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Stainless steels for general purposes —

Part 4: Bright products

Aciers inoxydables pour usage général —

Partie 4: Produits transformés à froid

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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 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

This first edition of ISO 16143-4, together with ISO 683-7, cancels and replaces ISO 683-18:2014, which has been technically revised.

The main changes are as follows:

— ISO 683-18 was split into ISO 683-7 for non-alloy and alloy steels and into ISO 16143-4 for stainless steels;

— three austenitic steel grades, three austenitic-ferritic steel grades, two ferritic steel grades and two martensitic steel grades were added;

— definition for out-of-round was modified with two new definitions on ovality and out-of-shape;

— editorial revision.

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.

Stainless steels for general purposes —

Part 4:
Bright products

1 Scope

This document specifies the technical delivery requirements for bright products made of stainless steels in the form of bars in the drawn, peeled/turned or additionally ground condition and they are intended for mechanical purposes, for example for machine parts, and/or for use at high temperature including creep-resistant applications.

NOTE 1 Bright steel products made of corrosion-resistant stainless steel are manufactured from steels mentioned in ISO 16143-2, and bright steel products intended for high-temperature purposes are manufactured from steels mentioned in ISO 4955.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404, *Steel and steel products — General technical delivery requirements*

ISO 4885, *Ferrous materials — Heat treatments — Vocabulary*

ISO 4948-1, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

ISO 4955, *Heat-resistant steels*

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

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

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

ISO 6929, *Steel products — Vocabulary*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 15510, *Stainless steels — Chemical composition*

ISO 16143-2, *Stainless steels for general purposes — Part 2: Corrosion-resistant semi-finished products, bars, rods and sections*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 4885, ISO 4948-1, ISO 4948-2, ISO 4955, ISO 6929, ISO 14284, ISO 15510, ISO 16143-2 and the following 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
bright product
drawn or peeled/turned product with smoother surface quality and better dimensional accuracy in comparison to hot-rolled product

3.2
drawn product
product of various cross-sectional shapes obtained, after descaling, by cold drawing of a hot-rolled product, on a drawing bench (cold formation without removing material)

Note 1 to entry: This operation gives the product special features with respect to shape, dimensional accuracy and surface finish. Products in lengths are delivered straightened, products of small cross-section may also be supplied in coils.

3.3
peeled/turned product
round bar produced by peeling or turning where the product can be further processed by straightening and polishing

Note 1 to entry: This operation gives the bar special features with respect to shape, dimensional accuracy and surface finish. The removal of metal is carried out in such a way that the bright product is generally free from rolling defects and surface decarburization.

3.4
product in the ground condition
ground product
drawn or peeled/turned round bar given an improved surface quality and dimensional accuracy by grinding or by grinding and polishing

3.5
thickness
nominal dimension of the product

Note 1 to entry: That means:

a) the diameter in the case of rounds;

b) the lateral length in the case of squares;

c) the width over flats in the case of hexagons;

d) the shorter lateral length in the case of flats (rectangular bars) and wide-flats.

For special sections, 'thickness' shall be defined at the time of enquiry and order.

3.6
ovality
difference between the smallest and largest dimension measured across the pairs of opposing points at a common cross-section

3.7
out of shape
deviation from the nominal section profile

EXAMPLE Parallelism, perpendicularity and twist.

3.8
ruling section
that section for which the specified mechanical properties apply

Note 1 to entry: Independent of the actual shape and dimensions of the cross-section of the product, the size of its ruling section is always given by a diameter. This corresponds to the diameter of an "equivalent round bar". That is a round bar which will show the same cooling rate as the actual ruling section of the product concerned at its position for taking the test pieces, when being cooled from austenitizing temperature.

3.9
stainless steel
steel with at least 10,5 % (mass fraction) Cr and a maximum of 1,2 % (mass fraction) C

Note 1 to entry: For the classification of stainless steels according to their structure, composition and application, see ISO 15510:2014, Annex C.

[SOURCE: ISO 15510:2014, 3.1]

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades is allocated in accordance with ISO 4948-1 and ISO 4948-2.

Stainless steels covered by this document are further classified according to their structure into

— austenitic steels,

— austenitic-ferritic steels,

— ferritic steels,

— martensitic steels, or

— precipitation-hardening steels.

4.2 Designation

For the steel grades covered by this document, the steel names given in the relevant tables are allocated in accordance with ISO/TS 4949.

NOTE Designation of steels covered by this document and of comparable grades covered in various other designation systems are given in Annex E.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The manufacturer shall obtain the following information from the purchaser at the time of enquiry and order:

a) quantity (mass, number of bars) to be delivered;

b) shape of the product (e. g. round, hexagon, square, flat);

c) the dimensions and tolerances of the product, see 7.6 and Table 3 and Tables 11 to 13;

d) a reference to this document, i.e. ISO 16143-4:2023;

e) the designation of the steel grade;

f) if for the relevant steel more than one heat treatment condition is possible (for the martensitic and precipitation hardening steels of Table 7), the symbol for the desired heat treatment conditions;

g) the desired condition (see symbols in Table 2) for steel grades ordered according to Tables 5 to 7 or the cold worked hardened condition for steel grades ordered according to Table 8;

h) standard designation for a test report 2.2 or, if required, any other type of inspection document in accordance with ISO 10474.

5.2 Options/Supplementary or special requirements

A number of options are specified in this document and listed below.

a) reference testing for products used in the quenched and tempered condition, only for martensitic and precipitation hardening steels ordered in the annealed condition (see 8.3.1 and C.2);

b) non-destructive testing (see 7.5 and C.3);

c) the disposition of tolerances in accordance with 7.6 and C.4;

d) bar end conditions may be specified at the time of enquiry and order in accordance with C.5;

e) product analysis (see 7.2, Table 1 and C.6);

f) any requirement to special marking (see Clauses 10 and C.7);

g) any additionally requirement concerning the surface condition, i.e. ground surface +G or polished surface +PL for round bars (see 6.2.2 and Table 3);

h) surface quality class if another than the standard class is requested (see 7.6 and Table 4);

i) verification of the straightness (see 7.6, Tables 12 and 13 and Annex D);

j) impact test at a temperature lower than room temperature (see 9.2.2).

5.3 Ordering example

3 t round bars with nominal diameter 80 mm, tolerance h8, stock length 6 000 mm made of steel grade X5CrNi18–10 according to this document in process route +2G, surface quality class 3 and a certificate 3.1 as specified in ISO 10474.

3 t round bars 80 h8 × stock 6 000

steel grade ISO 16143-4 - X5CrNi18–10+2G

Inspection certificate ISO 10474 - 3.1

6 Manufacturing process

6.1 General

The manufacturing process of the steel and of the products is, with the restrictions given by the requirements in 6.2 and 6.3, left to the discretion of the manufacturer.

6.2 Treatment and surface condition at delivery

6.2.1 Treatment condition

The treatment and heat-treatment condition (if any) at the time of delivery shall conform with the condition agreed in the order and shall be one of the conditions indicated in Table 2.

6.2.2 Surface conditions

The surface condition and the tolerance classes on bright steel products shall conform with Table 3. One of the classes written in brackets can be agreed at the time of enquiry and order if requested by the purchaser.

6.3 Traceability of the cast

Each product shall be traceable to the cast, see Clause 10.

7 Requirements

7.1 General

Combination of usual treatment conditions at the time of delivery and requirements concerning chemical composition and mechanical properties are shown in Table 2.

In addition to this document, the general technical delivery requirements of ISO 404 shall apply.

Further steel grades are suitable for manufacturing bright products listed in other standards, e.g. ISO 15510. They can also be used, but in this case the mechanical properties shall be agreed at the time of enquiry and order.

7.2 Chemical composition

The chemical composition of the steels determined by the cast analysis, shall conform to ISO 16143-2 and ISO 4955. The grades and the chemical composition of the steels are also listed for information in this document, see Annex A.

Permissible deviations between the limiting values for cast analysis and the values for product analysis are given in the corresponding table of ISO 16143-2 and ISO 4955. The product analysis shall be carried out when specified at the time of enquiry and order (see C.6).

7.3 Mechanical properties

For steels ordered in one of the treatment conditions in Table 2, the requirements for mechanical properties specified in Tables 5 to 7 apply (except for stainless steel bars ordered in condition +2D for which the mechanical properties are to be found in ISO 16143-2 and ISO 4955). The mechanical property values given in Tables 5 to 7 apply to test pieces that have been taken and prepared in accordance with Figure 1.

For stainless steel bars which are intentionally cold work hardened in order to increase their 0,2-proof strength to a specific level, the mechanical properties at room temperature as specified in Table 8 apply. For these products, the mechanical properties are prime, with the condition a secondary property.

An impact test shall be performed for peeled/turned bars if mentioned in the tables of mechanical properties. For cold drawn bars (+2H, +2H+2G. +2H+2P), requirements on impact tests can normally not be performed since there are no reference values, unless impact test and Charpy values are agreed at the time of enquiry and order. Additional requirements concerning the impact energy and the verification at temperatures other than room temperature (0 °C, –20 °C and –40 °C) can be agreed at the time of enquiry and order.

7.4 Internal soundness

Where appropriate, requirements relating to the internal soundness of the products shall be agreed at the time of enquiry and order (see C.3).

7.5 Shape, dimensions and tolerances

The tolerance class on thickness (and width for flats) shall conform with the requirements agreed at the time of enquiry and order and shall be in accordance with Table 3. If there is no agreement on the tolerance class, the bright products are delivered with the standard tolerance class given in Table 3. The tolerance class and the corresponding tolerances are given in Table 9 for rounds, squares and hexagons and in Table 10 for drawn flats. Where specified by the purchaser at the time of enquiry and order, the disposition tolerances specified in Table 9 shall be in accordance with C.4.

Unless otherwise agreed at the time of enquiry and order, the length and the tolerance on length shall be as specified in Table 11.

Maximum deviation from ovality' shall be not more than half the specified tolerance range and in any case never above the upper limit of the tolerance. Any requirements concerning out of shape may be agreed at the time of enquiry and order together with the measurement method.

For the evaluation of straightness, automatic methods can be used at the discretion of the manufacturer. Where specified at the time of enquiry and order and in cases of dispute, an agreed number of bars shall be evaluated for straightness in accordance with one of the methods specified in Annex D. The tolerances specified in Tables 12 and 13 shall apply.

Non-round bars (i.e. square, hexagon and flat) in widths ≤150 mm may have an undefined profile within a distance of 0,2 mm of the hypothetical edge and flats in widths >150 mm within a distance of 0,5 mm, unless otherwise agreed. For widths >150 mm, sharp corners can specifically be ordered.

7.6 Surface quality

Bright products shall have a smooth, scale free surface. Bright products in the final heat-treated condition shall be free from loose surface scale; their surface might be discoloured or darker. For hexagons, squares, flats and profiles with special cross-sections, one cannot achieve – for manufacturing reasons – the same quality of surface finish as for round cross-sections.

Since surface discontinuities (cracks, overlapping, scale, isolated pores, pits, grooves, etc.) cannot be completely avoided during manufacturing (hot and cold forming, heat treatments, handling and storage) and since they are retained when drawing, agreements shall be made regarding surface quality. The surface quality of the products shall be one of the classes in accordance with Table 4.

Cold drawn bars are normally delivered in class 1, while peeled/turned bars as well as ground/polished bars are delivered in class 3. Different classes may be agreed at the time of enquiry and order.

For flats, squares in sizes greater than 20 mm and hexagons in sizes greater than 50 mm, the maximum possible depth of surface discontinuities shall be agreed at the time of enquiry and order.

NOTE Where automatic testing of the surface is applied, 50 mm of each end of the bar is not normally covered.

Surface defects cannot be eliminated without removal of material. Products in the 'technically crack free by manufacture' condition are only available in the peeled/turned and/or ground conditions.

8 Inspection

8.1 Testing procedures and types of documents

8.1.1 Products conforming with this document shall be ordered and delivered with one of the inspection documents specified in ISO 10474. The type of document shall be agreed upon at the time of enquiry and order. If the order does not contain any specification of this type, a test report 2.2 shall be issued.

8.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report 2.2 must be provided, this shall cover the following information:

a) confirmation that the material complies with the requirements of the order;

b) results of the cast analysis for all elements specified for the steel type concerned.

8.1.3 If, in accordance with the agreements in the order, an inspection certificate 3.1 or 3.2 to ISO 10474 is to be provided, the specific inspections and tests described in 8.3 and Clause 9 shall be carried out and the results shall be confirmed in the inspection certificate.

In addition, the inspection certificate shall cover:

a) confirmation that the material complies with the requirements of the order;

b) results of the cast analysis for all elements specified for the steel type concerned;

c) the result of all inspections and tests ordered by supplementary requirements (see Annex C);

d) the symbol letters or numbers relating the inspection certificate, test pieces and products to each other.

8.2 Frequency of testing

The amount of testing, the sampling conditions and the test methods to be applied for the verification of the requirements shall be in accordance with the prescriptions of Table 1.

Table 1 — Test conditions for the verification of the requirements given in Tables 5 to 8

No.	Requirements	Amount of testing			Sampling and sample preparation	Test method to be used
		Test unit[a]	Number of [b]			
			samples per test unit	tests per sample		
1	Chemical composition	C	The cast analysis is given by the manufacturer (m); for product analysis, see C.7 (o)		ISO 14284	See list in ISO/ TR 9769[c]
2	Mechanical properties				ISO 377	Tensile test[d] ISO 6892-1 Impact test ISO 148-1
2.1	Cold drawn or peeled and heat treated	C+D	1	1 tensile (m)		
2.2	Annealed and cold drawn or peeled	C+D+T	1	1 tensile (m)		
2.3	Solution annealed, quenched and tempered and cold drawn or peeled	C+D+T	1	1 tensile (m) and 3 CVN [f] (o)		
3	Hardness[e]				ISO 6506-1	Brinell hardness test ISO 6506-1
3.1	Heat-treated and peeled	C+D+T	1	1 (m)		
3.2	Heat-treated and cold drawn	C+D+T	1	1 (m)		

NOTE Verification of the requirements is only necessary if an inspection certificate is ordered.

[a] The tests shall be carried out separately for each cast as indicated by 'C', each dimension as indicated by 'D', and each heat-treatment batch as indicated by 'T'. Products with different thickness may be grouped if the differences in thickness do not affect the properties.

[b] Tests marked with an "m" (mandatory) shall be carried out as specific tests. In all cases, those marked with an "o" (optional) shall be carried out as specific tests only if agreed at ordering.

[c] For routine testing, other methods are also available (e.g. spectrographic).

[d] In cases of dispute, the tensile test shall be carried out on proportional test pieces having a gauge length of $L_0 = 5{,}65\sqrt{S_0}$, where S_0 is the original cross-section area.

[e] Unless otherwise agreed at the order, the manufacturer shall decide whether to use the tensile test or hardness test. In the case of dispute the tensile test shall be done.

[f] For nominal thickness ≥16 mm, standard test pieces 10 mm x 10 mm shall be machined. For thicknesses <16 mm, the test shall only be done if test pieces with reduced widths and Charpy-V-notch (CVN) values are agreed at the time of enquiry and order.

8.3 Specific inspection and testing

8.3.1 Verification of the mechanical properties

For steels ordered in one of the process routes in Table 2, the mechanical properties shall be verified. For martensitic and precipitation-hardening (see Table 7) ordered in the annealed condition, the requirements given for the quenched and tempered condition (+QT) is only to be verified if the supplementary requirement specified in C.2 is ordered.

8.3.2 Visual and dimensional inspection

A sufficient number of products shall be inspected to ensure the compliance with the specification.

Dimensional inspection shall be carried out as follows:

a) for bars in manufacturing or stock length: not less than 150 mm from the end of the bar;

b) for bars cut to length: not less than 10 mm from the end of the bar.

If agreed at the time of enquiry and order, dimensional inspection shall be done for bars in manufacturing or stock length for nominal diameter > 100 mm, not less than 250 mm from both ends of the bar."

9 Test methods

9.1 Chemical analysis

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer. In cases of dispute, the method for product analysis used shall be agreed taking into account the relevant existing International Standards.

The list of available International Standards on chemical analysis is given in ISO/TR 9769.

9.2 Mechanical tests

9.2.1 Tensile test and hardness test

The tensile test shall be carried out in accordance with ISO 6892-1.

Unless otherwise agreed, the tensile strength, the 0,2 %-proof strength and elongation after fracture shall be determined. If a tensile test at elevated temperature has been ordered, this shall be carried out in accordance with ISO 6892-2.

The Brinell hardness test (only for martensitic and precipitation hardening steels) shall be carried out in accordance with ISO 6506-1.

9.2.2 Impact test

The Charpy-V-notch (CVN) impact test shall be carried out in accordance with ISO 148-1.

The average values of a set of three test pieces shall be equal to or greater than the specified value. One individual value may be below the specified value, provided that it is not less than 70 % of that value.

If these conditions are not satisfied, additional tests can be done according to ISO 404 on the assessment of results of sequential tests.

9.3 Verification of dimensions

The ovality shall be carried out by the two-point measuring method. Other methods shall be agreed at the time of enquiry and order.

9.4 Retests

Retests and criteria should be as specified in ISO 404.

10 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that the identification of the cast, the steel type and the origin of the delivery is possible (see C.7).

Table 2 — Types of process routes, surface finish and requirements for stainless steels[a]

	1	2	3	4	5	6	7
1		**Type of process route**	**Symbol[b]**	**Surface finish[b]**	**Remarks**	**Chemical composition**	**Mechanical properties**
2	Cold processed	Heat treated[c], mechanically or chemically descaled or rough machined, cold processed[d],	+2H	Smooth and matt or bright. Substantially smoother than finishes 1E, 1D or 1X. Not free of surface imperfections.	On products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly in austenitic materials, depending on the degree of forming. The surface hardness may be higher than the centre hardness.	See ISO 16143-2 and ISO 4955, for information see Table A.1	See Tables 5, 6, 7 and 8
3		Finish +2H, heat treated[c], pickled	+2D	Smooth and matt or bright. Smoother than finishes 1E or 1D. Not free of surface imperfections.	This finish allows the restoration of the mechanical properties after cold processing. Products with good ductility (cold heading) and specific magnetic properties.		See ISO 16143-2 and ISO 4955
4		Heat treated[c], mechanically or chemically descaled or rough machined, cold processed[d], mechanically smoothed[e]	+2B	Smoother, uniform and bright. Brighter than finishes 1E, 1D or 1X. Free of surface defects	Products used in their present condition or intended for better finishing. In products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly in austenitic materials, depending on the degree of cold processing. The surface hardness may be higher than the centre hardness. Pre-finish for close ISO-tolerances.		See Tables 5, 6 and 7

[a] Not all process routes and surface finishes are available for all steels.

[b] First digit, 1 = hot formed (see ISO 16143-2 and ISO 4955), 2 = cold processed.

[c] On ferritic, austenitic and austenitic-ferritic grades, the heat treatment may be omitted if the conditions for hot forming and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion are obtained.

[d] The type of cold processing, e.g. cold drawing, peeling/turning or centreless grinding, is left to the manufacturer's discretion, provided that the requirements concerning tolerances on dimensions and surface roughness are respected.

[e] The type of mechanical polishing (abrading) is left to the manufacturer's discretion unless otherwise agreed.

[f] The type of specular polishing (electro-polishing, felting, buffing...) is left to the manufacturer's discretion unless otherwise agreed.

Table 2 *(continued)*

	1	2	3	4	5	6	7
5	Cold processed with special finishing process	Finishes +2H, +2D or +2B, centreless ground, mechanically smoothed (optional)[f]	+2G	Smooth, uniform and bright. Free of surface defects	Finish for close ISO-tolerances (see Table 3). Unless otherwise agreed the surface roughness shall be Ra ≤ 1,2.		See finishes +2H, +2D and +2B
6		Finishes +2H, +2D or +2B, polished	+2P	Smoother and brighter than finish +2G. Free of surface defects.	Finish for close ISO-tolerances (see Table 3). Surface roughness can be specified at the time of enquiry and order.		See finishes +2H, +2D and +2B

[a] Not all process routes and surface finishes are available for all steels.

[b] First digit, 1 = hot formed (see ISO 16143-2 and ISO 4955), 2 = cold processed.

[c] On ferritic, austenitic and austenitic-ferritic grades, the heat treatment may be omitted if the conditions for hot forming and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion are obtained.

[d] The type of cold processing, e.g. cold drawing, peeling/turning or centreless grinding, is left to the manufacturer's discretion, provided that the requirements concerning tolerances on dimensions and surface roughness are respected.

[e] The type of mechanical polishing (abrading) is left to the manufacturer's discretion unless otherwise agreed.

[f] The type of specular polishing (electro-polishing, felting, buffing...) is left to the manufacturer's discretion unless otherwise agreed.

Table 3 — Surface condition and tolerance class at delivery

	1	2	3	4	5	6	7	8
1	**Surface condition at delivery**	**Symbol**	**Tolerance class to** ISO 286-2[a]					
			Rounds	**Squares**	**Hexagons**	**Drawn flats**	**Special sections**	**Notes**
2	'Cold processed' or 'heat-treated and cold processed'	+2H	h10 (h9 to h12) see Table 9	h11 for $d \leq 80$ mm, h12 for $d > 80$ mm [c] (h11 or h12); see Table 9		h11, h12, see Table 10	–[b]	See Table 2, line 2
3	'Cold drawn and heat treated' or 'heat treated and peeled/turned'	+2D	h11 see Table 9	–[b]	–[b]	–	–	Finish for good ductility see Table 2, line 3
4	Peeled/turned	+2B	h10 (h9 to h12) see Table 9	–	–	–	–	See Table 2, line 4
5	Ground	+2G	h9 (h6 to h10) see Table 9	–	–	–	–	Obtained e.g. from conditions Table 2, line 5
6	Polished	+2P	h9 (h6 to h12) see Table 9	–	–	–	–	Obtained e.g. from conditions Table 2, line 6

[a] Standard tolerance classes unless otherwise specified. In brackets: other possible tolerance classes according to ISO 286-2 if required at the time of enquiry and order.

[b] To be agreed at the time of enquiry and order.

[c] If squares above 100 mm thickness are agreed, the tolerance class shall be js15 in accordance with ISO 286-2.

Table 4 — Surface quality classes

Condition	Class			
	1	2	3	4
Permissible depth of discontinuities	max. 0,3 mm for $t \leq 15$ mm; max. 0,02t for $15 < t \leq 100$ mm	max. 0,3 mm for $t \leq 15$ mm; max. 0,02t for $15 < t \leq 75$ mm max. 1,5 mm for $t > 75$ mm	max. 0,2 mm for $t \leq 20$ mm; max. 0,01t for $20 < t \leq 75$ mm; max. 0,75 mm for $t > 75$ mm	technically crack free by manufacturer[e]
Maximum percentage of delivered weight with discontinuities in excess of specified level	4 %	1 %	1 %	0,2 %
Product form[a]				
Rounds	+	+	+	+
Squares	+	+ (for $t \leq 20$ mm)[c]	-	-
Hexagons	+	+ (for $t \leq 50$ mm)[c]	-	-
Flats	+[b]	-	-	-
Special sections	+[d]	-	-	-

t : nominal thickness that means diameter of bars and distance across flats of squares and hexagons.

[a] + indicates available in these classes, - indicates not commonly available in these classes.

[b] Maximum depth of discontinuities refers to respective section (width or thickness).

[c] Crack detection with eddy current device not possible for $t > 20$ mm or $t > 50$ mm as indicated.

[d] Reference dimensions to be agreed at the time of enquiry and order.

[e] The surface quality class shall be better than class 3. The requirements and the kind of verification shall be agreed at the time of enquiry and order.

Table 5 — Mechanical properties[a] for bright bars of solution annealed austenitic and austenitic-ferritic stainless steels[b, c] in conditions +2H, +2B, +2G and +2P

Steel designation		Thickness	Mechanical properties					
Name	ISO number	t^d mm	$R_{p0,2}$ MPa min.	R_m MPa	A_5[e] % min.		KV_2 J min.	
					(long.)	(tr.)	(long.)	(tr.)
Austenitic grades								

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information, see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 5 *(continued)*

Steel designation		Thickness	Mechanical properties					
Name	ISO number	t^d mm	$R_{p0,2}$ MPa min.	R_m MPa	$A_5{}^e$ % min.		KV_2 J min.	
					(long.)	(tr.)	(long.)	(tr.)
X2CrNi18–9	4307–304–03-I	≤10[f]	400	600 to 930	25	-	-	-
		10 < t ≤ 16	380	600 to 930	25	-	-	-
		16 < t ≤ 40	175	500 to 830	30	-	100	-
		40 < t ≤ 63	175	500 to 830	30	-	100	-
		63 < t ≤ 160	175	500 to 700	45	-	100	-
		160 < t ≤ 250	175	500 to 700	-	35	-	60
X10CrNiS18–9	4305–303–00-I	≤ 10[f]	400	600 to 950	15	-	-	-
		10 < t ≤ 16	400	600 to 950	15	-	-	-
		16 < t ≤ 40	190	500 to 850	20	-	-	-
		40 < t ≤ 63	190	500 to 850	20	-	-	-
		63 < t ≤ 160	190	500 to 750	35	-	-	-
X3Cr-NiCu18-9-4	4567-304-30-I	≤10[f]	400	600 to 850	25	-	-	-
		10 < t ≤ 16	340	600 to 850	25	-	-	-
		16 < t ≤ 40	175	450 to 800	30	-	100	-
		40 < t ≤ 63	175	450 to 800	30	-	100	-
		63 < t ≤ 160	175	450 to 650	40	-	100	-
X6CrNi-CuS18-9-2	4570-303-31-I	≤ 10[f]	400	600 to 950	15	-	-	
		10 < t ≤ 16	400	600 to 950	15	-	-	
		16 < t ≤ 40	185	500 to 910	20	-	-	
		40 < t ≤ 63	185	500 to 910	20	-	-	
		63 < t ≤ 160	185	500 to 710	35	-	-	
X5CrNi18–10	4301–304–00-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	400	600 to 950	25	-	-	-
		16 < t ≤ 40	190	600 to 850	30	-	100	-
		40 < t ≤ 63	190	580 to 850	30	-	100	-
		63 < t ≤ 160	190	500 to 700	45	-	100	-
		160 < t ≤ 250	190	500 to 700	-	35	-	60
X6CrNi-Ti18-10	4541–321–00-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	380	580 to 950	25	-	-	-
		16 < t ≤ 40	190	500 to 850	30	-	100	-
		40 < t ≤ 63	190	500 to 850	30	-	100	-
		63 < t ≤ 160	190	500 to 700	40	-	100	-

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information, see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 5 *(continued)*

Steel designation		Thickness	Mechanical properties					
Name	ISO number	t^d mm	$R_{p0,2}$ MPa min.	R_m MPa	$A_5{}^e$ % min.		KV_2 J min.	
					(long.)	(tr.)	(long.)	(tr.)
X2CrNi19–11	4306–304–03-I	≤10[f]	400	600 to 930	25	-	-	-
		10 < t ≤ 16	380	600 to 930	25	-	-	-
		16 < t ≤ 40	180	460 to 830	30	-	100	-
		40 < t ≤ 63	180	460 to 830	30	-	100	-
		63 < t ≤ 160	180	460 to 680	45	-	100	-
		160 < t ≤ 250	180	460 to 680	-	35	-	60
X8CrNi25-21	4845-310-08-E	≤10[f]	310	620 to 850	30	-	-	-
		10 < t ≤ 16	205	515 to 800	30	-	-	-
		16 < t ≤ 40	205	515 to 800	30	-	-	-
		40 < t ≤ 63	205	515 to 800	30	-	-	-
		63 < t ≤ 160	205	515 to 800	30	-	-	-
X2CrNi-Mo17–12–2	4404–316–03-I	≤10[f]	400	600 to 930	25	-	-	-
		10 < t ≤ 16	380	580 to 930	25	-	-	-
		16 < t ≤ 40	200	500 to 830	30	-	100	-
		40 < t ≤ 63	200	500 to 830	30	-	100	-
		63 < t ≤ 160	200	500 to 700	40	-	100	-
		160 < t ≤ 250	200	500 to 700	-	30	-	60
X5CrNi-Mo17–12–2	4401–316–00-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	380	580 to 950	25	-	-	-
		16 < t ≤ 40	200	500 to 850	30	-	100	-
		40 < t ≤ 63	200	500 to 850	30	-	100	-
		63 < t ≤ 160	200	500 to 700	40	-	100	-
		160 < t ≤ 250	200	500 to 700	-	30	-	60
X6CrNiMo-Ti17–12–2	4571–316–35-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	380	580 to 950	25	-	-	-
		16 < t ≤ 40	200	500 to 850	30	-	100	-
		40 < t ≤ 63	200	500 to 850	30	-	100	-
		63 < t ≤ 160	200	500 to 700	40	-	100	-
		160 < t ≤ 250	200	500 to 700	-	30	-	60

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information, see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 5 *(continued)*

Steel designation		Thickness	Mechanical properties					
Name	ISO number	t^d mm	$R_{p0,2}$ MPa min.	R_m MPa	$A_5{}^e$ % min.		KV_2 J min.	
					(long.)	(tr.)	(long.)	(tr.)
X2CrNi-Mo17–12–3	4432–316–03-I	≤10[f]	400	600 to 930	25	-	-	-
		10 < t ≤ 16	380	600 to 880	25	-	-	-
		16 < t ≤ 40	200	500 to 850	30		100	-
		40 < t ≤ 63	200	500 to 850	30	-	100	-
		63 < t ≤ 160	200	500 to 700	40	-	100	-
		160 < t ≤ 250	200	500 to 700	-	30	-	60
Austenitic grades								
X3CrNi-Mo17–12–3	4436–316–00-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	400	600 to 950	25	-	-	-
		16 < t ≤ 40	200	500 to 850	30	-	100	-
		40 < t ≤ 63	190	500 to 850	30	-	100	-
		63 < t ≤ 160	200	500 to 700	40	-	100	-
		160 < t ≤ 250	200	500 to 700	-	30	-	60
X2CrNi-Mo18-14-3	4435-316-91-I	≤10[f]	400	600 to 950	25	-	-	-
		10 < t ≤ 16	400	600 to 950	25	-	-	-
		16 < t ≤ 40	235	500 to 850	30	-	100	-
		40 < t ≤ 63	235	500 to 850	30	-	100	-
		63 < t ≤ 160	235	500 to 700	40	-	100	-
		160 < t ≤ 250	235	500 to 700	-	30	-	60
X1NiCr-MoCu25–20–5	4539–089–04-I	≤10[f]	400	600 to 930	20	-	-	-
		10 < t ≤ 16	400	600 to 930	20	-	-	-
		16 < t ≤ 40	230	530 to 880	25		100	-
		40 < t ≤ 63	230	530 to 880	25	-	100	-
		63 < t ≤ 160	230	530 to 730	35	-	100	-
		160 < t ≤ 250	230	530 to 730	-	30	-	60
X1NiCrMo-CuN25-20-7	4529-089-26-I	≤10[f]	550	700 to 1 150	15	-	-	-
		10 < t ≤ 16	550	700 to 1 150	15	-	-	-
		16 < t ≤ 40	300	650 to 1 050	30	-	100	-
		40 < t ≤ 63	300	650 to 900	30	-	100	-
		63 < t ≤ 160	300	650 to 850	40	-	100	-
Austenitic-ferritic steels								

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information, see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 5 *(continued)*

Steel designation		Thickness	Mechanical properties					
Name	ISO number	t[d] mm	$R_{p0,2}$ MPa min.	R_m MPa	A_5[e] % min.		KV_2 J min.	
					(long.)	(tr.)	(long.)	(tr.)
X2CrNiN22-2	4062-322-02-U	≤10[f]	600	650 to 1 100	15	-	-	-
		10 < t ≤ 40	500	700 to 1 100	15	-	-	-
		40 < t	500	700 to 1 100	20	-	-	-
X2CrMn-NiN21-5-1	4162-321-01-E	≤10[f]	500	700 to 1 050	15	-	-	-
		10 < t ≤ 16	500	700 to 1 050	20	-	-	-
		16 < t ≤ 40	500	700 to 1 050	20	-	-	-
		40 < t ≤ 160	450	650 to 850	30	-	60	-
X2CrNi-MoN22–5-3	4462–318–03-I	≤10[f]	650	850 to 1 150	12	-	-	-
		10 < t ≤ 16	650	850 to 1 100	12	-	-	-
		16 < t ≤ 40	450	650 to 1 000	15	-	100	-
		40 < t ≤ 63	450	650 to 1 000	15	-	100	-
		63 < t ≤ 160	450	650 to 880	25	-	100	-
X2CrNiMn-Mo-CuN24–4-3–2	4662–824–41-X	≤10[f]	700	900 to 1 150	15	-	-	-
		10 < t ≤ 30	700	900 to 1 100	20	-	-	-
		30 < t ≤ 160	450	650 to 900	25	-	60	-
X3CrNi-MoN27–5-2	4460–312–00-I	≤10[f]	610	770 to 1 030	12	-	-	-
		10 < t ≤ 16	560	770 to 1 030	12	-	-	-
		16 < t ≤ 40	460	620 to 950	15	-	85	-
		40 < t ≤ 63	460	620 to 950	15	-	85	-
		63 < t ≤ 160	460	620 to 880	20	-	85	-
X2CrNiMoC-uN25-6-3	4507-325-20-I	≤10[f]	-	-	-	-	-	-
		10 < t ≤ 16	-	-	-	-	-	-
		16 < t ≤ 40	60	60	60	-	60	-
		40 < t ≤ 63	60	60	60	-	60	-
		63 < t ≤ 160	60	60	60	-	60	-

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information, see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 6 — Mechanical properties [a] for bright bars of annealed ferritic stainless steels[b, c] in conditions +2H, +2B, +2G or +2P

Steel designation		Thickness	Mechanical properties		
Name	ISO number	t [d] mm	0,2 %-proof strength $R_{p0,2}$ MPa min.	Tensile strength R_m MPa	Elongation after fracture A_5 [e] % min.
X6Cr17	4016–430–00-I	≤10[f]	320	500 to 750	8
		10 < t ≤ 16	300	480 to 750	8
		16 < t ≤ 40	240	400 to 700	15
		40 < t ≤ 63	240	400 to 700	15
		63 < t ≤ 100	240	400 to 630	20
X3CrNb17	4511-430-71-I	≤10[f]	320	500 to 750	8
		10 < t ≤ 16	300	480 to 750	10
		16 < t ≤ 40	240	400 to 700	15
		40 < t ≤ 63	240	400 to 700	15
X2CrTiNb18	4509-439-40-X	≤10[f]	320	500 to 750	8
		10 < t ≤ 16	300	480 to 750	10
		16 < t ≤ 40	240	400 to 700	15
		40 < t ≤ 63	240	400 to 700	15
X6CrMo17–1	4113–434–00-I	≤10[f]	340	540 to 700	8
		10 < t ≤ 16	320	500 to 700	12
		16 < t ≤ 40	280	440 to 700	15
		40 < t ≤ 63	280	440 to 700	15
		63 < t ≤ 100	280	440 to 660	18

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Initial annealing treatment may be omitted if the conditions for previous hot working and subsequent cooling have been such that the requirements for the final mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained. For further information see ISO 16143-2.

[d] Width across flats for hexagons.

[e] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 7 — Mechanical properties[a] for bright bars of heat treated martensitic and precipitation-hardening stainless steels[b] in conditions +2H, +2B, +2G or +2P

Steel designation		Thickness	Mechanical properties								
			Annealed		Quenched + tempered						
Name	ISO number	t [c] mm	R_m MPa max.	HBW [d] max.	Heat-treatment condition	$R_{p0,2}$ MPa min.	R_m MPa	A_5 [e] % min.		KV_2 J min.	
								(long.)	(tr.)	(long.)	(tr.)
Martensitic steels											
X12Cr13	4006–410–00-I	≤10[f]	880	261	+QT650	550	700 to 1 000	9	-	-	-
		10 < t ≤ 16	880	261		500	700 to 1 000	9	-	-	-
		16 < t ≤ 40	800	234		450	650 to 930	10	-	25	-
		40 < t ≤ 63	760	222		450	650 to 880	10	-	25	-
		63 < t ≤ 160	730	213		450	650 to 850	15	-	25	-
X12CrS13	4005–416–00-I	≤10[f]	880	261	+QT650	550	700 to 1 000	8	-	-	-
		10 < t ≤ 16	880	261		500	700 to 1 000	8	-	-	-
		16 < t ≤ 40	800	234		450	650 to 930	10	-	-	-
		40 < t ≤ 63	760	222		450	650 to 880	10	-	-	-
		63 < t ≤ 160	730	213		450	650 to 850	12	-	-	-
X20Cr13	4021–420–00-I	≤10[f]	910	269	+QT700	600	750 to 1 000	8	-	-	-
		10 < t ≤ 16	910	269		550	750 to 1 000	8	-	-	-
		16 < t ≤ 40	850	252		500	700 to 950	10	-	25	-
		40 < t ≤ 63	800	234		500	700 to 900	12	-	25	-
		63 < t ≤ 160	760	222		500	700 to 850	13	-	25	-

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Width across flats for hexagons.

[d] In case of dispute, the tensile strength values are the decisive factor.

[e] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 7 *(continued)*

Steel designation		Thickness	Mechanical properties								
			Annealed		Quenched + tempered						
Name	ISO number	t [c] mm	R_m MPa max.	HBW [d] max.	Heat-treatment condition	$R_{p0,2}$ MPa min.	R_m MPa	A_5 [e] % min.		KV_2 J min.	
								(long.)	(tr.)	(long.)	(tr.)
X30Cr13	4028–420–00-I	≤10 [f]	950	280	+QT850	700	900 to 1 050	7	-	-	-
		10 < t ≤ 16	950	280		650	900 to 1 150	7	-	-	-
		16 < t ≤ 40	900	266		650	850 to 1 100	9	-	12	-
		40 < t ≤ 63	840	249		650	850 to 1 050	9	-	12	-
		63 < t ≤ 160	800	234		650	850 to 1 000	10	-	15	-
X17CrNi16–2	4057–431–00-X	≤10 [f]	1 050	311	+QT800	750	850 to 1 100	7	-	-	-
		10 < t ≤ 16	1 050	311		700	850 to 1 100	7	-	-	-
		16 < t ≤ 40	1 000	296		650	800 to 1 050	9	-	25	-
		40 < t ≤ 63	950	280		650	800 to 1 000	12	-	25	-
		63 < t ≤ 160	950	280		650	800 to 950	12	-	16	-
X14CrS17	4019–430–20-I	≤10 [f]	880	280	+QT650	580	700 to 980	7	-	-	-
		10 < t ≤ 16	880	280		530	700 to 980	7	-	-	-
		16 < t ≤ 40	800	250		500	650 to 930	9	-	-	-
		40 < t ≤ 63	760	230		500	650 to 880	10	-	-	-
		63 < t ≤ 160	730	220		500	650 to 850	10	-	-	-

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Width across flats for hexagons.

[d] In case of dispute, the tensile strength values are the decisive factor.

[e] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 7 *(continued)*

Steel designation		Thickness	Mechanical properties							
			Annealed		Quenched + tempered					
Name	ISO number	t [c] mm	R_m MPa max.	HBW [d] max.	Heat-treatment condition	$R_{p0,2}$ MPa min.	R_m MPa	A_5 [e] % min.		KV_2 J min.	
								(long.)	(tr.)	(long.)	(tr.)
X4CrNiMo16-5-1	4418-431-77-E	≤10 [f]	1 150	380	+QT900	750	900 to 1 150	10	-	-	-
		10 < t ≤ 16	1 150	380		750	900 to 1 150	10	-	-	-
		16 < t ≤ 40	1 100	320		700	900 to 1 100	12	-	80	-
		40 < t ≤ 63	1 100	320		700	900 to 1 100	16	-	80	-
		63 < t ≤ 160	1 100	320		700	900 to 1 100	16	-	80	-
		160 < t ≤ 250	1 100	320		700	900 to 1 100	-	14	-	60
X39CrMo17-1	4122-434-09-I	≤10f	1 000	340	+QT750	650	800 to 1 050	8	-	-	-
		10 < t ≤ 16	1 000	340		600	800 to 1 050	8	-	-	-
		16 < t ≤ 40	980	310		550	750 to 1 000	10	-	14	-
		40 < t ≤ 63	930	290		550	750 to 950	12	-	14	-
		63 < t ≤ 160	900	280		550	750 to 950	12	-	10	-
Precipitation-hardening steels											

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Width across flats for hexagons.

[d] In case of dispute, the tensile strength values are the decisive factor.

[e] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 7 *(continued)*

Steel designation		Thickness	Mechanical properties								
			Annealed		Quenched + tempered						
Name	ISO number	t [c] mm	R_m MPa max.	HBW [d] max.	Heat-treatment condition	$R_{p0,2}$ MPa min.	R_m MPa	A_5 [e] % min.		KV_2 J min.	
								(long.)	(tr.)	(long.)	(tr.)
X5CrNiCuNb16–4	4542–174–00-I	≤10 [f]	1 200	355	+P800	600	900 to 1 100	10	-	-	-
		10 < t ≤ 16	1 200	355		600	900 to 1 100	10	-	-	-
		16 < t ≤ 40	1 200	355		520	800 to 1 050	12	-	75	-
		40 < t ≤ 63	1 200	355		520	800 to 1 000	18	-	75	-
		63 < t ≤ 160	1 200	355		520	800 to 950	18	-	75	-
		≤100	-	-	+P930	720	930 to 1 100	12	-	40	-
		≤100	-	-	+P960	790	960 to 1 160	10	-	-	-
		≤100	-	-	+P1070	1 000	1 070 to 1 270	10	-	-	-

[a] Lower dimensions are usually cold drawn and higher dimensions are usually peeled.

[b] Including cut lengths from wire.

[c] Width across flats for hexagons.

[d] In case of dispute, the tensile strength values are the decisive factor.

[e] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of order.

[f] In the range 1 mm ≤ t < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses <5 mm shall be agreed at the time of enquiry and order.

Table 8 — Mechanical properties for bars at room temperature of steels in the cold work hardened (+2H) condition

Steel designation		0,2 %-proof strength level	0,2 %-proof strength	Tensile strength	Elongation after fracture
Name	ISO number		$R_{p0,2}$ MPa min.	R_m MPa	A % min.
Austenitic grades					
X2CrNi18–9	4307–304–03-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X10CrNiS18–9	4305–303–00-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X5CrNi18–10	4301–304–00-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X6CrNiTi18–10	4541–321–00-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X2CrNi19–11	4306–304–03-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X2CrNiMo17–12–2	4404–316–03-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X5CrNiMo17–12–2	4401–316–00-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12
X6CrNiMo-Ti17–12–2	4571–316–35-I	+CP350[b]	350	700 to 850	20
		+CP500[a]	500	800 to 1 000	12

[a] Maximum diameter for this 0,2-proof strength level shall be agreed at the time of enquiry and order; it should not be greater than 25 mm.

[b] Maximum diameter for this 0,2-proof strength level shall be agreed at the time of enquiry and order; it should not be greater than 35 mm.

Table 9 — Tolerance classes for rounds, squares and hexagons

Nominal thickness mm	Tolerance class to ISO 286-2[a] mm						
	h6	h7	h8	h9	h10	h11	h12
$1 < t \leq 3$	0,006	0,010	0,014	0,025	0,040	0,060	0,100
$3 < t \leq 6$	0,008	0,012	0,018	0,030	0,048	0,075	0,120
$6 < t \leq 10$	0,009	0,015	0,022	0,036	0,058	0,090	0,150
$10 < t \leq 18$	0,011	0,018	0,027	0,043	0,070	0,110	0,180
$18 < t \leq 30$	0,013	0,021	0,033	0,052	0,084	0,130	0,210
$30 < t \leq 50$	0,016	0,025	0,039	0,062	0,100	0,160	0,250
$50 < t \leq 80$	0,019	0,030	0,046	0,074	0,120	0,190	0,300
$80 < t \leq 120$	0,022	0,035	0,054	0,087	0,140	0,220	0,350
$120 < t \leq 180$	0,025	0,040	0,063	0,100	0,160	0,250	0,400
$180 < t \leq 250$	0,029	0,046	0,072	0,115	0,185	0,290	0,460

[a] The above deviation values are negatively disposed about the nominal dimension. For example, a 20 mm nominal diameter having a tolerance class h9 is 20 mm +0/–0,052 mm or 19,948/20,000 mm.

Table 10 — Tolerances for drawn flats

Width	Deviation		ISO 286-2
mm	mm	mm	Class
$w \leq 18$	-	-	h11
$18 < w \leq 30$	+0	−0,13	h11
$30 < w \leq 50$	+0	−0,16	h11
$50 < w \leq 80$	+0	−0,19	h11
$80 < w \leq 100$	+0	−0,22	h11
$100 < w \leq 150$	+0,50	−0,50	-
$150 < w \leq 200$	+1,00	−1,00	-
$200 < w \leq 300$	+2,00	−2,00	-
$300 < w \leq 400$	+2,50	−2,50	-
$400 < w \leq 500$	+1 %	- 1 %	-
Thickness [b]	**Deviation**[a]		
mm	mm	mm	
$3 < t \leq 6$	+0	−0,075	h11
$6 < t \leq 10$	+0	−0,090	h11
$10 < t \leq 18$	+0	−0,11	h11
$18 < t \leq 30$	+0	−0,13	h11
$30 < t \leq 50$	+0	−0,16	h11
$50 < t \leq 60$	+0	−0,19	h11
$60 < t \leq 80$	+0	−0,30	h12
$80 < t \leq 120$	+0	−0,35	h12
$120 < t \leq 140$	+0	−0,40	h12

[a] The tolerances in this table apply to austenitic, austenitic-ferritic and ferritic steels. For martensitic steels, deviation may increase to 150 % of the mentioned deviation in this table.

[b] For $w > 150$ mm and $t \leq 18$ mm the tolerance of the thickness is h12.

Table 11 — Types of length and length tolerances

Type of length	Length mm	Length tolerance mm	To be stated on order
manufacturing length[a]	3 000 to 9 000	±500	length
stock length[a]	3 000 or 6 000	0, +200 0, +400	e.g. stock 6 000
cut to length	up to 9 000	corresponding to agreement, but at least ±5 minimum	length and tolerance

[a] Short bars: each bundle may contain a percentage of short bars.

— Dimensions ≤25 mm: the percentage is 5 % maximum, the length of these short bars being at the minimum two thirds the nominal length ordered.

— Dimensions >25 mm: the percentage is 10 % maximum, with the same restriction on the minimum length.

If agreed at the time of enquiry and order, bright products are delivered without any short bars.

Table 12 — Deviation from straightness for rounds, squares and hexagons [a]

Product form	Steel group	Nominal dimension mm	Deviation max. mm
Rounds	Austenitic, austenitic-ferritic and ferritic stainless steels		1,0[b]
	Martensitic stainless steels		1,5
Squares and hexagons	Austenitic, austenitic-ferritic and ferritic stainless steels	$t \leq 75$	1,0
	Martensitic stainless steels	$t \leq 75$	2,0
	Austenitic, austenitic-ferritic and ferritic stainless steels	$t > 75$	1,5
	Martensitic stainless steels	$t > 75$	2,5

[a] For the method of evaluating straightness, see Annex D.

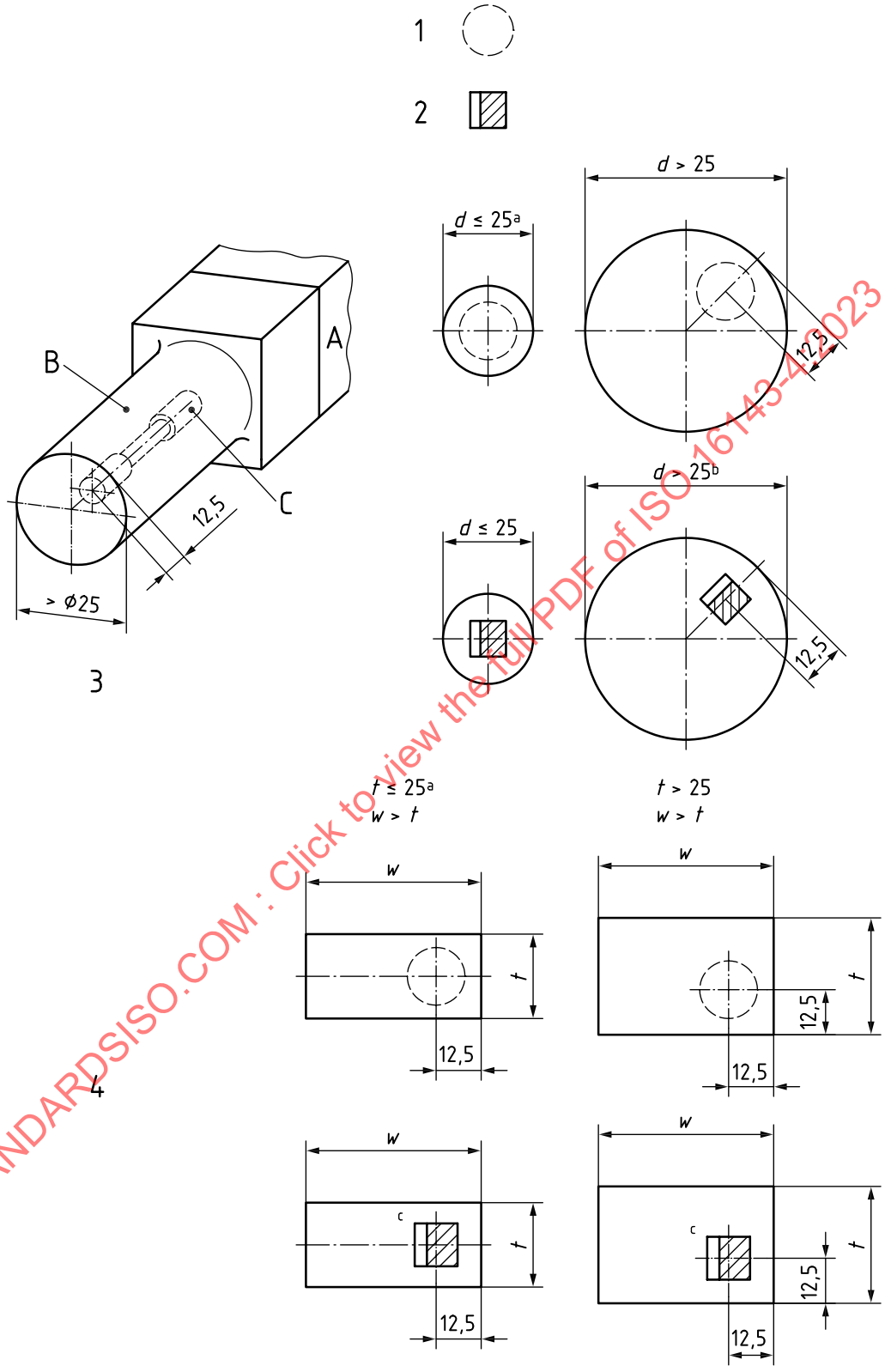
[b] For austenitic, austenitic-ferritic and ferritic stainless steels with thicknesses >55 mm, the deviation is max. 1,5 mm.

Table 13 — Deviation from straightness for flats [a]

Product form	Steel group	Nominal dimension mm	Deviation on width and thickness max. mm	
			for $w/t \geq 10:1$	for $w/t < 10:1$
Flats	Austenitic, austenitic-ferritic and ferritic steels	$w < 120$	2	1,5
		$w \geq 120$	2,5	2
	Martensitic steels	$w < 120$	2,5	2
		$w \geq 120$	3	2,5

[a] For the method of evaluating straightness, see Annex D.

Dimensions in millimetres



Key

1 tensile test piece
2 notched bar impact test piece
3 round and similar shaped sections
4 rectangular and square sections
A sample

B rough specimen

C test piece

[a] For small products (*d or w* ≤ 25 mm), the test piece shall, if possible, consist of an un-machined part of the bar.

[b] For round bars, the longitudinal axis of the notch shall be about parallel to the direction of a diameter.

[c] For rectangular bars, the longitudinal axis of the notch shall be perpendicular to the wider rolling surface.

Figure 1 — Location of the test pieces in bars

Annex A
(informative)

Steel grades and chemical composition according to ISO 16143-2 and ISO 4955

The chemical composition in Table A.1 is according to ISO 16143-2 and ISO 4955.

Table A.1 — Steel grades and chemical composition (cast analysis) of stainless bright steels
(chemical composition as listed in **ISO 16143-2 and ISO 4955**)

Steel designation		%, mass fraction[a]									
Name	ISO-number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
Austenitic steels											
X2CrNi18–9	4307–304–03-I	0,030	1,00	2,00	0,045	0,030	17,5 to 19,5	—	8,0 to 10,0 (10,5)[b]	0,10	—
X10CrNiS18–9	4305–303–00-I	0,12	1,00	2,00	0,060	≥0,15	17,0 to 19,0		8,0 to 10,0	0,10	Cu:[c]
X3CrNiCu18-9-4	4567-304-30-I	0,04	1,00	2,00	0,045	0,030	17,0 to 19,0	—	8,0 to 10,5	0,10	Cu: 3,0 to 4,0
X6CrNiCuS18-9-2	4570-303-31-I	0,08	1,00	2,00	0,045	≥0,15	17,0 to 19,0	0,60	8,0 to 10,0	0,10	Cu: 1,40 to 1,80
X5CrNi18–10	4301–304–00-I	0,07	1,00	2,00	0,045	0,030	17,5 to 19,5	—	8,0 to 10,5	0,10	—
X6CrNiTi18–10	4541–321–00-I	0,08	1,00	2,00	0,045	0,030	17,0 to 19,0	—	9,0 to 12,0 (13,0)[b]	—	Ti: 5 × C to 0,70
X2CrNi19–11	4306–304–03-I	0,030	1,00	2,00	0,045	0,030	18,0 to 20,0	—	10,0 to 12,0 (13,0)[b]	0,10	—
X8CrNi25-21	4845-310-08-E	0,10	1,50	2,00	0,045	0,015	24,0 to 26,0	—	19,0 to 22,0	0,10	—
X2CrNiMo17–12–2	4404–316–03-I	0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0 (14,5)[b]	0,10	—
X5CrNiMo17–12–2	4401–316–00-I	0,07	1,00	2,00	0,045	0,030	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0	0,10	—
X6CrNiMoTi17–12–2	4571–316–35-I	0,08	1,00	2,00	0,045	0,030	16,5 to 18,5	2,00 to 2,50	10,5 to 13,5 (14,0)[b]	—	Ti: 5 × C to 0,70

Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for finishing the cast. All appropriate precautions shall be taken to avoid the addition of such elements from scrap and other materials used in production, which would impair mechanical properties and the suitability of the steel.

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons, e.g. hot workability or low magnetic permeability, it is necessary to minimize the ferrite content, the maximum nickel content may be increased to this value.

[c] Copper may be added up to 1 %. If added, it shall be reported in the inspection certificate, provided such a document has been ordered.

[d] For certain applications, e.g. weldability or high strength wire, a maximum of 0,12 % C may be agreed upon.

[e] By special agreement, the steel, when intended for cold deformation, may also be ordered with 7,0 % to 8,3 % Ni.

[f] Patented steel grade.

Table A.1 *(continued)*

Steel designation		%, mass fraction[a]									
Name	ISO-number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
X2CrNiMo17–12–3	4432–316–03-I	0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 (14,5)[b]	0,10	—
X3CrNiMo17–12–3	4436–316–00-I	0,05	1,00	2,00	0,045	0,030	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 (14,0)[b]	0,10	—
X2CrNiMo18-14-3	4435-316-91-I	0,030	1,00	2,00	0,045	0,015	17,0 to 19,0	2,50 to 3,00	12,5 to 15,0	0,10	—
X1NiCrMoCu25–20–5	4539–089–04-I	0,020	0,75	2,00	0,035	0,015	19,0 to 22,0	4,0 to 5,0	23,5 to 26,0	0,15	Cu: 1,20 to 2,00
X1NiCrMoCuN25-20-7	4529-089-26-I	0,020	0,75	2,00	0,035	0,015	19,0 to 21,0	6,0 to 7,0	24,0 to 26,0	0,15 to 0,25	Cu: 0,50 to 1,50
Austenitic-ferritic steels											
X2CrNiN22-2[f]	4062-322-02-U[f]	0,030	1,00	2,00	0,040	0,010	21,5 to 24,0	0,45	1,00 to 2,90	0,16 to 0,28	—
X2CrMnNiN21-5-1[f]	4162-321-01-E[f]	0,040	1,00	4,0 to 6,0	0,040	0,015	21,0 to 22,0	0,10 to 0,80	1,35 to 1,90	0,20 to 0,25	Cu: 0,10 to 0,80
X2CrNiMoN22–5-3	4462–318–03-I	0,030	1,00	2,00	0,035	0,015	21,0 to 23,0	2,5 to 3,5	4,5 to 6,5	0,10 to 0,22	—
X2CrNiMnMoCuN24–4-3–2[f]	4662–824–41-X[f]	0,030	0,70	2,50 to 4,0	0,035	0,005	23,0 to 25,0	1,00 to 2,00	3,0 to 4,5	0,20 to 0,30	Cu: 0,10 to 0,80
X3CrNiMoN27–5-2	4460–312–00-I	0,050	1,00	2,00	0,035	0,015	25,0 to 28,0	1,30 to 2,00	4,5 to 6,5	0,05 to 0,20	—
X2CrNiMoCuN25-6-3	4507-325-20-I	0,030	0,70	2,00	0,035	0,015	24,0 to 26,0	2,5 to 4,0	5,0 to 7,5	0,15 to 0,30	Cu: 1,00 to 2,50

Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for finishing the cast. All appropriate precautions shall be taken to avoid the addition of such elements from scrap and other materials used in production, which would impair mechanical properties and the suitability of the steel.

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons, e.g. hot workability or low magnetic permeability, it is necessary to minimize the ferrite content, the maximum nickel content may be increased to this value.

[c] Copper may be added up to 1 %. If added, it shall be reported in the inspection certificate, provided such a document has been ordered.

[d] For certain applications, e.g. weldability or high strength wire, a maximum of 0,12 % C may be agreed upon.

[e] By special agreement, the steel, when intended for cold deformation, may also be ordered with 7,0 % to 8,3 % Ni.

[f] Patented steel grade.

Table A.1 *(continued)*

Steel designation		%, mass fraction[a]									
Name	ISO-number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
Ferritic steels											
X6Cr17	4016–430–00-I	0,08[d]	1,00	1,00	0,040	0,030	16,0 to 18,0	—	—	—	—
X3CrNb17	4511-430-71-I	0,05	1,00	1,00	0,040	0,015	16,0 to 18,0	—	—	—	Nb: 12 × C to 1,00
X2CrTiNb18	4509-439-40-X	0,030	1,00	1,00	0,040	0,015	17,5 to 18,5	—	—	—	Ti: 0,10 to 0,60 Nb: 0,30 + 3 × C to 1,00
X6CrMo17–1	4113–434–00-I	0,08	1,00	1,00	0,040	0,030	16,0 to 18,0	0,90 to 1,40	—	—	—
Martensitic steels											
X12Cr13	4006–410–00-I	0,08 to 0,15	1,00	1,50	0,040	0,030	11,5 to 13,5	—	0,75	—	—
X12CrS13	4005–416–00-I	0,08 to 0,15	1,00	1,50	0,040	≥0,15	12,0 to 14,0	0,60	—	—	—
X20Cr13	4021–420–00-I	0,16 to 0,25	1,00	1,50	0,040	0,030	12,0 to 14,0	—	—	—	—
X30Cr13	4028–420–00-I	0,26 to 0,35	1,00	1,50	0,040	0,030	12,0 to 14,0	—	—	—	—
X17CrNi16–2	4057–431–00-X	0,12 to 0,22	1,00	1,50	0,040	0,030	15,0 to 17,0	—	1,50 to 2,50	—	—
X14CrS17	4019–430–20-I	0,10 to 0,17	1,00	1,50	0,040	≥0,15	16,0 to 18,0	0,60	—	—	—

Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for finishing the cast. All appropriate precautions shall be taken to avoid the addition of such elements from scrap and other materials used in production, which would impair mechanical properties and the suitability of the steel.

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons, e.g. hot workability or low magnetic permeability, it is necessary to minimize the ferrite content, the maximum nickel content may be increased to this value.

[c] Copper may be added up to 1 %. If added, it shall be reported in the inspection certificate, provided such a document has been ordered.

[d] For certain applications, e.g. weldability or high strength wire, a maximum of 0,12 % C may be agreed upon.

[e] By special agreement, the steel, when intended for cold deformation, may also be ordered with 7,0 % to 8,3 % Ni.

[f] Patented steel grade.

Table A.1 *(continued)*

Steel designation		%, mass fraction[a]									
Name	**ISO-number**	**C**	**Si**	**Mn**	**P**	**S**	**Cr**	**Mo**	**Ni**	**N**	**Others**
X4CrNiMo16-5-1	4418-431-77-E	0,06	0,70	1,50	0,040	0,015	15,0 to 17,0	0,80 to 1,50	4,0 to 6,0	≥0,020	—
X39CrMo17-1	4122-434-09-I	0,33 to 0,45	1,00	1,50	0,040	0,015	15,5 to 17,5	0,80 to 1,30	1,00	—	—
Precipitation-hardening steels											
X5CrNiCuNb16–4	4542–174–00-I	0,07	0,70	1,50	0,040	0,030	15,0 to 17,0	0,60	3,0 to 5,0	—	Cu: 3,0 to 5,0 Nb: 5 × C to 0,45

Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for finishing the cast. All appropriate precautions shall be taken to avoid the addition of such elements from scrap and other materials used in production, which would impair mechanical properties and the suitability of the steel.

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons, e.g. hot workability or low magnetic permeability, it is necessary to minimize the ferrite content, the maximum nickel content may be increased to this value.

[c] Copper may be added up to 1 %. If added, it shall be reported in the inspection certificate, provided such a document has been ordered.

[d] For certain applications, e.g. weldability or high strength wire, a maximum of 0,12 % C may be agreed upon.

[e] By special agreement, the steel, when intended for cold deformation, may also be ordered with 7,0 % to 8,3 % Ni.

[f] Patented steel grade.

Annex B
(normative)

Determination of the diameter of the equivalent ruling section for mechanical properties

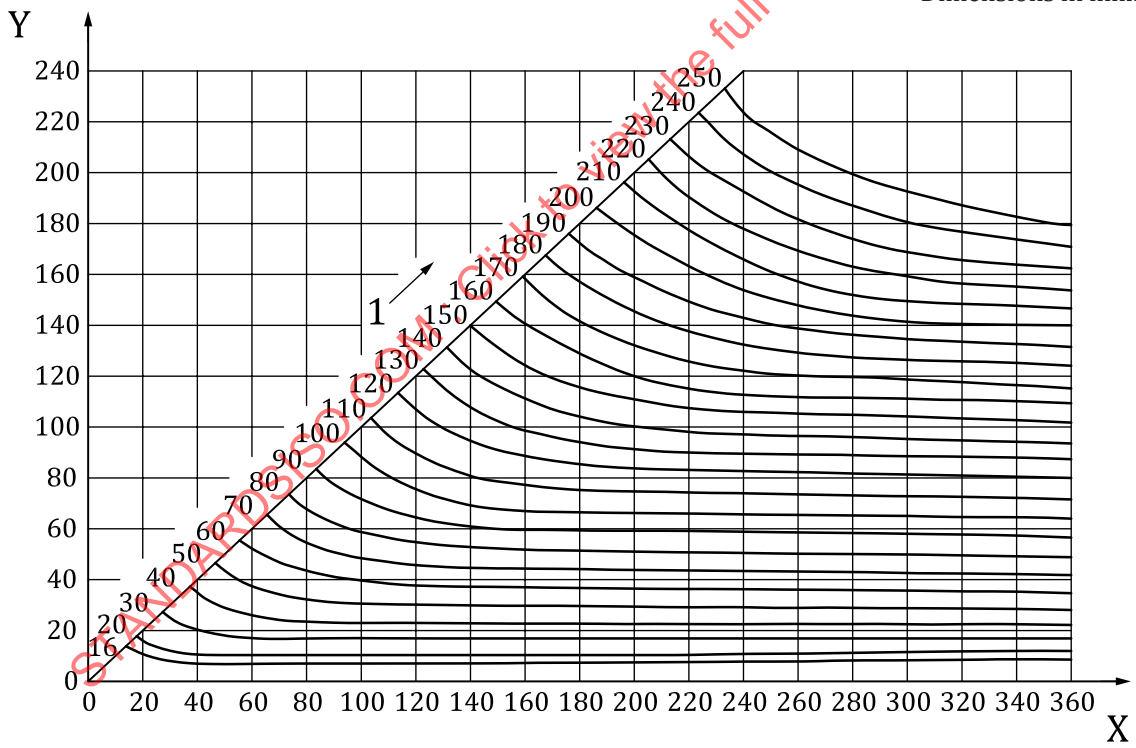
B.1 If the test pieces are taken from products with simple cross-sections and from positions with quasi two-dimensional heat flow, B.1.2 to B.1.3 shall apply.

B.1.1 For rounds, the nominal diameter of the product (not comprising the machining allowance) shall be taken as the diameter of the ruling section.

B.1.2 For hexagons and octagons, the nominal distance between two opposite sides of the cross-section shall be taken as the diameter of the ruling section.

B.1.3 For square and rectangular bars, the diameter of the ruling section shall be determined in accordance with the example shown in Figure B.1.

Dimensions in millimetres



Key

X width

Y thickness

1 diameter of the ruling cross-section

EXAMPLE For a rectangular bar with a section of 40 mm × 60 mm, the diameter of the ruling section is 50 mm.

Figure B.1 — Diameter of the equivalent ruling section for square and rectangular sections for quenching in oil or water