Hexagon products — Widths across flats*

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

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

ISO 3651-1, *Determination of resistance to intergranular corrosion of 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, *Determination of resistance to intergranular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid*

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 (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 16048, *Passivation of corrosion-resistant stainless-steel fasteners*

ISO 16426, *Fasteners — Quality assurance system*

3 Symbols

D	nominal thread diameter
m	height of the nut (nominal value)
P	pitch of the thread
R_{eL}	lower yield stress
$R_{p0,2}$	stress at 0,2 % permanent strain
s	width across flats
S_p	stress under proof load
μ_r	permeability value in a magnetic field

4 Designation, marking and finish

4.1 Designation

The designation system for stainless steel grades and property classes for nuts is given 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 and the second block, the property class.

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

— **A** for austenitic steel,

— **C** for martensitic steel, or

— **F** for ferritic steel

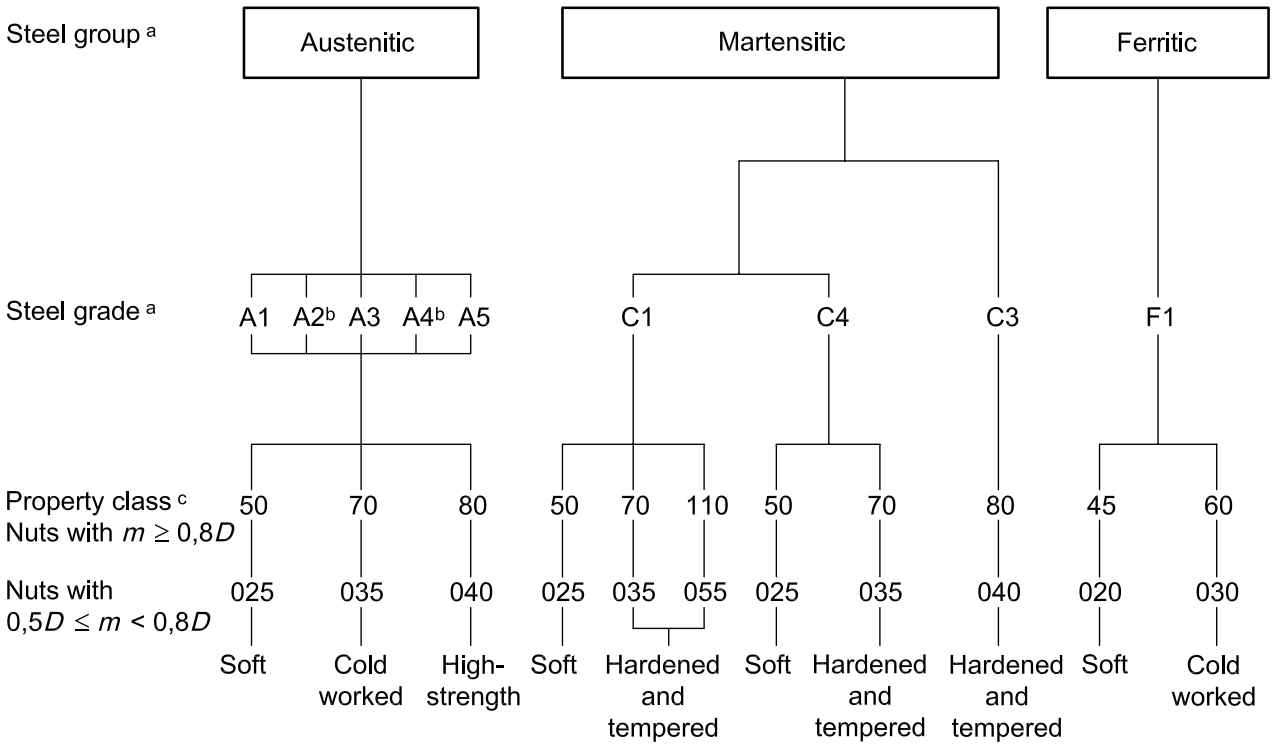
which indicates the group of steel and a digit, which indicates a range of chemical compositions within this steel group (see Table 1).

The designation of the property class (second block) consists of two digits for nuts with height $m \geqslant 0{,}8D$ (style 1 or style 2 or hexagon flange nuts), representing 1/10 of the stress under proof load, and three digits for nuts with height $0{,}5D \leqslant m < 0{,}8D$ (thin nuts/style 0), the first digit "0" indicating that the nut has a reduced loadability and the following digits representing 1/10 of the stress under proof load. The following are examples for the designation of material.

EXAMPLE 1 **A2-70** indicates: austenitic steel, cold worked, minimum 700 MPa stress under proof load (nut with $m \geqslant 0{,}8D$).

EXAMPLE 2 **C4-70** indicates: martensitic steel, hardened and tempered, minimum 700 MPa stress under proof load (nut with $m \geqslant 0{,}8D$).

EXAMPLE 3 **A2-035** indicates: austenitic steel, cold worked, minimum 350 MPa stress under proof load (nut with $0{,}5D \leqslant m < 0{,}8D$).



[a] 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.

[b] Low carbon austenitic stainless steels with carbon content not exceeding 0,03 % may additionally be marked with an “L”.

EXAMPLE **A4L-80**

[c] Nuts passivated in accordance with ISO 16048 may additionally be marked with a “P”.

EXAMPLE **A4-80P**

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

4.2 Marking

4.2.1 General

Nuts manufactured according to the requirements of this part of ISO 3506 shall be designated in accordance with the designation system described in 4.1 and marked in accordance with 4.2.2 and 4.2.3. However, the designation system described in 4.1 and the provisions for marking according to 4.2.3 shall be used only if all relevant requirements of this part of ISO 3506 are met.

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

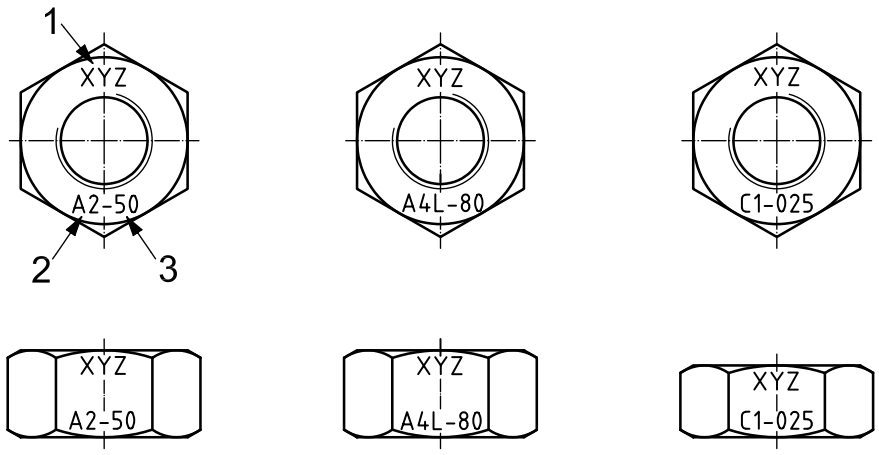
4.2.2 Manufacturer's identification mark

A manufacturer's identification mark shall be included during the manufacturing process on all nuts which are marked with a property class symbol, provided this is possible for technical reasons. Manufacturer's identification marking is also recommended on nuts which are not marked with a property class symbol.

4.2.3 Nuts

All nuts of nominal thread diameter $D \geqslant 5$ mm shall be clearly marked in accordance with 4.1, Figure 1 and Figure 2 or Figure 3. The marking is mandatory and shall include the steel grade and property class. Marking

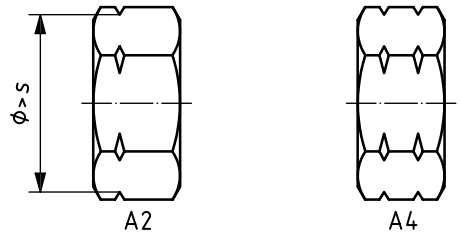
of only one nut face is acceptable and shall be by indentation only, when applied to the bearing surface of the nuts. Alternatively, marking on one side of the nuts is permissible.



Key

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

Figure 2 — Marking with material designation and manufacturer's identification mark



Key

s width across flats

Figure 3 — Alternative groove marking (for steel grades A2 and A4 only)

When the marking is made with grooves (see Figure 3) and the property class is not indicated, property class 50 or 025 will apply.

It is possible that certain nuts would not fulfil the proof load requirements because of fine pitch thread or the geometry of the nut. These nuts may be marked with the steel grade, but shall not be marked with the property class.

4.2.4 Packages

All packages for all types of nuts of all sizes shall be marked (e.g. through labelling). The marking or labelling shall include the manufacturer's and/or distributor's identification and the marking symbol for the steel grade and property class according to Figure 1 and the manufacturing lot number, as defined in ISO 16426.

4.3 Finish

Unless otherwise specified, nuts in accordance with this part of ISO 3506 shall be supplied clean and bright. For maximum corrosion resistance, passivation is recommended. When passivation is required, it shall be performed in accordance with ISO 16048. Nuts that are passivated may additionally be marked with the symbol “P” after the symbols for steel grade and property class (see footnote c of Figure 1).

For nuts manufactured to a specific order, the additional marking should be applied to both the fastener and the label. For nuts delivered from stock, the additional marking should be applied to the label.

5 Chemical composition

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

NOTE The chemical compositions given in Table 1 correspond with the chemical compositions given in ISO 3506-1:2009, Table 1, for the relevant steel grades.

The final choice of the chemical composition within the specified steel grade is at the discretion of the manufacturer, otherwise 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 of grades A3 and A5 or stainless steels of grades A2 and A4 with carbon content not exceeding 0,03 % are recommended.

Table 1 — Stainless steel grades — Chemical composition

Steel group	Steel grade	Chemical composition[a] mass fraction, %									Footnotes
		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	bcd
	A2	0,10	1	2	0,05	0,03	15 to 20	—[e]	8 to 19	4	fg
	A3	0,08	1	2	0,045	0,03	17 to 19	—[e]	9 to 12	1	h
	A4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	4	gi
	A5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	hi
Martensitic	C1	0,09 to 0,15	1	1	0,05	0,03	11,5 to 14	—	1	—	i
	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	—	bi
Ferritic	F1	0,12	1	1	0,04	0,03	15 to 18	—[j]	1	—	kl

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

NOTE 2 Examples of stainless steels standardized in accordance with ISO 683-13 and ISO 4954 are given in Annexes B and C, respectively.

NOTE 3 Certain materials for specific application are given in Annex D.

[a] Values are maximum, unless otherwise indicated.

[b] Sulfur may be replaced by selenium.

[c] If the nickel content is below 8 %, the minimum manganese content shall be 5 %.

[d] There is no minimum limit to the copper content, provided that the nickel content is greater than 8 %.

[e] Molybdenum may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this shall be stated at the time of ordering by the purchaser.

[f] If the chromium content is below 17 %, the minimum nickel content should be 12 %.

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

[h] This shall contain titanium $\geqslant 5 \times C$ up to 0,8 % maximum for stabilization and be marked appropriately as specified in this table, or shall contain niobium (columbium) and/or tantalum $\geqslant 10 \times C$ up to 1,0 % maximum for stabilization and be marked appropriately as specified in this table.

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

[j] Molybdenum may be present at the discretion of the manufacturer.

[k] This may contain titanium $\geqslant 5 \times C$ up to 0,8 % maximum.

[l] This may contain niobium (columbium) and/or tantalum $\geqslant 10 \times C$ up to 1 % maximum.

6 Mechanical properties

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

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

— hardness test, according to 7.1 (only steel grades C1, C3 and C4, hardened and tempered);

— proof load test, according to 7.2.

NOTE Although a great number of property classes are specified in this part of ISO 3506, this does not mean that all classes are appropriate for all nuts. Further guidance for application of the specific property classes is given in the relevant product standards.

For non-standard nuts, the choice already made for similar standard nuts should be followed as closely as possible.

Table 2 — Mechanical properties for nuts — Austenitic steel grades

Steel group	Steel grade	Property class		Stress under proof load S_p min. MPa	
		Nuts with $m \geqslant 0{,}8D$	Nuts with $0{,}5D \leqslant m < 0{,}8D$	Nuts with $m \geqslant 0{,}8D$	Nuts with $0{,}5D \leqslant m < 0{,}8D$
Austenitic	A1, A2,	50	025	500	250
	A3, A4,	70	035	700	350
	A5	80	040	800	400

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

Steel group	Steel grade	Property class		Stress under proof load S_p min. MPa		Hardness		
		Nuts with $m \geqslant 0{,}8D$	Nuts with $0{,}5D \leqslant m < 0{,}8D$	Nuts with $m \geqslant 0{,}8D$	Nuts with $0{,}5D \leqslant m < 0{,}8D$	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[a]	055[a]	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[b]	45	020	450	200	128 to 209	—	135 to 220
		60	030	600	300	171 to 271	—	180 to 285

[a] Hardened and tempered at a minimum tempering temperature of 275 °C.

[b] Nominal thread diameter $D \leqslant 24$ mm.

7 Test methods

7.1 Hardness HB, HRC or HV

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

The tests 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.

7.2 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 (all parts), 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.

The characteristics of the above-mentioned steel groups and steel grades are described in this annex.

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)

A.2.1 General

Five main grades of austenitic steels, A1 to A5, are included in ISO 3506 (all parts). They cannot be hardened and are usually non-magnetic. In order to reduce the susceptibility to work hardening, copper may be added to the 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 F).

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 of about 20 % and Mo of 4,5 % to 6,5 % are required.

When risk of corrosion is high, experts should be consulted.

A.2.2 Steel grade A1

Steels of grade A1 are specially designed for machining. Due to high sulfur content, the steels within this grade have lower resistance to corrosion than corresponding steels with normal sulfur content.

A.2.3 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. in swimming pools and sea water.

A.2.4 Steel grade A3

Steels of grade A3 are stabilized “stainless steels” with properties of steels of grade A2.

A.2.5 Steel grade A4

Steels of grade A4 are “acid proof steels”, which are Mo alloyed and give a 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 (hence the name “acid proof”) and is, to a certain extent, also suitable in an environment with chloride content. A4 is also frequently used by the food industry and by the shipbuilding industry.

A.2.6 Steel grade A5

Steels of grade A5 are stabilized “acid proof steels” with properties of steels of grade A4.

A.3 Steel group F (ferritic structure)

A.3.1 General

One ferritic steel grade, F1, is included in ISO 3506 (all parts). The steels within F1 cannot normally be hardened and should not be hardened even if possible in certain cases. The F1 steels are magnetic.

A.3.2 Steel grade F1

Steels of grade F1 are normally used for simpler equipment with the exception of the superferrites, which have extremely low C and N contents. The steels within grade F1 can, if need be, replace steels of grades A2 and A3 and be used in an environment with a higher chloride content.

A.4 Steel group C (martensitic structure)

A.4.1 General

Three types of martensitic steel grades, C1, C3 and C4, are included in this part of ISO 3506. They can be hardened to an excellent strength and are magnetic.

A.4.2 Steel grade C1

Steels of grade C1 have limited resistance to corrosion. They are used in turbines, pumps and knives.

A.4.3 Steel grade C3

Steels of grade C3 have limited resistance to corrosion, though better resistance than C1. They are used in pumps and valves.

A.4.4 Steel grade C4

Steels of grade C4 have limited resistance to corrosion. They are intended for machining, otherwise they are similar to steels of grade C1.

A.5 Steel group FA (ferritic-austenitic structure)

Steel group FA is not included in ISO 3506 (all parts), but will probably be included in a future edition.

Steels of this steel group are the so-called duplex steels. The FA steels first developed had some drawbacks, which were eliminated in the steels developed later. FA steels have better properties than steels of grades A4 and A5, especially where strength is concerned. They also exhibit superior resistance to pitting and crack corrosion.

Examples of composition are given in Table A.1.

Table A.1 — Examples of compositions of steels with ferritic-austenitic structure

Steel group	**Chemical composition** mass fraction, %						
	C max.	Si	Mn	Cr	Ni	Mo	N
Ferritic-austenitic	0,03	1,7	1,5	18,5	5	2,7	0,07
	0,03	< 1	< 2	22	5,5	3	0,14

Annex B
(informative)

Stainless steel composition specifications

[Extract from ISO 683-13:1986[1)]]

1) International Standard withdrawn.

Table B.1 — Stainless steel composition specifications

Type[a] of steel	Chemical composition[b] mass fraction, % C	Si max.	Mn max.	P max.	S	N	Al	Cr	Mo	Nb[c]	Ni	Se min.	Ti	Cu	Steel grade identification[d]
Ferritic steels															
8	0,08 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	—	—	F1
8b	0,07 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	$7 \times \%\ C \leqslant 1,10$	—	F1
9c	0,08 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	0,90 to 1,30	—	1,0 max.	—	—	—	F1
F1	0,025 max.[e]	1,0	1,0	0,040	0,030 max.	0,025 max.[e]	—	17,0 to 19,0	1,75 to 2,50	—[f]	0,60 max.	—	—[f]	—	F1
Martensitic steels															
3	0,09 to 0,15	1,0	1,0	0,040	0,030 max.	—	—	11,5 to 13,5	—	—	1,0 max.	—	—	—	C1
7	0,08 to 0,15	1,0	1,5	0,060	0,15 to 0,35	—	—	12,0 to 14,0	0,60 max.[g]	—	1,0 max.	—	—	—	C4
4	0,16 to 0,25	1,0	1,0	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—	C1
9a	0,10 to 0,17	1,0	1,5	0,060	0,15 to 0,35	—	—	15,5 to 17,5	0,60 max.[g]	—	1,0 max.	—	—	—	C3
9b	0,14 to 0,23	1,0	1,0	0,040	0,030 max.	—	—	15,0 to 17,5	—	—	1,5 to 2,5	—	—	—	C3
5	0,26 to 0,35	1,0	1,0	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—	C1
Austenitic steels															
10	0,030 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	—	—	A2[h]
11	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	8,0 to 11,0	—	—	—	A2
15	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	$5 \times \%\ C \leqslant 0,80$	—	A3[i]
16	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	$10 \times \%\ C \leqslant 1,0$	9,0 to 12,0	—	—	—	A3[i]
17	0,12 max.	1,0	2,0	0,060	0,15 to 0,35	—	—	17,0 to 19,0	—[j]	—	8,0 to 10,0[k]	—	—	—	A1
13	0,10 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	11,0 to 13,0	—	—	—	A2
19	0,030 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	—	—	A4
20	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—	A4
21	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	$5 \times \%\ C \leqslant 0,80$	—	A5[i]
23	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	$10 \times \%\ C \leqslant 1,0$	11,0 to 14,0	—	—	—	A5[i]
19a	0,030 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—	A4
20a	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,0 to 14,0	—	—	—	A4
10N	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	17,0 to 19,0	—	—	8,5 to 11,5	—	—	—	A2
19N	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—	A4[h]
19aN	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—	A4[h]

Table B.1 (*continued*)

[a] The type numbers are tentative and subject to alteration once the relevant International Standards are established.
[b] Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.
[c] Tantalum determined as niobium.
[d] This is not part of ISO 683-13.
[e] Maximum mass fraction (C + N) is 0,040 %.
[f] Mass fraction $8 \times (C + N) \leqslant$ mass fraction $(Nb + Ti) \leqslant 0{,}80$ %.
[g] Following agreement at the time of enquiry and order, the steel may be supplied with a mass fraction of Mo between 0,20 % and 0,60 %.
[h] Excellent resistance to intergranular corrosion.
[i] Stabilized steels.
[j] The manufacturer has the option of adding a mass fraction of $Mo < 0{,}70$ %.
[k] The maximum mass fraction of Ni of semi-finished products for fabrication into seamless tubes may be increased by 0,5 %.

Annex C
(informative)

Stainless steels for cold heading and extruding

(Extract from ISO 4954:1993)

Table C.1 — Stainless steels for cold heading and extruding

No.	Type of steel Designation[a] Name	In accordance with ISO 4954:1979	Chemical composition[b] mass fraction, % C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Other	Steel grade identification[c]
Ferritic steels												
71	X 3 Cr 17 E	—	⩽ 0,04	1,00	1,00	0,040	0,030	16,0 to 18,0		⩽ 1,0		F1
72	X 6 Cr 17 E	D 1	⩽ 0,08	1,00	1,00	0,040	0,030	16,0 to 18,0		⩽ 1,0		F1
73	X 6 CrMo 17 1 E	D 2	⩽ 0,08	1,00	1,00	0,040	0,030	16,0 to 18,0	0,90 to 1,30	⩽ 1,0		F1
74	X 6 CrTi 12 E	—	⩽ 0,08	1,00	1,00	0,040	0,030	10,5 to 12,5		⩽ 0,50	Ti: 6 × % C ⩽ 1,0	F1
75	X 6 CrNb 12 E	—	⩽ 0,08	1,00	1,00	0,040	0,030	10,5 to 12,5		⩽ 0,50	Nb: 6 × % C ⩽ 1,0	F1
Martensitic steels												
76	X 12 Cr 13 E	D 10	0,90 to 0,15	1,00	1,00	0,040	0,030	11,5 to 13,5		⩽ 1,0		C1
77	X 19 CrNi 16 2 E	D 12	0,14 to 0,23	1,00	1,00	0,040	0,030	15,0 to 17,5		1,5 to 2,5		C3
Austenitic steels												
78	X 2 CrNi 18 10 E	D 20	⩽ 0,030	1,00	2,00	0,045	0,030	17,0 to 19,0		9,0 to 12,0		A2[d]
79	X 5 CrNi 18 9 E	D 21	⩽ 0,07	1,00	2,00	0,045	0,030	17,0 to 19,0		8,0 to 11,0		A2
80	X 10 CrNi 18 9 E	D 22	⩽ 0,12	1,00	2,00	0,045	0,030	17,0 to 19,0		8,0 to 10,0		A2
81	X 5 CrNi 18 12 E	D 23	⩽ 0,07	1,00	2,00	0,045	0,030	17,0 to 19,0		11,0 to 13,0		A2
82	X 6 CrNi 18 16 E	D 25	⩽ 0,08	1,00	2,00	0,045	0,030	15,0 to 17,0		17,0 to 19,0		A2
83	X 6 CrNiTi 18 10 E	D 26	⩽ 0,08	1,00	2,00	0,045	0,030	17,0 to 19,0		9,0 to 12,0	Ti: 5 × % C ⩽ 0,80	A3[e]
84	X 5 CrNiMo 17 12 2 E	D 29	⩽ 0,07	1,00	2,00	0,045	0,030	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5		A4
85	X 6 CrNiMoTi 17 12 2 E	D 30	⩽ 0,08	1,00	2,00	0,045	0,030	16,5 to 18,5	2,0 to 2,5	11,0 to 14,0	Ti: 5 × % C ⩽ 0,80	A5[e]
86	X 2 CrNiMo 17 13 3 E	—	⩽ 0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,5 to 3,0	11,5 to 14,5		A4[d]
87	X 2 CrNiMoN 17 13 3 E	—	⩽ 0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,5 to 3,0	11,5 to 14,5	N: 0,12 to 0,22	A4[d]
88	X 3 CrNiCu 18 9 3 E	D 32	⩽ 0,04	1,00	2,00	0,045	0,030	17,0 to 19,0		8,5 to 10,5	Cu: 3,00 to 4,00	A2

[a] The designations given in the first column are consecutive numbers. The designations given in the second column are in accordance with the system proposed by ISO/TC 17/SC 2. The designations given in the third column represent the antiquated numbers of ISO 4954:1979 (revised by ISO 4954:1993).

[b] Elements not quoted in this table should not be intentionally added to the steel without the agreement of the purchaser, other than for finishing the heat. All reasonable precautions should be taken to prevent the addition, from scrap or other materials used in manufacture, of elements which affect mechanical properties and applicability.

[c] This is not part of ISO 4954.

[d] Excellent resistance to intergranular corrosion.

[e] Stabilized steels.

Annex D
(informative)

Austenitic stainless steels with particular resistance to chloride induced stress corrosion

(Extract from EN 10088-1:2005)

The risk of failure of bolts, screws and studs by chloride induced stress corrosion (for example in indoor swimming pools) can be reduced by using the materials given in Table D.1.

Table D.1 — Austenitic stainless steels with particular resistance to chloride induced stress corrosion

Austenitic stainless steel (Symbol/material number)	**Chemical composition** mass fraction, %									
	C max.	Si max.	Mn max.	P max.	S max.	N	Cr	Mo	Ni	Cu
X2CrNiMoN17-13-5 (1.4439)	0,030	1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	4,0 to 5,0	12,5 to 14,5	
X1NiCrMoCu25-20-5 (1.4539)	0,020	0,70	2,00	0,030	0,010	$\leqslant$ 0,15	19,0 to 21,0	4,0 to 5,0	24,0 to 26,0	1,20 to 2,00
X1NiCrMoCuN25-20-7 (1.4529)	0,020	0,50	1,00	0,030	0,010	0,15 to 0,25	19,0 to 21,0	6,0 to 7,0	24,0 to 26,0	0,50 to 1,50
X2CrNiMoN22-5-3[a] (1.4462)	0,030	1,00	2,00	0,035	0,015	0,10 to 0,22	21,0 to 23,0	2,5 to 3,5	4,5 to 6,5	

[a] Ferritic-austenitic stainless steel.

Annex E
(informative)

Mechanical properties at elevated temperatures; application at low temperatures

NOTE If the bolts, screws or studs are properly calculated, the mating nuts automatically meet the requirements. Therefore, in the case of application at elevated or low temperatures, it is sufficient to consider the mechanical properties of bolts, screws and studs only.

E.1 Lower yield stress or stress at 0,2 % permanent strain at elevated temperatures

The values given in this annex are for guidance only. Users should understand that the actual chemistry, the loading of the installed fastener and the environment can cause significant variation. If loads are fluctuating and operating periods at elevated temperatures are great or the possibility of stress corrosion is high, the user should consult the manufacturer.

For values for lower yield stress, R_{eL}, and stress at 0,2 % permanent strain, $R_{p0,2}$, at elevated temperatures in % of the values at room temperature, see Table E.1.

Table E.1 — Influence of temperature on R_{eL} and $R_{p0,2}$

Steel grade	R_{eL} and $R_{p0,2}$ % Temperature			
	+ 100 °C	+ 200 °C	+ 300 °C	+ 400 °C
A2, A3, A4, A5	85	80	75	70
C1	95	90	80	65
C3	90	85	80	60
NOTE This applies to property classes 70 and 80 only.				

E.2 Application at low temperatures

For application of stainless steel bolts, screws and studs at low temperatures, see Table E.2.

Table E.2 — Application of stainless steel bolts, screws and studs at low temperatures
(austenitic steel only)

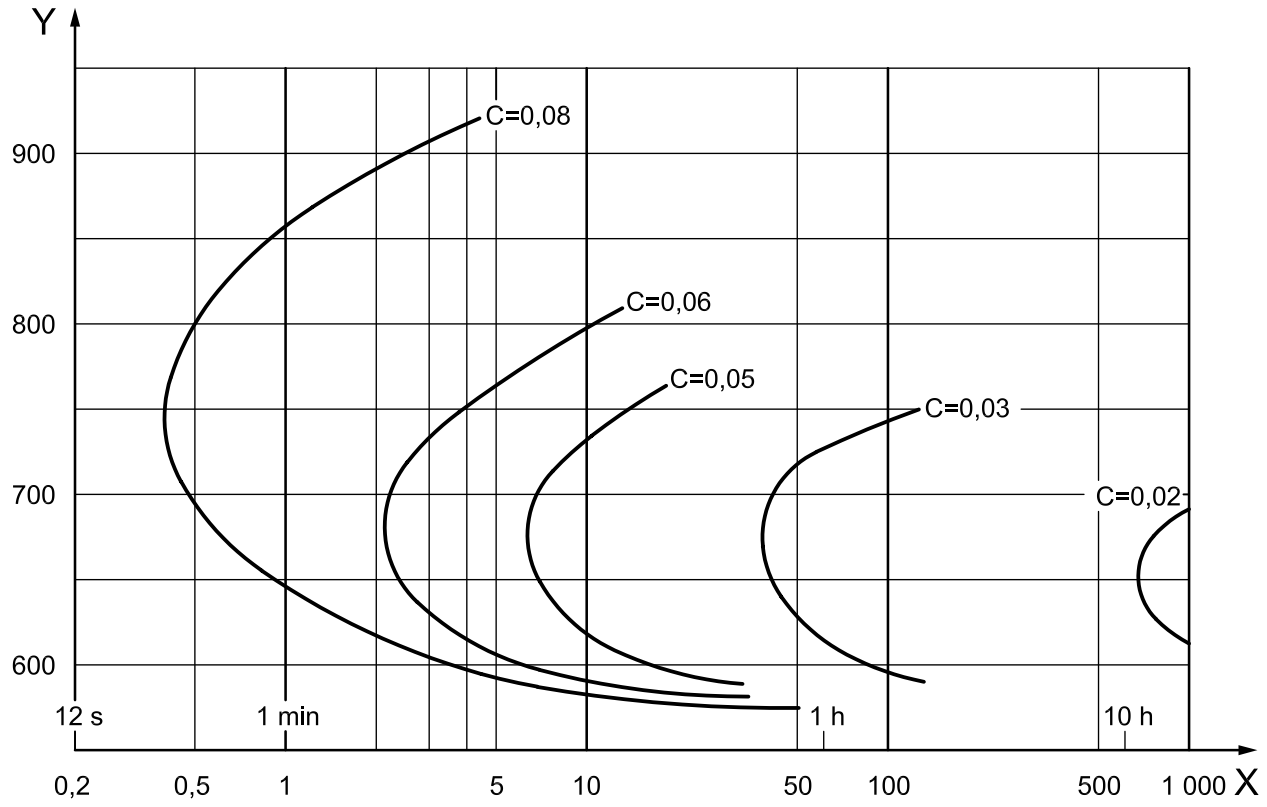
Steel grade	Lower limits of operational temperature at continuous operation	
A2, A3	– 200 °C	
A4, A5	bolts and screws[a]	– 60 °C
	studs	– 200 °C
[a] In connection with the alloying element Mo, the stability of the austenite is reduced and the transition temperature is shifted to higher values, if a high degree of deformation during the manufacture of the fastener is applied.		

Annex F
(informative)

Time-temperature diagram of intergranular corrosion in austenitic stainless steels, grade A2 (18/8 steels)

Figure F.1 gives the approximate time for austenitic stainless steels, grade A2 (18/8 steels), with different carbon contents in the temperature zone between 550 °C and 925 °C before risk of intergranular corrosion occurs.

NOTE With lower carbon contents, the resistance against intergranular corrosion is improved.



Key

X time, expressed in minutes

Y temperature, expressed in degrees Celsius

Figure F.1 — Time-temperature diagram of intergranular corrosion in austenitic stainless steels, grade A2

Annex G
(informative)

Magnetic properties for austenitic stainless steels

Where specific magnetic properties are required, an experienced metallurgist should be consulted.

All austenitic stainless steel fasteners are normally non-magnetic; after cold working, it is possible for some magnetic properties to be evident.

Each material is characterized by its ability to be magnetized, which applies even to stainless steel. It is only possible for a vacuum to be entirely non-magnetic. The measure of the material's permeability in a magnetic field is the permeability value μ_r for that material in relation to a vacuum. The material has low permeability if μ_r becomes close to 1.

EXAMPLE 1 A2: $\mu_r \approx 1{,}8$

EXAMPLE 2 A4: $\mu_r \approx 1{,}015$

EXAMPLE 3 A4L: $\mu_r \approx 1{,}005$

EXAMPLE 4 F1: $\mu_r \approx 5$

Bibliography

[1] ISO 683-13:1986[2)], *Heat-treatable steels, alloy steels and free cutting steels — Part 13: Wrought stainless steels*

[2] ISO 4954:1993, *Steels for cold heading and cold extruding*

[3] ISO 8044, *Corrosion of metals and alloys — Basic terms and definitions*

[4] EN 10088-1:2005, *Stainless steels — Part 1: List of stainless steels*

2) International Standard withdrawn.

ICS 21.060.20

Price based on 21 pages