



International
Standard

ISO 3506-3

**Fasteners — Mechanical properties
of corrosion resistant stainless steel
fasteners —**

Part 3:

**Set screws (and similar fasteners not
under tensile stress) with specified
grades and hardness classes**

*Fixations — Caractéristiques mécaniques des fixations en acier
inoxydable résistant à la corrosion —*

*Partie 3: Vis sans tête (et fixations similaires non soumises à des
contraintes de traction) de grades et classes de dureté spécifiés*

Third edition
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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 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 2, *Fasteners*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 185 *Fasteners*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 3506-3:2009), which has been technically revised.

The main changes are as follows:

- annexes common to several parts of the ISO 3506 series have been withdrawn from this document and are now included in the new ISO 3506-6 which is to be used with this document;
- austenitic stainless steel of grade A8 and duplex (austenitic-ferritic) stainless steels of grades D2 to D8 for hardness class 21H have been added (see [Figure 1](#));
- operational temperature ranges have been clarified (see [Clause 1](#));
- terms and definitions have been added (see [Clause 3](#));
- wording for surface conditions and corrosion resistance have been improved (see [5.2](#) and [5.3](#));
- manufacturer's, supplier's and purchaser's inspections have been added (see [Clause 7](#));
- hardness test and proof torque test methods have been improved (see [Clause 8](#));
- marking and labelling have been improved (see [Clause 9](#));
- structure and content of this document have been brought in line with other parts of ISO 3506 published recently.

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.

Introduction

The properties of stainless steel fasteners result from the chemical composition of the material (especially corrosion resistance) and from the mechanical properties due to manufacturing process. Austenitic and duplex (austenitic-ferritic) stainless steel fasteners are generally manufactured by cold working; they consequently do not have homogeneous local material properties when compared to quenched and tempered fasteners.

Austenitic-ferritic stainless steels referred to as duplex stainless steels were originally invented in the 1930s and have been increasingly used since the 1980s. This document was revised to reflect their standardization for fasteners.

All duplex stainless steels show improved resistance to stress corrosion cracking compared to the commonly used A2 to A5 austenitic grades. Most duplex grades also show higher levels of pitting corrosion resistance, where D2 matches at least A2 and where D4 matches at least A4.

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Fasteners — Mechanical properties of corrosion resistant stainless steel fasteners —

Part 3: Set screws (and similar fasteners not under tensile stress) with specified grades and hardness classes

1 Scope

This document specifies the mechanical and physical properties of set screws and similar fasteners not under tensile stress, made of corrosion resistant austenitic and duplex stainless steels, with specified grades and hardness classes.

ISO 3506-6 provides general rules and additional technical information on suitable stainless steels and their properties (detailed properties of stainless steel grades, corrosion behaviour with regards to pitting, crevice and intergranular corrosion, magnetic properties, etc.).

WARNING — Set screws conforming to the requirements of this document are tested at the ambient temperature range of 10 °C to 35 °C and are used in application ranging from -20 °C to +150 °C. It is possible that they do not retain the specified mechanical and physical properties at lower and/or elevated temperatures. Therefore, it is the responsibility of the user to determine the appropriate choices based on service environment conditions of the assembly (see also [Clauses 5](#) and [6](#)).

This document applies to set screws and similar fasteners not under tensile stress

- with ISO metric thread in accordance with ISO 68-1,
- with diameter/pitch combinations in accordance with ISO 261 and ISO 262,
- with nominal thread diameter 1,6 mm to 24 mm,
- with thread tolerances in accordance with ISO 965-1 and ISO 965-2,
- with specified hardness classes, and
- of any shape.

NOTE The term set screw is used in the following for all screws and similar fasteners not under tensile stress within the scope of this document.

This document does not apply to screws under tensile stress (see ISO 3506-1). It does not specify requirements for functional properties such as shear strength or weldability.

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 965-3, *ISO general purpose metric screw threads — Tolerances — Part 3: Limit deviations for screw threads*

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

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 16228, *Fasteners — Types of inspection documents*

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

set screw

headless screw with ISO metric thread designed to be used under compression load

3.2

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]

3.3

austenitic stainless steel

stainless steel (3.2) with high amounts of chromium and nickel which usually cannot be hardened by heat treatment, providing excellent resistance to corrosion, good ductility, and usually low or non-magnetic properties

[SOURCE: ISO 3506-1:2020, 3.6]

3.4

duplex stainless steel

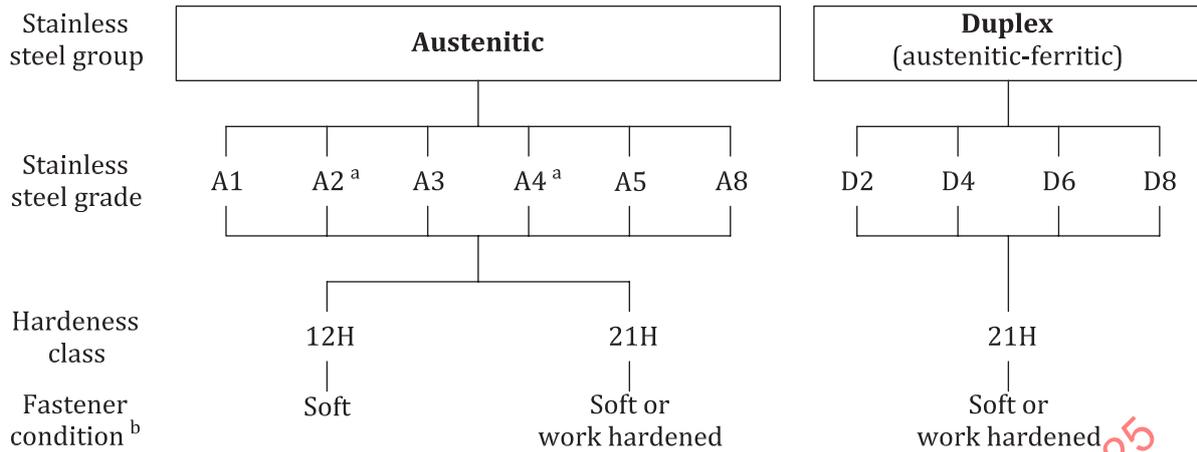
stainless steel (3.2) with a micro-structure that includes both austenitic and ferritic phases providing excellent resistance to corrosion, containing a higher amount of chromium and a reduced quantity of nickel compared to austenitic steel, with high strength, and with magnetic properties

[SOURCE: ISO 3506-1:2020, 3.9]

4 Designation system for stainless steel grades and hardness classes

4.1 General

The designation system for stainless steel set screws consists of two blocks, separated by a hyphen: the stainless steel grade and the hardness class, as specified in [Figure 1](#).



^a For low carbon austenitic stainless steels with carbon content not exceeding 0,030 %, set screws can additionally be designated with the letter “L” just after the grade. Example: A4L-21H.

^b For information only.

Figure 1 — Designation system for stainless steel set screws

The marking, labelling and designation of set screws with stainless steel grade and hardness class shall be as specified in [Clause 9](#).

This designation system may be used for sizes outside the diameter limits specified in this document (e.g. for $d > 24$ mm), provided that all applicable chemical, mechanical and physical requirements are met.

4.2 Designation of stainless steel grades (first block)

The designation of the stainless steel grade (first block) consists of one letter which specifies the stainless steel group:

- **A** for austenitic,
- **D** for duplex (austenitic-ferritic),

and

- a digit which specifies the range of chemical compositions within this stainless steel group.

The chemical compositions of stainless steel groups and grades classified in [Figure 1](#) are specified in [Table 2](#).

4.3 Designation of hardness classes (second block)

The designation of the hardness class (second block) consists of two parts, as specified in [Table 1](#):

- the number to the left corresponds to 1/10 of the minimum Vickers hardness, and
- the letter H to the right represents Vickers hardness.

Table 1 — Designation of hardness classes in relation to Vickers hardness

Hardness class		12H	21H
Vickers hardness, HV	min.	125	210

EXAMPLE 1 A2-12H specifies a set screw in austenitic stainless steel of grade A2, soft, with a minimum hardness of 125 HV.

EXAMPLE 2 D4-21H specifies a set screw in duplex stainless steel of grade D4, soft or work hardened, with a minimum hardness of 210 HV.

5 Materials

5.1 Chemical composition

[Table 2](#) specifies the limits for chemical composition of the stainless steel grades for fasteners. The chemical composition shall be assessed in accordance with the relevant International Standards.

The final choice of the chemical composition within the specified stainless steel grade is at the discretion of the manufacturer, unless otherwise agreed between the purchaser and the manufacturer.

The stainless steel grade suitable for an application shall be selected in accordance with ISO 3506-6. ISO 3506-6 also gives examples of stainless steels related to each grade specified in [Table 2](#) (see also Bibliography for additional material information).

Stainless steel grades A2 and A4, as well as A1 for machined screws (e.g. slotted set screws), are usually available on the market; for other grades, it is recommended that a fastener expert be consulted.

For corrosion resistance, see also [5.2](#) and [5.3](#).

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Table 2 — Stainless steel grades — Chemical composition

Stainless steel grade	Chemical composition ^a (cast analysis, % by mass) ^b										Other elements and notes	
	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N		
Austenitic	A1	0,12	1,00	6,5	0,020	0,15 to 0,35	16,0 to 19,0	5,0 to 10,0	0,70	1,75 to 2,25	—	c, d, e
	A2	0,10	1,00	2,00	0,050	0,030	15,0 to 20,0	8,0 to 19,0	— ^f	4,0	—	g, h
	A3	0,08	1,00	2,00	0,045	0,030	17,0 to 19,0	9,0 to 12,0	— ^f	1,00	—	5C ≤ Ti ≤ 0,80 and/or 10C ≤ Nb ≤ 1,00
	A4	0,08	1,00	2,00	0,045	0,030	16,0 to 18,5	10,0 to 15,0	2,00 to 3,00	4,0	—	^{h, i}
	A5	0,08	1,00	2,00	0,045	0,030	16,0 to 18,5	10,5 to 14,0	2,00 to 3,00	1,00	—	5C ≤ Ti ≤ 0,80 and/or 10C ≤ Nb ≤ 1,00 ⁱ
	A8	0,030	1,00	2,00	0,040	0,030	19,0 to 22,0	17,5 to 26,0	6,0 to 7,0	1,50	—	—
Duplex	D2	0,04	1,00	6,0	0,040	0,030	19,0 to 24,0	1,50 to 5,5	0,10 to 1,00	3,00	0,050 to 0,20	Cr+3,3Mo+16N ≤ 24,0 ^j
	D4	0,04	1,00	6,0	0,040	0,030	21,0 to 25,0	1,00 to 5,5	0,10 to 2,00	3,00	0,050 to 0,30	24,0 < Cr+3,3Mo+16N ^j
	D6	0,030	1,00	2,00	0,040	0,015	21,0 to 23,0	4,5 to 6,5	2,50 to 3,5	—	0,080 to 0,35	—
	D8	0,030	1,00	2,00	0,035	0,015	24,0 to 26,0	6,0 to 8,0	3,00 to 4,5	2,50	0,20 to 0,35	W ≤ 1,00

^a According to material standards, values are maximum unless otherwise specified; the number of digits shown is in accordance with usual rules, see e.g. ISO 6306 or EN 10088-1.

^b In case of dispute, product analysis applies.

^c Selenium can be used to replace sulphur, however restrictions may apply to its use.

^d If the nickel content is below 8,0 %, the minimum manganese content shall be 5,0 %.

^e There is no minimum limit to the copper content provided that the nickel content is greater than 8,0 %.

^f 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.

^g If the chromium content is below 17,0 %, the minimum nickel content should be 12,0 %.

^h For austenitic stainless steels having a maximum carbon content of 0,030 %, nitrogen may be present but shall not exceed 0,22 % (see ISO 15510).

ⁱ At the discretion of the manufacturer, the carbon content may be higher as necessary to achieve the specified mechanical and physical properties for larger diameters, but shall not exceed 0,12 %.

^j This formula is used solely for the purpose of classifying duplex stainless steels in accordance with this document (it is not intended to be used as a selection criterion for corrosion resistance).

5.2 Surface condition (finish and/or coating)

Unless otherwise specified, set screws in accordance with this document shall be supplied clean and bright.

For maximum corrosion resistance, an additional passivation process may be performed, e.g. in accordance with ISO 16048. Additional passivation, if any, shall be required by the purchaser at the time of the order. Set screws that are passivated in accordance with ISO 16048 may additionally be referenced on the label with the letter “P” just after the hardness class (see 9.3).

NOTE Set screws with additional passivation do not always show a bright surface aspect.

Any other specific requirement shall be agreed between the purchaser and the supplier at the time of the order.

5.3 Corrosion resistance

The stainless steel grade suitable for an application shall be selected in accordance with ISO 3506-6, by taking into account the corrosion resistance in the expected corrosive service environment.

Details on the different types of corrosion (stress corrosion cracking, pitting and crevice corrosion, intergranular corrosion) are given in ISO 3506-6.

Galvanic corrosion (also called contact corrosion) should be considered when designing a joint where materials with different electrical potentials are assembled (stainless steel fasteners and assembled parts), if the joint is exposed to a wet or humid atmosphere and/or if condensation may occur.

For further information about the risk of corrosion, consulting an experienced materials specialist is recommended.

5.4 Magnetic properties

Details on magnetic properties are given in ISO 3506-6.

Austenitic stainless steels in the annealed state are usually non-magnetic; however, some residual magnetism can occur as a result of work hardening during the fastener manufacture.

6 Requirements for mechanical and physical properties

6.1 General

The manufacturer shall ensure the fastener conformity with the mechanical and physical properties specified in this document.

When tested at ambient temperature by the methods specified in [Clause 8](#), the set screws with specified stainless steel grade and hardness class shall meet all the applicable requirements specified in [6.2](#) and [6.3](#), regardless of which tests are performed during manufacture or final inspection (see [Clause 7](#)).

6.2 Hardness requirements

When tested in accordance with [8.2](#), the set screws shall meet the hardness requirements specified in [Table 3](#).

Table 3 — Hardness requirements

Test method	Hardness class			
	12H		21H	
	Hardness requirements			
	min.	max.	min.	max.
Vickers hardness, HV	125	209	210	—

6.3 Proof torque requirements for socket set screws

When tested in accordance with [8.3](#), the set screws with hexagon normal socket depth and hexalobular socket set screws shall withstand the proof torque specified in [Table 4](#) without failing, i.e. no socket splitting, thread stripping, cracking or fracture.

Visual marks at the socket due to proof torque testing shall not be cause of rejection.

7 Inspection

7.1 Manufacturer's inspection

Set screws produced in accordance with this document shall meet to all applicable requirements specified in [Clauses 5](#) and [6](#), when using the applicable test methods specified in [Clause 8](#).

This document does not mandate which of the tests the manufacturer shall perform on each manufacturing lot. It is the responsibility of the manufacturer to apply the suitable methods of their choice, such as in-process control or final inspection, to ensure that the manufactured lot does indeed conform to all specified requirements. For additional information, see ISO 16426.

In case of dispute, the test methods in accordance with [Clause 8](#) shall apply.

7.2 Supplier's inspection

The supplier may control and/or test the set screws they provide using methods of their choice (periodic evaluation of the manufacturer, checking of test results from the manufacturer, tests on the set screws themselves, etc.), provided the chemical, mechanical and physical properties specified in [Clauses 5](#) and [6](#) are met.

In case of dispute, the test methods in accordance with [Clause 8](#) shall apply.

7.3 Purchaser's inspection

The purchaser may control and/or test the delivered set screws by using the test methods specified in [Clause 8](#).

In case of dispute, the test methods in accordance with [Clause 8](#) shall apply.

7.4 Delivery of test results

If the purchaser requires test results from the supplier, the type of test report shall be agreed upon at the time of the order. The test report shall be established in accordance with ISO 16228, unless otherwise specified. The type of test report (F2.2, F3.1 or F3.2) and any additional or specific test shall also be specified by the purchaser and agreed upon at the time of the order.

8 Test methods

8.1 General

Set screws shall be tested in the as-received condition.

8.2 Hardness test for set screws

8.2.1 General

The purpose of this test is to determine that the hardness of the set screw meets the requirements specified in [Table 3](#) (minimum and maximum values).

This test applies to all types of set screws within the scope of this document.

8.2.2 Test procedure

The hardness test shall be carried out in accordance with ISO 6507-1 (HV).

The hardness determination shall be performed on a flat surface at the point end of the set screw, as close as possible to the fastener axis.

For set screws with flat end, the surface shall be prepared with a suitable process where hardness is not altered by excessive heating or work hardening (e.g. by a light grinding and/or polishing).

For set screws with non-flat end, the point shall first be levelled with a suitable process where hardness is not altered by excessive heating or work hardening (e.g. by grinding), and the surface shall be suitably prepared:

- for cone point, the flat surface shall provide the edge distance required for the hardness determination;
- for cup point, the cup shall be completely levelled so that the hardness determination can be performed at the fastener axis.

The hardness shall be determined by taking three readings, either on the same fastener if the size of the flat area allows it, or on three set screws from the same manufacturing lot. The hardness value shall be the mean of these three readings.

8.2.3 Test result and requirement

Hardness value shall be in accordance with [Table 3](#).

In case of dispute, the Vickers hardness test with HV 10 shall be the reference test method. If the largest possible surface area does not provide the edge distance required for the hardness determination with HV 10, then HV 5 (or even HV 1) shall be the reference test method.

8.3 Proof torque test for socket set screws

8.3.1 General

The purpose of this proof torque test is to check the functional ability of the socket.

This test applies to:

- hexagon socket set screws with normal socket depth¹⁾,
- hexalobular socket set screws.

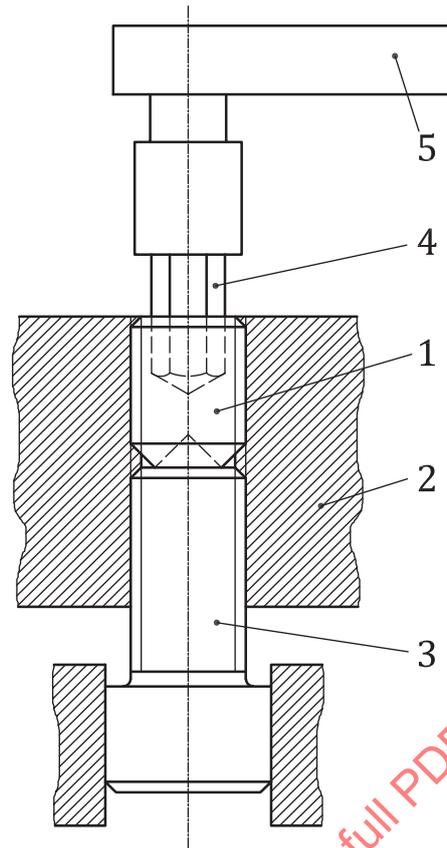
8.3.2 Test procedure

The testing device consists of a threaded test block, a supporting element, a drive bit and a torque measuring device (see [Figure 2](#)). The testing device shall fulfil the following requirements.

- a) Steel test block: thread tolerance class 5H in accordance with ISO 965-3, and minimum hardness of 50 HRC.
- b) Supporting element: flat bearing surface and hardness of 450 HV to 570 HV (a backing screw can be used).
- c) Drive bit for hexagon socket: tolerance h9 for the width across flats s , width across corners $e \geq 1,13 s_{\min}$, and hardness of 50 HRC to 60 HRC.
- d) Drive bit for hexalobular socket: hardness of 50 HRC to 60 HRC.
- e) The torque measuring device shall have an accuracy of $\pm 4\%$ of the value to be applied, or better.

The testing device shall be sufficiently rigid to avoid deformation that could influence the test result.

1) Hexagon socket set screws with short socket depth are not subject to the proof torque test.



Key

- 1 set screw to be tested
- 2 threaded test block
- 3 supporting element, e.g. backing screw
- 4 drive bit for hexagon or hexalobular socket
- 5 torque measuring device

Figure 2 — Example of testing device for proof torque test

The set screw shall be inserted in the threaded test block as shown in [Figure 2](#); the top of the screw at the socket side shall be flush with the test block. The point of the set screw shall firmly bear on the supporting element, for example a backing screw inserted from the other side.

The bit shall be engaged to the full depth of the hexagon or hexalobular socket. The driving tool shall be aligned with the axis of the set screw.

The torque shall be applied in a continuously increasing manner until the proof torque specified in [Table 4](#) is reached. The proof torque shall be maintained for 15 s, and then released. The set screw shall be removed from the test block.

Table 4 — Proof torque test

Nominal thread diameter <i>d</i>	Proof torque ^a (Nm)	
	Hardness class	
	12H	21H
1,6	0,03	0,05
2	0,06	0,10
2,5	0,18	0,30
3	0,25	0,42
4	0,80	1,40
5	1,70	2,80
6	3,00	5,00
8	7,00	12,0
10	14,0	24,0
12	25,0	42,0
16	63,0	105
20	126	210
24	200	332

^a Only for hexalobular socket set screws, and for hexagon socket set screws with normal socket depth.

8.3.3 Test result and requirement

After removal of the set screw from the testing device, the socket shall fulfil the requirements specified in [6.3](#).

9 Marking and labelling

9.1 General

Stainless steel set screws manufactured to the requirements of this document shall be designated in accordance with the designation system specified in [Clause 4](#).

The designation system specified in [Clause 4](#) shall only be used and marking and labelling shall only be affixed in accordance with this [Clause 9](#) when all applicable requirements of this document are met:

- chemical composition as specified in [Table 2](#),

and

- mechanical and physical properties specified in [Clause 6](#), when tested in accordance with [Clause 8](#).

Marking on the set screws is not mandatory but left to the manufacturer's choice. If marking is performed, it should be in accordance with [9.2](#).

Labelling of the packages is always required and shall be in accordance with [9.3](#).

9.2 Marking on the set screws

Marking of set screws is not usual, however it may be included during the manufacturing process at the manufacturer's discretion. If marking is performed, it shall result in a durable identification on the set screws.

Marking on set screws should include the stainless steel grade and hardness class in accordance with [Clause 4](#) (in case of lack of space on the screw the letter H may be omitted), and the manufacturer's identification mark.