INTERNATIONAL STANDARD

ISO 683-18

Third edition
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Heat-treatable steels, alloy steels and free-cutting steels —

Part 18: Bright steel products

Aciers pour traitement thermique, aciers alliés et aciers pour décolletage —

Partie 18: Produits en aciers transformés à froid

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

This third edition cancels and replaces the second edition (ISO 683-18:1996), which has been technically revised.

ISO 683 consists of the following parts, under the general title *Heat treatable, alloy steels and free-cutting steels*:

— *Part 1: Non-alloy steels for quenching and tempering*

— *Part 2: Alloy steels for quenching and tempering*

— *Part 3: Case-hardening steels*

— *Part 4: Free-cutting steels*

— *Part 5: Nitriding steels*

— *Part 14: Hot-rolled steels for quenched and tempered springs*

— *Part 15: Valve steels for internal combustion engines*

— *Part 17: Ball and roller bearing steels*

— *Part 18: Bright steel products*

Heat-treatable steels, alloy steels and free-cutting steels —

Part 18:
Bright steel products

1 Scope

1.1 This part of ISO 683 specifies the technical delivery requirements for bright steel bars in the drawn or peeled/turned condition and they are intended for mechanical purposes, for example for machine parts. The bright bars are subdivided into the following steel types:

a) non-alloy general engineering steels;

b) non-alloy free-cutting steels;

c) non-alloy and alloy case-hardening steels;

d) non-alloy and alloy steels for quenching and tempering;

e) stainless steels.

1.2 In addition to this part of ISO 683, the general technical delivery requirements of ISO 404 are applicable.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 643, *Steels — Micrographic determination of the apparent grain size*

ISO 683-1, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering*·

ISO 683-2, *Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering*

ISO 683-3:—[1)], *Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels*

ISO 683-4, *Heat-treatable steels, alloy steels and free-cutting steels — Part 4: Free-cutting steels*

ISO 3887, *Steels — Determination of depth of decarburization*

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1) To be published. (Revision of ISO 683-11:2012.)

ISO 4885, *Ferrous products — 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/TS 4949, *Steel names based on letter symbols*

ISO 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

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 6929, *Steel products — Vocabulary*

ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

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 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 6929, ISO 14284 and the following apply.

3.1
bright steel products
are drawn or peeled/turned bars with smoother surface quality and better dimensional accuracy in comparison with hot-rolled bars

3.2
drawn products
products of various cross-sectional shapes obtained, after descaling, by cold drawing of hot-rolled bars or rod, on a drawing bench (cold deformation 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 products
steel bars of circular cross-section having the same features of drawn products concerning shape, dimensional accuracy and bright surface finish but without work hardening

Note 1 to entry: They are produced by peeling on a peeling machine usually followed by straightening and by polishing. The removal of metal by peeling is carried out in such a way that the bright product is generally free from surface defects and decarburization coming from the hot-rolling process.

3.4
ground products
drawn or peeled/turned round bars 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' has to be defined at the time of enquiry and order.

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

3.7
ruling section
that section for which the specified mechanical properties shall 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, at the position of its cross-section specified for taking the test pieces for the mechanical tests, will, when being cooled from austenitizing temperature, show the same cooling rate as the actual ruling section of the product concerned at its position for taking the test pieces.

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. The general engineering and the free cutting steels are quality steels. The steels for case hardening, for quenching and tempering and the stainless steels are special 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.

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 7.7 and Tables 3 and 16 to 18;

d) reference to this part of ISO 683, i.e ISO 683-18;

e) the designation of the steel grade and the delivery condition (see Tables 5 to 15);

f) 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 part of ISO 683 and listed below. If the purchaser does not indicate the wish to implement any of these options, the products will be supplied in accordance with the basic specifications of this part of ISO 683 (see 5.1).

a) Reference testing for products used in the quenched and tempered condition (for steels for quenching and tempering only, see Table 1, footnote d and C.2);

b) any fine grain requirement and verification of fine grain size (see 7.3 and C.3);

c) non-destructive testing (see 7.5 and C.4);

d) the disposition of tolerances in accordance with 7.7 and C.5;

e) end conditions may be specified at the time of enquiry and order in accordance with C.6;

f) product analysis (see 7.1.2, Table 20 and C.7);

g) for a minimum reduction ratio or minimum thickness deformation (see 6.1 and C.8)

h) temporary corrosion protection (see 6.2.1 and C.9);

i) any requirement to special marking (see Clauses 10 and C.10)

j) 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);

k) surface quality class if another than the standard class is requested (see 7.8 and Table 4);

l) verification of the straightness (see 7.7, Table 19 and Annex D);

m) any requirement to the hardenability (+H, +HH, +HL), for special steels only (see 7.1.4);

n) any requirement regarding the permissible depth of decarburization (see 7.6);

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

EXAMPLE 1

2 t round bars with nominal diameter 20 mm, tolerance h9, stock length 6000 mm made of steel grade C45 according to this standard in delivery condition +C, surface quality class 1 and a test report 2.2 as specified in ISO 10474.

2 t round bars 20 h9 × stock 6000

steel grade ISO 683-18 - C45+C

Inspection document ISO 10474 - 2.2

EXAMPLE 2

3 t round bars with nominal diameter 80 mm, tolerance h8, stock length 6000 mm made of steel grade X5CrNi18–10 according to this standard in process route +2B, surface quality class 3, with surface condition +2G and a certificate 3.1 as specified in ISO 10474.

3 t round bars 80 h8 × stock 6000

steel grade ISO 683-18 - X5CrNi18–10+2B+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.

For minimum reduction ratio or minimum thickness deformation ratio of rolled and forged products, see C.8.

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 must comply with the condition agreed in the order and shall be one of the conditions indicated in Table 1 or Table 2.

Bright steel products in cold drawn or peeled/turned condition are coated with a light film of grease from processing, for bright steel products in a finally heat treated condition the manufacturer chooses the rust protection after heat treatment.

The usual light application of ordinary grease or oil does not afford positive protection against rusting, particularly in the presence of condensation water. The use of a selected rust inhibitor or a special type of packing shall, if required, be agreed at the time of enquiry and order, see C.9.

6.2.2 Particular surface conditions

Table 3 shows the possible surface conditions and tolerance classes according to ISO 286-2 at delivery.

6.3 Traceability of the cast

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

7 Requirements

7.1 Chemical composition, mechanical properties and hardenability

7.1.1 General

Combination of usual treatment conditions at the time of delivery and requirements concerning chemical composition and mechanical properties are shown in Tables 1 and 2.

7.1.2 Chemical composition

The chemical composition of the steels determined by the cast analysis, shall comply to ISO 630-2, ISO 683-1, ISO 683-2, ISO 683-3, ISO 683-4 and ISO 16143-2. The grades and the chemical composition of the steels are listed for information in Annex A for ISO 630-2, ISO 683-1, ISO 683-2, ISO 683-3, ISO 683-4 and ISO 16143-2.

Permissible deviations between the limiting values for cast analysis and the values for product analysis are given in the corresponding tables of ISO 630-2, ISO 683-1, ISO 683-2, ISO 683-3, ISO 683-4 and

ISO 16143-2. The product analysis shall be carried out when specified at the time of enquiry and order (see C.7).

If steels for case hardening or for quenching and tempering are ordered with hardenability requirements according to ISO 683-1, ISO 683-2 and ISO 683-3, such hardenability requirements shall be considered as the governing criteria for acceptance. In such cases, the cast analysis may deviate by the values given in ISO 683-1, ISO 683-2 and ISO 683-3:—, Table 3, footnote b.

WARNING — Due to hazardous effects to health and environmental problems of Pb, it is recommended to use instead steels only with sulfur and other innocuous free-cutting element additions.

7.1.3 Mechanical properties

For steels ordered in one of the treatment condition in Tables 1 and 2, the requirements for mechanical properties specified in Tables 5 to 15 apply (except for stainless steel bars ordered in condition +2D for which the mechanical properties are to be found in ISO 16143-2). The mechanical property values given in Tables 5 to 15 apply to test pieces which have been taken and prepared in accordance with Figure 1.

In this case, the normal and narrowed hardenability values given in ISO 683-1, ISO 683-2 for special steels and the narrowed hardenability values in ISO 683-3 for alloy special steels are for guidance purposes only.

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 15 apply. For these products, the mechanical properties are prime, with the condition a secondary property.

NOTE In this Tables 5 to 14, grades alloyed with further elements for better machinability are not explicitly mentioned, but the mechanical properties are also valid for them (see Tables A.1 to A.5).

7.1.4 Hardenability

Unless otherwise agreed for alloy case-hardening steels, the hardenability requirements given in ISO 683-3:—, Table 5 apply. If agreed at the time of enquiry and order, alloy case-hardening steels with restricted hardenability scatterbands given in ISO 683-3:—, Table 6 shall be supplied and these values apply in addition to Table 1, columns 6 and 7.

If special steels for quenching and tempering are ordered by using the designations to normal or to narrowed hardenability scatterbands, the values of hardenability given in ISO 683-1 or ISO 683-2 apply in addition to Table 1, columns 8 and 9.

NOTE In Tables 9 to 11, grades alloyed with further elements for better machinability are not explicitly mentioned, but the mechanical properties are also valid for them (see Tables A.3 and A.4).

7.2 Machinability

All non-stainless steels are machinable in the conditions 'soft annealed' (+A) and treated to ferrite/pearlite structure (+FP).

Where improved machinablity is required the grades with a specified sulfur or lead range should be ordered and/or with a specific treatment to improve machinability (see also footnote b in Tables A.1, A.3 and A.4).

Free-cutting steels with low carbon content have their best machinability in the cold drawn condition.

NOTE Non-leaded steels with comparable chemical composition generally have identical mechanical properties but often lower machinability than leaded steels.

7.3 Grain size

Unless otherwise agreed at the time of enquiry and order the grain size of the general engineering, free-cutting steels, the non-alloy steels for quenching and tempering and the stainless steels shall be left to the discretion of the manufacturer. If a fine grain structure is required for non-alloy steels for quenching and tempering or for case-hardening or quenched and tempered free-cutting steels, Annex C, Option C.3 shall be ordered.

NOTE If direct hardening treatment is used for free-cutting case-hardening steels, a fine grain structure should be ordered.

The case-hardening and the alloy steels for quenching and tempering shall have a fine grain structure with an austenite grain size of 5 or finer, when tested in accordance with ISO 643. Only for verification see C.3.

7.4 Non-metallic inclusions

7.4.1 Microscopic inclusions

The special steels shall have a certain degree of cleanness, however, verification of the non-metallic inclusion content requires a special agreement. If there is such an agreement at the time of enquiry and order the microscopically non-metallic inclusion content shall be determined to an agreed procedure and within agreed limits (see ISO 4967 or another regional standard: i.e. EN 10247 or JIS G 0555)

NOTE For grades with specified minimum sulfur content, the agreement should only concern the oxides.

7.4.2 Macroscopic inclusions

This requirement is applicable for the verification of the macroscopic inclusions in special steels. If verification is agreed then the method and acceptance limits shall be agreed at the time of enquiry and order.

7.5 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.4).

7.6 Decarburization

For non-stainless steels for quenching and tempering, requirements relating to the permissible depth of decarburization may be agreed at the time of enquiry and order.

The depth of decarburization shall be determined in accordance with the micrographic method specified in ISO 3887.

7.7 Shape, dimensions and tolerances

The tolerance class on thickness (and width for flats) shall comply 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 16 for rounds, squares and hexagons and in Table 17 for drawn flats. Where specified by the purchaser at the time of enquiry and order the disposition tolerances specified in Table 16 shall be in accordance with C.5.

Unless otherwise agreed at the time of enquiry and order, the length and the tolerance on length shall be as specified in Table 18.

Maximum deviation from 'out of roundness' shall be not more than half the specified tolerance range in any case never above the upper limit of the tolerance.

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 the method specified in Annex D and the tolerances specified in Table 19 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, flats in widths > 150 mm within a distance of 0,5 mm, unless otherwise agreed. For widths > 150 mm, the corner profile may be undefined within a distance of 0,5 mm of the hypothetical edge, unless sharp corners have specifically been ordered.

7.8 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 according to Table 4. Cold drawn bars and ground/polished bars (+C, +C+QT, +C+G, +C+PL, +2H, +2D, +2H+2G, +2H+2P) are delivered in class 1, while peeled/turned bars as well as ground/polished bars produced from peeled/turned bars (+SH, +SH+G, +SH+PL, +2B, +2B+2G, +2B+2P) 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 complying with this part of ISO 683 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 is to 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 in Tables A.1 to A.5 for the steel grade 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 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 in Table A.1 to A.5 for the steel grade 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 20.

8.3 Specific inspection and testing

8.3.1 Verification of the hardenability, hardness and mechanical properties

For steels ordered in one of the treatment condition in Table 1 or Table 2, the hardness requirements or mechanical properties, shall, with the following exception, be verified. The requirements given in Table 1, footnote d (mechanical properties of reference test pieces), is only to be verified if supplementary requirement specified in C.2 is ordered.

For steels being ordered with the symbol +H, +HH or +HL in the designation, unless otherwise agreed, only the hardenability requirements according to ISO 683-1, ISO 683-2 and ISO 683-3 are to be verified.

8.3.2 Visual and dimensional inspection

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

Dimensional inspection shall be carried out as follows:

a) for round bars: not less than 150 mm from the end of the bar;

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

c) for shapes other than round: not less than 25 mm from the end 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.

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

9.2 Mechanical tests

9.2.1 Tensile test

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

For the specified yield strength in the tables on mechanical properties in this standard, the upper yield strength (R_{eH}) shall be determined.

If a yield phenomenon is not present, the 0,2 % proof strength ($R_{p0,2}$) shall be determined.

9.2.2 Impact test

The Charpy-V-notch (CVN) impact test shall be carried out in accordance with ISO 148-1. For cold drawn bars (+C, +C+G, +C+PL, +2H, +2H+2G. +2H+2P), requirements on impact tests can normally not be fulfilled, impact tests can only be performed if mentioned in the tables for mechanical properties.

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.

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 the sample product is rejected and retests may be carried out on the remainder of the test unit.

9.3 Hardness and hardenability tests

9.3.1 Hardness in treatment conditions +A and +FP

For products in treatment conditions +SH (hot-rolled and peeled/turned), +A+SH (soft annealed and peeled/turned), +A+C (soft annealed and cold drawn, +FP +SH (treated to ferrite-pearlite structure and peeled/turned) and +FP+C (treated to ferrite-pearlite structure and cold drawn), the hardness tests shall be carried out in accordance with ISO 6506-1.

9.3.2 Verification of hardenability

For verification of hardenability, see ISO 683-1, ISO 683-2 and ISO 683-3.

9.4 Verification of dimensions

The out-of-roundness test has to be carried out by the two-point measuring method. Other methods have to be agreed at the time of enquiry and order.

9.5 Retests

Retests for steels for quenching and tempering 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.10).

Table 1 — Combinations of usual treatment conditions at delivery and requirements for non-stainless steels

	1	2	3	4	5	6	7	8	9
1	**Treatment condition at delivery**	**Symbol**	**Chemical composition** **All steels**	**Mechanical properties** **General engineering steels**	**Free cutting steels**	**Non-alloy case-hardening steels**	**Alloy case-hardening steels**	**Non-alloy steels for quenching and tempering**	**Alloy steels for quenching and tempering**
2	As-rolled and peeled/turned[a]	+SH	Chemical composition according to ISO 630-2, ISO 683-1, ISO 683-2, ISO 683-4, and ISO 683-3, for information see Tables A.1 to A.4	See Table 5	See Table 6, 7	See Table 8	–	See Table 10[d]	–
3	Cold drawn[b]	+C		See Table 5[c]	See Table 6, 7	See Table 8	–	See Table 10[d]	–
4	Soft annealed and peeled/turned	+A+SH		–	–	See Table 8	See Table 9	–	See Table 11[d]
5	Soft annealed and cold drawn	+A+C		–	–	See Table 8	See Table 9	–	See Table 11[d]
6	Treated to ferrite-pearlite structure and hardness range and peeled/turned	+FP+SH		–	–	–	See Table 9	–	–
7	Treated to ferrite-pearlite structure and hardness range and cold drawn	+FP+C		–	–	–	See Table 9	–	–
8	Quenched and tempered and peeled or cold drawn and quenched and tempered	+QT+SH +C+QT		–[c]	See Table 7	–	–	See Table 10	See Table 11
9	Quenched+tempered and cold drawn	+QT+C		–	See Table 7	–	–	See Table 10	See Table 11
10	Other heat-treatment conditions, for example, stress relieved (+SR), normalized (+N) and the mechanical properties, may be agreed at the time of enquiry and order. The condition "annealed to achieve a spheroidization of the carbides" as required for cold heading and cold extrusion is covered in ISO 4954.			To be agreed					

a Peeling is in general possible for diameters of 16 mm and over.

b For rounds with diameters over 80 mm, it is more usual to apply peeling/turning instead of drawing.

c If these steels should be drawn and quenched and tempered, values for this treatment could be found at the comparable special steel grades in Table 10.

d The mechanical properties specified in Table 10, respectively Table 11, for the condition +C+QT must be achievable after appropriate heat treatment if so agreed in the order (for reference test pieces see C.2).

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]	Note	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, for information see Table A.5	See Tables 12, 13, 14, 15
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
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 12, 13, 14
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, 2 = cold processed, for further information on the symbols see ISO 16143-2.

[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 Drawn or heat-treated and cold drawn	+C +2H	h10 (h9 to h12) see Table 16	h11 for $d \leq 80$ mm, h12 for $d > 80$ mm (h11 or h12); see Table 16		h11, h12, see Table 17	–[b]	See Table 1, lines 3,5,7,9 and Table 2 line 2
3	Cold drawn, heat treated	+C+QT (+C+N) (+C+SR) (+C+A) +2D	h11 see Table 16	–	–	–	–	Finish for good ductility see Table 1, line 8 and Table 2 line 3
4	Peeled/turned	+SH +2B	h10 (h9 to h12) see Table 16	–	–	–	–	See Table 1, lines 2,4,6 and Table 2, line 4
5	Ground	+G +2G	h9 (h6 to h12) see Table 16	–	–	–	–	Obtained e.g. from conditions Table 1, lines 2 to 7 and 9 and see Table 2 line 5
6	Polished	+PL +2P	h9 (h6 to h12) see Table 16	–	–	–	–	Obtained e.g. from conditions Table 1, lines 2 to 7 and 9 and see 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.

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 manufacture[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]	-	-	-

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

a + indicates available in these classes, - indicates not 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 are to be agreed at the time of enquiry and order.

Table 5 — Mechanical properties of bright steels for general engineering use

Steel name	Thickness[a] t mm	Mechanical properties[a]				
		As-rolled + peeled (+SH)		Cold drawn (+C)		
		Hardness[b] HBW	R_m MPa	$R_{p0,2}$[c] MPa min.	R_m[c] MPa	A min.
S235B	$5 \le t \le 10$	-	-	355	470 to 840	8
	$10 < t \le 16$	-	-	300	420 to 770	9
	$16 < t \le 40$	107 to 152	360 to 510	260	390 to 730	10
	$40 < t \le 63$	107 to 152	360 to 510	235	380 to 670	11
	$63 < t \le 100$	107 to 152	360 to 510	215	360 to 640	11
S355D	$5 \le t \le 10$	-	-	520	630 to 950	6
	$10 < t \le 16$	-	-	450	580 to 880	7
	$16 < t \le 40$	140 to 187	470 to 630	350	530 to 850	8
	$40 < t \le 63$	140 to 187	470 to 630	335	500 to 770	9
	$63 < t \le 100$	140 to 187	470 to 630	315	470 to 740	9
C25	$5 \le t \le 10$	-	-	420	560 to 860	6
	$10 < t \le 16$	-	-	380	530 to 830	7
	$16 < t \le 40$	131 to 187	440 to 640	300	510 to 810	8
	$40 < t \le 63$	131 to 187	440 to 640	265	490 to 790	9
	$63 < t \le 100$	131 to 187	440 to 640	245	440 to 740	10
C30	$5 \le t \le 10$	-	-	455	610 to 910	6
	$10 < t \le 16$	-	-	420	570 to 870	7
	$16 < t \le 40$	143 to 198	480 to 680	345	550 to 850	8
	$40 < t \le 63$	143 to 198	480 to 680	300	520 to 820	9
	$63 < t \le 100$	143 to 198	480 to 680	250	480 to 780	9
C35	$5 \le t \le 10$	-	-	510	650 to 1 000	6
	$10 < t \le 16$	-	-	420	600 to 950	7
	$16 < t \le 40$	156 to 204	520 to 700	320	580 to 880	8
	$40 < t \le 63$	156 to 204	520 to 700	300	550 to 840	9
	$63 < t \le 100$	156 to 204	520 to 700	270	520 to 800	9
C40	$5 \le t \le 10$	-	-	540	700 to 1 000	6
	$10 < t \le 16$	-	-	460	650 to 980	7
	$16 < t \le 40$	164 to 207	550 to 710	365	620 to 920	8
	$40 < t \le 63$	164 to 207	550 to 710	330	590 to 840	9
	$63 < t \le 100$	164 to 207	550 to 710	290	550 to 820	9

a For thickness < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

b In case of dispute, the tensile strength values are the decisive factor.

c For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) by ± 10 %.

d Steels C50 and C60 in delivery condition +C may be soft annealed before cold drawing.

Table 5 *(continued)*

Steel name	Thickness[a] t mm	Mechanical properties[a]				
		As-rolled + peeled (+SH)		**Cold drawn** (+C)		
		Hardness[b] HBW	R_m MPa	$R_{p0,2}$[c] MPa min.	R_m[c] MPa	A min.
C45	$5 \leq t \leq 10$	-	-	565	750 to 1 050	5
	$10 < t \leq 16$	-	-	500	710 to 1 030	6
	$16 < t \leq 40$	172 to 241	580 to 820	410	650 to 1 000	7
	$40 < t \leq 63$	172 to 241	580 to 820	360	630 to 900	8
	$63 < t \leq 100$	172 to 241	580 to 820	310	580 to 850	8
C50[d]	$5 \leq t \leq 10$	-	-	590	770 to 1 100	5
	$10 < t \leq 16$	-	-	520	730 to 1 080	6
	$16 < t \leq 40$	179 to 269	610 to 910	440	690 to 1 050	7
	$40 < t \leq 63$	179 to 269	610 to 910	390	650 to 1030	8
	$63 < t \leq 100$	179 to 269	610 to 910	-	-	-
C60[d]	$5 \leq t \leq 10$	-	-	630	800 to 1 150	5
	$10 < t \leq 16$	-	-	550	780 to 1 130	5
	$16 < t \leq 40$	196 to 278	670 to 940	480	730 to 1 100	6
	$40 < t \leq 63$	196 to 278	670 to 940	-	-	-
	$63 < t \leq 100$	196 to 278	670 to 940	-	-	-

a For thickness < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

b In case of dispute, the tensile strength values are the decisive factor.

c For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) by ± 10 %.

d Steels C50 and C60 in delivery condition +C may be soft annealed before cold drawing.

Table 6 — Mechanical properties of free-cutting bright steels (except steels for quenching and tempering)

Steel name	Thickness[a] t mm	Mechanical properties				
		As-rolled + peeled (+SH)		Cold drawn (+C)		
		Hardness[b] HBW max.	R_m MPa	$R_{p0,2}$ [c] MPa min.	R_m [c] MPa	A min.
Steels not intended for heat treatment						
9S20	$t \leq 16$	154	330 to 520	-	-	-
	$16 < t \leq 40$	154	330 to 520	-	-	-
	$40 < t \leq 63$	154	320 to 520	-	-	-
	$63 < t \leq 100$	140	310 to 470	-	-	-
11SMn30 11SMnPb30 11SMn37 11SMnPb37	$5 \leq t \leq 10$	–	–	440	510 to 810	6
	$10 < t \leq 16$	–	–	410	490 to 760	7
	$16 < t \leq 40$	169	380 to 570	375	460 to 710	8
	$40 < t \leq 63$	169	370 to 570	305	400 to 650	9
	$63 < t \leq 100$	154	360 to 520	245	360 to 630	9
Case-hardening steels						
10S20 10SPb20	$5 \leq t \leq 10$	–	–	410	520 to 780	7
	$10 < t \leq 16$	–	–	390	490 to 740	8
	$16 < t \leq 40$	156	360 to 530	360	460 to 720	9
	$40 < t \leq 63$	156	360 to 530	295	410 to 660	10
	$63 < t \leq 100$	146	350 to 490	235	380 to 630	11
15SMn13	$5 \leq t \leq 10$	–	–	450	560 to 840	6
	$10 < t \leq 16$	–	–	430	500 to 800	7
	$16 < t \leq 40$	178	430 to 600	390	470 to 770	8
	$40 < t \leq 63$	172	430 to 580	350	460 to 680	9
	$63 < t \leq 100$	160	420 to 540	265	440 to 650	10
17SMn20	$5 \leq t \leq 10$	–	–	450	560 to 840	6
	$10 < t \leq 16$	–	–	430	500 to 800	7
	$16 < t \leq 40$	178	430 to 600	390	470 to 770	8
	$40 < t \leq 63$	172	430 to 580	350	460 to 680	9
	$63 < t \leq 100$	160	420 to 540	265	440 to 650	10

a For thickness < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

b In case of dispute, the tensile strength values are the decisive factor.

c For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) by ± 10 %.

Table 7 — Mechanical properties of free-cutting bright steels for quenching and tempering

Steel name	Thickness[a,b] t mm	Mechanical properties										
		As-rolled + peeled (+SH)		Cold drawn (+C)			Quenched and tempered and peeled[c] (+QT+SH)			Quenched and tempered + cold drawn (+QT +C)		
		Hardness[d] HBW max.	R_m MPa	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$[e] MPa min.	R_m[e] MPa	A % min.
35S20 35SPb20	$5 \le t \le 10$	–	–	480	640 to 880	6	430	630 to 780	-	490	700 to 900	9
	$10 < t \le 16$	–	–	400	590 to 830	7	430	630 to 780	-	490	700 to 900	11
	$16 < t \le 40$	198	520 to 680	360	560 to 800	8	380	600 to 750	16	455	650 to 850	12
	$40 < t \le 63$	196	520 to 670	340	530 to 760	9	320	550 to 700	17	400	570 to 770	13
	$63 < t \le 100$	190	500 to 650	300	510 to 680	9	320	550 to 700	17	385	550 to 750	14
36SMn14 36SMnPb14	$5 \le t \le 10$	–	–	500	660 to 960	6	480	700 to 850	-	525	750 to 1000	6
	$10 < t \le 16$	–	–	440	620 to 920	6	460	700 to 850	-	520	740 to 990	6
	$16 < t \le 40$	219	560 to 750	390	600 to 900	7	420	670 to 820	15	505	720 to 970	8
	$40 < t \le 63$	216	560 to 740	360	580 to 840	8	400	640 to 790	16	475	680 to 930	9
	$63 < t \le 100$	216	550 to 740	340	560 to 820	9	360	570 to 720	17	405	580 to 840	9
35SMn20 35SMnPb20	$5 \le t \le 10$	–	–	500	660 to 960	6	-	-	-	595	850 to 1000	9
	$10 < t \le 16$	–	–	440	620 to 920	6	420	620 to 820	14	545	775 to 925	10
	$16 < t \le 40$	219	560 to 750	390	600 to 900	7	365	590 to 790	15	490	700 to 900	12
	$40 < t \le 63$	216	560 to 740	360	580 to 840	8	335	540 to 740	16	490	700 to 900	13
	$63 < t \le 100$	216	550 to 740	340	560 to 820	9	-	-	16	440	625 to 850	14

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thickness < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn and quenched and tempered condition" (+C+QT).

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

e For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) by ± 10 %.

Table 7 *(continued)*

Steel name	Thickness[a,b] t mm	Mechanical properties										
		As-rolled + peeled (+SH)		Cold drawn (+C)			Quenched and tempered and peeled[c] (+QT+SH)			Quenched and tempered + cold drawn (+QT +C)		
		Hardness[d] HBW max.	R_m MPa	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$[e] MPa min.	R_m[e] MPa	A % min.
38SMn28 38SMnPb28	$5 \le t \le 10$	–	–	550	700 to 960	6	480	700 to 850	-	595	850 to 1000	9
	$10 < t \le 16$	–	–	500	660 to 960	6	460	700 to 850	-	595	850 to 1000	9
	$16 < t \le 40$	213	560 to 730	420	610 to 900	7	420	700 to 850	16	490	700 to 900	11
	$40 < t \le 63$	213	560 to 730	400	600 to 840	7	400	700 to 850	16	490	700 to 900	12
	$63 < t \le 100$	204	550 to 700	350	580 to 820	8	380	630 to 800	16	490	700 to 900	12
44SMn28 44SMnPb28	$5 \le t \le 10$	-	-	600	760 to 1030	5	520	700 to 850	-	595	850 to 1000	9
	$10 < t \le 16$	-	-	530	710 to 980	5	480	700 to 850	-	595	850 to 1000	9
	$16 < t \le 40$	241	630 to 820	460	660 to 900	6	420	700 to 850	16	490	700 to 900	11
	$40 < t \le 63$	231	620 to 790	430	650 to 870	7	410	700 to 850	16	490	700 to 900	12
	$63 < t \le 100$	228	610 to 780	390	630 to 840	7	400	700 to 850	16	490	700 to 900	12
46S20 46SPb20	$5 \le t \le 10$	-	-	570	740 to 980	5	490	700 to 850	-	595	850 to 1000	8
	$10 < t \le 16$	-	-	470	690 to 930	6	490	700 to 850	-	560	800 to 950	9
	$16 < t \le 40$	222	590 to 760	400	640 to 880	7	430	650 to 800	13	490	700 to 850	10
	$40 < t \le 63$	213	580 to 730	380	610 to 850	8	370	630 to 780	14	490	700 to 850	11
	$63 < t \le 100$	207	560 to 710	340	580 to 820	8	370	630 to 780	14	455	650 to 850	11

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thickness < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn and quenched and tempered condition" (+C+QT).

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

e For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) by ± 10 %.

Table 8 — Mechanical properties of non-alloy bright steels for case hardening

Steel name	Thickness[a] t mm	Mechanical properties: As-rolled + peeled (+SH)		Cold drawn (+C)			+A + peeled (+A +SH)	+A + cold drawn (+A +C)
		Hardness[c] HBW	R_m MPa	$R_{p\,0,2}$[b] MPa min.	R_m[b] MPa	A % min.	Hardness HBW max.	Hardness[d] HBW max.
C10E C10R	$5 \le t \le 10$	-	-	350	460 to 760	8	-	225
	$10 < t \le 16$	-	-	300	430 to 730	9	-	216
	$16 < t \le 40$	92 to 163	310 to 550	250	400 to 700	10	131	207
	$40 < t \le 63$	92 to 163	310 to 550	200	350 to 640	12	131	190
	$63 < t \le 100$	92 to 163	310 to 550	180	320 to 580	12	131	172
C15E C15R	$5 \le t \le 10$	-	-	380	500 to 800	7	-	238
	$10 < t \le 16$	-	-	340	480 to 780	8	-	231
	$16 < t \le 40$	98 to 178	330 to 600	280	430 to 730	9	143	216
	$40 < t \le 63$	98 to 178	330 to 600	240	380 to 670	11	143	198
	$63 < t \le 100$	98 to 178	330 to 600	215	340 to 600	12	143	178
C16E C16R	$5 \le t \le 10$	-	-	400	520 to 820	7	-	242
	$10 < t \le 16$	-	-	360	500 to 800	8	-	238
	$16 < t \le 40$	105 to 184	350 to 620	300	450 to 750	9	156	222
	$40 < t \le 63$	105 to 184	350 to 620	260	400 to 690	11	156	204
	$63 < t \le 100$	105 to 184	350 to 620	235	360 to 620	12	156	184

a For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

b For flats and special sections, the yield strength ($R_{p0,2}$) may deviate by –10 % and the tensile strength (R_m) by ± 10 %.

c In case of dispute, the tensile strength values are the decisive factor.

d The hardness values for flats may deviate by ± 10 %.

Table 9 — Mechanical properties of alloy bright steels for case hardening

Steel name	Thickness[a] t mm	Mechanical properties			
		+A+ **peeled** (+A+SH) **Hardness** HBW max.	+A+**cold drawn** (+A+C) **Hardness**[b] HBW max.	+FP+ **peeled** (+FP+SH) **Hardness** HBW	+FP+**cold drawn** (+FP+C) **Hardness**[b] HBW
20Cr4 20CrS4	$5 \leq t \leq 10$	-	-	-	-
	$10 < t \leq 16$	-	-	-	-
	$16 < t \leq 40$	197	-	-	140 to 240
	$40 < t \leq 63$	197	-	-	140 to 240
	$63 < t \leq 100$	197	-	-	140 to 240
16MnCr5 16MnCrS5	$5 \leq t \leq 10$	-	260	-	-
	$10 < t \leq 16$	-	250	-	-
	$16 < t \leq 40$	207	245	140 to 187	140 to 240
	$40 < t \leq 63$	207	240	140 to 187	140 to 235
	$63 < t \leq 100$	207	240	140 to 187	140 to 235
20MnCr5 20MnCrS5	$5 \leq t \leq 10$	-	270	-	-
	$10 < t \leq 16$	-	260	-	-
	$16 < t \leq 40$	217	255	152 to 201	152 to 250
	$40 < t \leq 63$	217	250	152 to 201	152 to 245
	$63 < t \leq 100$	217	250	152 to 201	152 to 245
24CrMo4 24CrMoS4	$5 \leq t \leq 10$	-	270	-	-
	$10 < t \leq 16$	-	260	-	-
	$16 < t \leq 40$	212	255	-	-
	$40 < t \leq 63$	212	250	-	-
	$63 < t \leq 100$	212	250	-	-
20NiCrMo2–2 20NiCrMoS2–2	$5 \leq t \leq 10$	-	270	-	-
	$10 < t \leq 16$	-	260	-	-
	$16 < t \leq 40$	212	255	149 to 194	149 to 240
	$40 < t \leq 63$	212	255	149 to 194	149 to 235
	$63 < t \leq 100$	212	255	149 to 194	149 to 235
18CrNiMo7–6	$5 \leq t \leq 10$	-	-	-	-
	$10 < t \leq 16$	-	-	-	-
	$16 < t \leq 40$	229	-	149 to 201	149 to 280
	$40 < t \leq 63$	229	-	149 to 201	149 to 280
	$63 < t \leq 100$	229	-	149 to 201	149 to 280

[a] For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

[b] The hardness values for flats may deviate by ± 10 %.

Table 10 — Mechanical properties of non-alloy bright steels for quenching and tempering

Steel name	Thickness[a, b] t mm	Mechanical properties											
		As-rolled + peeled (+SH)		Cold drawn (+C)			Quenched and tempered and peeled[c] (+QT+SH)				Quenched and tempered + cold drawn (+QT +C)		
		Hardness[d] HBW	R_m MPa	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	$R_{p0,2}$[e] MPa min.	R_m[e] MPa	A % min.
C25E C25R	$5 \le t \le 10$	-	-	420	560 to 860	6	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	380	530 to 880	7	-	-	-	-	-	-	-
	$16 < t \le 40$	130 to 187	440 to 640	300	510 to 810	8	320	500 to 650	20	45	-	-	-
	$40 < t \le 63$	130 to 187	440 to 640	265	490 to 790	9	-	-	-	-	-	-	-
	$63 < t \le 100$	130 to 187	440 to 640	245	440 to 740	10	-	-	-	-	-	-	-
C30E C30R	$5 \le t \le 10$	-	-	455	610 to 910	6	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	420	570 to 870	7	-	-	-	-	-	-	-
	$16 < t \le 40$	145 to 198	480 to 680	345	550 to 850	8	350	550 to 750	20	40	-	-	-
	$40 < t \le 63$	145 to 198	480 to 680	300	520 to 820	9	300	500 to 650	20	40	-	-	-
	$63 < t \le 100$	145 to 198	480 to 680	250	480 to 780	9	300	500 to 650	20	40	-	-	-
C35E C35R	$5 \le t \le 10$	-	-	510	650 to 1000	6	-	-	-	-	525	750 to 950	9
	$10 < t \le 16$	-	-	420	600 to 950	7	-	-	-	-	490	700 to 900	9
	$16 < t \le 40$	156 to 204	520 to 700	320	580 to 880	8	370	600 to 750	19	35	455	650 to 850	10
	$40 < t \le 63$	156 to 204	520 to 700	300	550 to 840	9	320	550 to 700	20	35	400	570 to 770	11
	$63 < t \le 100$	156 to 204	520 to 700	270	520 to 800	9	320	550 to 700	20	35	385	550 to 750	12
C40E C40R	$5 \le t \le 10$	-	-	540	700 to 1000	6	-	-	-	-	560	800 to 1 000	8
	$10 < t \le 16$	-	-	460	650 to 980	7	-	-	-	-	525	750 to 950	8
	$16 < t \le 40$	164 to 207	550 to 710	365	620 to 920	8	400	630 to 780	18	30	490	680 to 880	9
	$40 < t \le 63$	164 to 207	550 to 710	330	590 to 840	9	350	600 to 750	19	30	435	620 to 820	10
	$63 < t \le 100$	164 to 207	550 to 710	290	550 to 820	9	350	600 to 750	19	30	420	600 to 800	11

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn + quenched and tempered condition" (+C+QT).

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

e For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 10 *(continued)*

Steel name	Thickness[a, b] t mm	Mechanical properties												
		As-rolled + peeled (+SH)		**Cold drawn** (+C)			**Quenched and tempered and peeled**[c] (+QT+SH)				**Quenched and tempered + cold drawn** (+QT +C)		
		Hardness[d] HBW	R_m MPa	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	$R_{p0,2}$[e] MPa min.	R_m[e] MPa	A % min.
C45E C45R	$5 \le t \le 10$	-	-	565	750 to 1050	5	-	-	-	-	595	850 to 1 050	8
	$10 < t \le 16$	-	-	500	710 to 1030	6	-	-	-	-	565	810 to 1 010	8
	$16 < t \le 40$	172 to 241	580 to 820	410	650 to 1000	7	430	650 to 800	16	25	525	700 to 900	9
	$40 < t \le 63$	172 to 241	580 to 820	360	630 to 900	8	370	630 to 780	17	25	455	650 to 850	10
	$63 < t \le 100$	172 to 241	580 to 820	310	580 to 850	8	370	630 to 780	17	25	455	650 to 850	11
C50E C50R	$5 \le t \le 10$	-	-	590	770 to 1100	5	-	-	-	-	610	870 to 1 070	7
	$10 < t \le 16$	-	-	520	730 to 1080	6	-	-	-	-	580	830 to 1 030	7
	$16 < t \le 40$	179 to 269	610 to 910	440	690 to 1050	7	460	700 to 850	15	-	555	790 to 990	8
	$40 < t \le 63$	179 to 269	610 to 910	390	650 to 1030	8	400	650 to 800	16	-	510	730 to 930	9
	$63 < t \le 100$	179 to 269	610 to 910	-	-	-	400	650 to 800	16	-	475	680 to 880	9
C60E C60R	$5 \le t \le 10$	-	-	630	800 to 1150	5	-	-	-	-	630	900 to 1 100	6
	$10 < t \le 16$	-	-	550	780 to 1130	5	-	-	-	-	615	880 to 1 080	6
	$16 < t \le 40$	196 to 278	670 to 940	480	730 to 1100	6	520	800 to 950	13	-	580	830 to 1 030	7
	$40 < t \le 63$	196 to 278	670 to 940	-	-	-	450	750 to 900	14	-	545	780 to 980	8
	$63 < t \le 100$	196 to 278	670 to 940	-	-	-	450	750 to 900	14	-	525	750 to 950	8
28Mn6	$16 < t \le 40$	-	-	-	-	-	490	700 to 850	15	40	-	-	-
	$40 < t \le 63$	-	-	-	-	-	440	650 to 800	16	40	-	-	-
	$63 < t \le 100$	-	-	-	-	-	440	650 to 800	16	40	-	-	-
36Mn6	$16 < t \le 40$	-	-	-	-	-	540	750 to 900	14	40	-	-	-
	$40 < t \le 63$	-	-	-	-	-	460	700 to 850	15	40	-	-	-
	$63 < t \le 100$	-	-	-	-	-	460	700 to 850	15	40	-	-	-

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn + quenched and tempered condition" (+C+QT).

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

e For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 10 *(continued)*

Steel name	Thickness[a, b] t mm	Mechanical properties											
		As-rolled + peeled (+SH)		Cold drawn (+C)			Quenched and tempered and peeled[c] (+QT+SH)				Quenched and tempered + cold drawn (+QT +C)		
		Hardness[d] HBW	R_m MPa	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	$R_{p0,2}$[e] MPa min.	R_m[e] MPa	A % min.
42Mn6	$16 < t \leq 40$	-		-	-	-	590	800 to 900	14	40	-	-	-
	$40 < t \leq 63$	-		-	-	-	480	750 to 900	15	40	-	-	-
	$63 < t \leq 100$	-		-	-	-	480	750 to 900	15	40	-	-	-

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn + quenched and tempered condition" (+C+QT).

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

e For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 11 — Mechanical properties of bright alloy steels for quenching and tempering

Steel name	Thickness[a,b] t mm	Mechanical properties								
		S.annealed + peeled (+A +SH)	S.annealed + Cold drawn (+A +C)	Quenched and tempered and peeled[c] (+QT+SH)				Quenched and tempered + cold drawn (+QT +C)		
		Hardness HBW max.	Hardness HBW max.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	$R_{p0,2}$ MPa min.	R_m[d] MPa	A % min.
34Cr4 34CrS4	$5 \le t \le 10$	-	285	-	-	-	-	700	900 to 1 100	8
	$10 < t \le 16$	-	275	-	-	-	-	700	900 to 1 100	9
	$16 < t \le 40$	223	270	590	800 to 950	14	40	580	800 to 1 000	9
	$40 < t \le 63$	223	265	460	700 to 850	15	40	510	700 to 900	10
	$63 < t \le 100$	223	265	460	700 to 850	15	40	480	700 to 900	11
37Cr4 37CrS4	$5 \le t \le 10$	-	-	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	-	-	-	-	-	-	-
	$16 < t \le 40$	235	-	630	850 to 1000	13	35	-	-	-
	$40 < t \le 63$	235	-	510	750 to 900	14	35	-	-	-
	$63 < t \le 100$	235	-	510	750 to 900	14	35	-	-	-
41Cr4 41CrS4	$5 \le t \le 10$	-	295	-	-	-	-	770	1 000 to 1 200	8
	$10 < t \le 16$	-	285	-	-	-	-	750	1 000 to 1 200	8
	$16 < t \le 40$	241	280	660	900 to 1 100	12	35	670	900 to 1 100	9
	$40 < t \le 63$	241	270	560	800 to 950	14	35	570	800 to 1 000	10
	$63 < t \le 100$	241	270	560	800 to 950	14	35	570	800 to 1 000	11
25CrMo4 25CrMoS4	$5 \le t \le 10$	-	270	-	-	-	-	700	900 to 1 100	9
	$10 < t \le 16$	-	260	-	-	-	-	700	900 to 1 100	9
	$16 < t \le 40$	212	255	600	800 to 950	14	50	600	800 to 1 000	10
	$40 < t \le 63$	212	250	450	700 to 850	15	50	520	700 to 900	11
	$63 < t \le 100$	212	250	450	700 to 850	15	50	450	700 to 900	12

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn and quenched and tempered condition" (+C+QT).

d For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 11 *(continued)*

Steel name	Thickness[a,b] t mm	Mechanical properties: S.annealed + peeled (+A +SH) Hardness HBW max.	S.annealed + Cold drawn (+A +C) Hardness HBW max.	Quenched and tempered and peeled[c] (+QT+SH) $R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	Quenched and tempered + cold drawn (+QT +C) $R_{p0,2}$ MPa min.	R_m[d] MPa	A % min.
34CrMo4 34CrMoS4	$5 \le t \le 10$	-	-	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	-	-	-	-	-	-	-
	$16 < t \le 40$	223	-	650	900 to 1100	12	40	-	-	-
	$40 < t \le 63$	223	-	550	800 to 950	14	45	-	-	-
	$63 < t \le 100$	223	-	550	800 to 950	14	45	-	-	-
42CrMo4 42CrMoS4	$5 \le t \le 10$	-	300	-	-	-	-	770	1 000 to 1 200	8
	$10 < t \le 16$	-	290	-	-	-	-	750	1 000 to 1 200	8
	$16 < t \le 40$	241	285	750	1 000 to 1 200	11	35	720	1 000 to 1 200	9
	$40 < t \le 63$	241	280	650	900 to 1 100	12	35	650	900 to 1 100	10
	$63 < t \le 100$	241	280	650	900 to 1 100	12	35	650	900 to 1 100	10
50CrMo4	$5 \le t \le 10$	-	-	-	-	-	-	-	-	
	$10 < t \le 16$	-	-	-	-	-	-	-	-	-
	$16 < t \le 40$	248	-	780	1000 to 1200	10	30	-	-	-
	$40 < t \le 63$	248	-	700	900 to 1100	12	30	-	-	-
	$63 < t \le 100$	248	-	700	900 to 1100	12	30	-	-	-
51CrV4	$t \le 16$	248	311	900	1 100 to 1 300	9	-	-	-	-
	$16 < t \le 40$	248	293	800	1 000 to 1 200	10	30	-	-	-
	$40 < t \le 80$	248	287	700	900 to 1 100	12	30	-	-	-

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn and quenched and tempered condition" (+C+QT).

d For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 11 *(continued)*

Steel name	Thickness[a,b] t mm	Mechanical properties								
		S.annealed + peeled (+A +SH)	S.annealed + Cold drawn (+A +C)	Quenched and tempered and peeled[c] (+QT+SH)				Quenched and tempered + cold drawn (+QT +C)		
		Hardness HBW max.	Hardness HBW max.	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	KV_2 J min.	$R_{p0,2}$ MPa min.	R_m[d] MPa	A % min.
36CrNiMo4	$5 \le t \le 10$	-	-	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	-	-	-	-	-	-	-
	$16 < t \le 40$	248	-	800	1000 to 1200	11	40	-	-	-
	$40 < t \le 63$	248	-	700	900 to 1100	12	45	-	-	-
	$63 < t \le 100$	248	-	700	900 to 1100	12	45	-	-	-
34CrNiMo6	$5 \le t \le 10$	-	308	-	-	-	-	770	1 000 to 1 200	8
	$10 < t \le 16$	-	298	-	-	-	-	750	1 000 to 1 200	8
	$16 < t \le 40$	248	293	900	1 100 to 1 300	10	40	720	1 000 to 1 200	9
	$40 < t \le 63$	248	288	800	1 000 to 1 200	11	45	650	1 000 to 1 200	10
	$63 < t \le 100$	248	288	800	1 000 to 1 200	11	45	650	1 000 to 1 200	10
30CrNiMo8	$5 \le t \le 10$	-	-	-	-	-	-	-	-	-
	$10 < t \le 16$	-	-	-	-	-	-	-	-	-
	$16 < t \le 40$	248	-	850	1030 to 1230	12	30	-	-	-
	$40 < t \le 63$	248	-	800	980 to 1180	12	35	-	-	-
	$63 < t \le 100$	248	-	800	980 to 1180	12	35	-	-	-

a For non-round products in the quenched and tempered conditions, see Figure B.1.

b For thicknesses < 5 mm, the mechanical properties may be agreed at the time of enquiry and order.

c These values are also valid for the "cold drawn and quenched and tempered condition" (+C+QT).

d For flats and special sections, the proof strength ($R_{p0,2}$) may deviate by – 10 % and the tensile strength (R_m) may deviate by ± 10.

Table 12 — 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 name	Thickness t[d] mm	Mechanical properties					
		$R_{p0,2}$ MPa min.	R_m MPa	A_5[e] % min.		KV_2 J min.	
				(long.)	(tr.)	(long.)	(tr.)
Austenitic grades							
X2CrNi18–9	≤ 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	≤ 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	-	-	-
X5CrNi18–10	≤ 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
X6CrNiTi18–10	≤ 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	-
X2CrNi19–11	≤ 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

Table 12 — *(continued)*

Steel name	Thickness t^d mm	Mechanical properties					
		$R_{p0,2}$ MPa min.	R_m MPa	$A_5{}^e$ % min.		KV_2 J min.	
				(long.)	(tr.)	(long.)	(tr.)
Austenitic grades							
X2CrNiMo17–12–2	≤ 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
X5CrNiMo17–12–2	≤ 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
X6CrNiMoTi17–12–2	≤ 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
X2CrNiMo17–12–3	≤ 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
X3CrNiMo17–12–3	≤ 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

Table 12 — *(continued)*

Steel name	Thickness t^d mm	Mechanical properties					
		$R_{p0,2}$ MPa min.	R_m MPa	$A_5{}^e$ % min.		KV_2 J min.	
				(long.)	(tr.)	(long.)	(tr.)
Austenitic grades							
X1NiCrMoCu25–20–5	≤ 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
Austenitic-ferritic steels							
X2CrNiMoN22–5-3	≤ 10[f]	650	850 to 1150	12	-	-	-
	10 < t ≤ 16	650	850 to 1100	12	-	-	-
	16 < t ≤ 40	450	650 to 1000	15	-	100	-
	40 < t ≤ 63	450	650 to 1000	15	-	100	-
	63 < t ≤ 160	450	650 to 880	25	-	100	-
X2CrNiMnMo-CuN24–4-3–2	≤ 10[f]	700	900 to 1150	15	-	-	-
	10 < t ≤ 30	700	900 to 1100	20	-	-	-
	30 < t ≤ 160	450	650 to 900	25	-	60	-
X3CrNiMoN27–5-2	≤ 10[f]	610	770 to 1030	12	-	-	-
	10 < t ≤ 16	560	770 to 1030	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	-

[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 has to 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 have to be agreed at the time of enquiry and order.

Table 13 — Mechanical properties[a] for bright bars of annealed ferritic stainless steels[b, c] in conditions +2H, +2B, +2G or +2P

Steel name	Thickness t [d] mm	Mechanical properties 0,2 %-proof strength $R_{p0,2}$ MPa min.	Tensile strength R_m MPa	Elongation after fracture A_5 [e] % min.
X6Cr17	≤ 10[f]	320	500 to 750	8
	$10 < t \leq 16$	300	480 to 750	8
	$16 < t \leq 40$	240	400 to 700	15
	$40 < t \leq 63$	240	400 to 700	15
	$63 < t \leq 100$	240	400 to 630	20
X6CrMo17-1	≤ 10[f]	340	540 to 700	8
	$10 < t \leq 16$	320	500 to 700	12
	$16 < t \leq 40$	280	440 to 700	15
	$40 < t \leq 63$	280	440 to 700	15
	$63 < t \leq 100$	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 has to 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 have to be agreed at the time of enquiry and order.

Table 14 — Mechanical properties[a] for bright bars of heat treated martensitic and precipitation-hardening stainless steels[b] in conditions +2H, +2B, +2G or +2P

Steel name	Thickness t [c] mm	Mechanical properties								
		Annealed		Quenched + tempered						
		R_m MPa max.	HB [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	≤ 10[f]	880	261	+QT650	550	700 to 1000	9	-	-	-
	10 < t ≤ 16	880	261		500	700 to 1000	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	≤ 10[f]	880	261	+QT650	550	700 to 1000	8	-	-	-
	10 < t ≤ 16	880	261		500	700 to 1000	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	≤ 10[f]	910	269	+QT700	600	750 to 1000	8	-	-	-
	10 < t ≤ 16	910	269		550	750 to 1000	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	-
X30Cr13	≤ 10[f]	950	280	+QT850	700	900 to 1050	7	-	-	-
	10 < t ≤ 16	950	280		650	900 to 1150	7	-	-	-
	16 < t ≤ 40	900	266		650	850 to 1100	9	-	12	-
	40 < t ≤ 63	840	249		650	850 to 1050	9	-	12	-
	63 < t ≤ 160	800	234		650	850 to 1000	10	-	15	-
X17CrNi16–2	≤ 10[f]	1050	311	+QT800	750	850 to 1100	7	-	-	-
	10 < t ≤ 16	1050	311		700	850 to 1100	7	-	-	-
	16 < t ≤ 40	1000	296		650	800 to 1050	9	-	25	-
	40 < t ≤ 63	950	280		650	800 to 1000	12	-	25	-
	63 < t ≤ 160	950	280		650	800 to 950	12	-	16	-
X14CrS17	≤ 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	-	-	-

Table 14 — *(continued)*

Steel name	Thickness t [c] mm	Mechanical properties: Annealed R_m MPa max.	Annealed HB [d] max.	Quenched + tempered: Heat-treatment condition	$R_{p0,2}$ MPa min.	R_m MPa	A_5 [e] % min. (long.)	A_5 % min. (tr.)	KV_2 J min. (long.)	KV_2 J min. (tr.)
Precipitation-hardening steels										
X5CrNiCuNb16–4	≤ 10[f]	1200	355	+P800	600	900 to 1100	10	-	-	-
	10 < t ≤ 16	1200	355		600	900 to 1100	10	-	-	-
	16 < t ≤ 40	1200	355		520	800 to 1050	12	-	75	-
	40 < t ≤ 63	1200	355		520	800 to 1000	18	-	75	-
	63 < t ≤ 160	1200	355		520	800 to 950	18	-	75	-
	≤ 100	-	-	+P930	720	930 to 1100	12	-	40	-
	≤ 100	-	-	+P960	790	960 to 1160	10	-	-	-
	≤ 100	-	-	+P1070	1000	1070 to 1270	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 has to 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 have to be agreed at the time of enquiry and order.

Table 15 — Mechanical properties for bars at room temperature of steels in the cold work hardened (+2H) condition

Steel name	0,2 %-proof strength level	0,2 %-proof strength $R_{p0,2}$ MPa[c] min.	Tensile strength R_m MPa*)	Elongation after fracture A % min.
Austenitic grades				
X2CrNi18–9	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X10CrNiS18–9	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X5CrNi18–10	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X6CrNiTi18–10	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X2CrNi19–11	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X2CrNiMo17–12–2	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X5CrNiMo17–12–2	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	12
X6CrNiMoTi17–12–2	+CP350[b]	350	700 to 850	20
	+CP500[a]	500	800 to 1000	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.

[c] 1 MPa = 1 N/mm^2.

Table 16 — Tolerance classes for rounds, squares and hexagons

Nominal thickness mm	**Tolerance class to** ISO 286-2[a]						
	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 17 — Tolerances for drawn flats

Width mm	**Deviation** mm	mm	ISO 286-2 **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 mm	**Deviation**[a] 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 low carbon (C ≤ 0,20 %) and low carbon free-cutting steels only. For all other steels, deviation increases to 150 % of the mentioned tolerance class.

Table 18 — Types of length and length tolerances

Type of length	Length mm	Length tolerance mm	To be stated on order
manufacturing length[a]	3000 to 9000	±500	length
stock length[a]	3000 or 6000	0, +200 0, +200	e.g. stock 6000
cut to length	up to 9000	corresponding to specifications with ± 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 19 — Deviation from straightness[a]

Product form	Steel group	Nominal dimension	Deviation max. mm
Rounds	< 0,25 % C		1,0
	≥ 0,25 % C, alloy steels, quenched and tempered steels		1,5
	stainless steels		1,0
Squares and hexagons	< 0,25 % C	$t \leq 75$ mm	1,0
	≥ 0,25 % C, alloy steels, quenched and tempered steels	$t \leq 75$ mm	2,0
	stainless steels	$t \leq 75$ mm	1,0
	< 0,25 % C	$t > 75$ mm	1,5
	≥ 0,25 % C, alloy steels, quenched and tempered steels	$t > 75$ mm	2,5
	stainless steels	$t > 75$ mm	1,5
Flats		$w < 120$ mm	on width:
	< 0,25 % C		1,5
	≥ 0,25 % C, alloy steels, quenched and tempered steels		1,5
	stainless steels		1,5
		$w < 120$ mm	on thickness
	< 0,25 % C		1,5
	≥ 0,25 % C, alloy steels, quenched and tempered steels		2,0
	stainless steels		2,0
		$w \geq 120$ mm $w/t < 10:1$	on width
	< 0,25 % C		1,5
	≥ 0,25 % C, alloy steels, quenched and tempered steels		2,0
	stainless steels		2,0
		w ≥ 120 mm w/t < 10: 1	on thickness:
	< 0,25 % C		2,0
	≥ 0,25 % C, alloy steels, quenched and tempered steels		2,5
	stainless steels		2,5
		w ≥ 120 mm w/t ≥ 10: 1	on width:
	< 0,25 % C		2,0
	≥ 0,25 % C, alloy steels, quenched and tempered steels		2,5
	stainless steels		2,5
		w ≥ 120 mm w/t ≥ 10: 1	on thickness:
	< 0,25 % C		2,5
	≥ 0,25 % C, alloy steels, quenched and tempered steels		3,0
	stainless steels		3,0

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

Table 20 — Test conditions for the verification of the requirements given in Tables 4 to 16

No.	Requirements	Test unit[a]	Amount of testing		Sampling and sample preparation	Test method to be used
			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	ISO/TR 9769[c]
2	Mechanical properties				ISO 377	Tensile test[d] ISO 6892-1 Impact test ISO 148-1
2.1	As-rolled and peeled	C+D	1	1 tensile (m)		
2.2	Cold drawn	C+D	1	1 tensile (m)		
2.3	Quenched and tempered and peeled and Cold drawn and quenched and tempered	C+D+T	1	1 tensile (m) and 3 CVN (m)		
2.4	Quenched and tempered and cold drawn	C+D+T	1	1 tensile (m)		
2.5	Solution annealed, annealed, quenched and tempered or precipitation hardened and cold drawn or peeled (only for stainless steels)	C+D+T	1	1 tensile (m) and 3 CVN (o)		
3	Hardness[e]				ISO 6506-1	Brinell hardness test ISO 6506-1
3.1	As-rolled and peeled	C+D	1	1 (m)		
3.2	Heat-treated and peeled	C+D+T	1	1 (m)		
3.3	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.

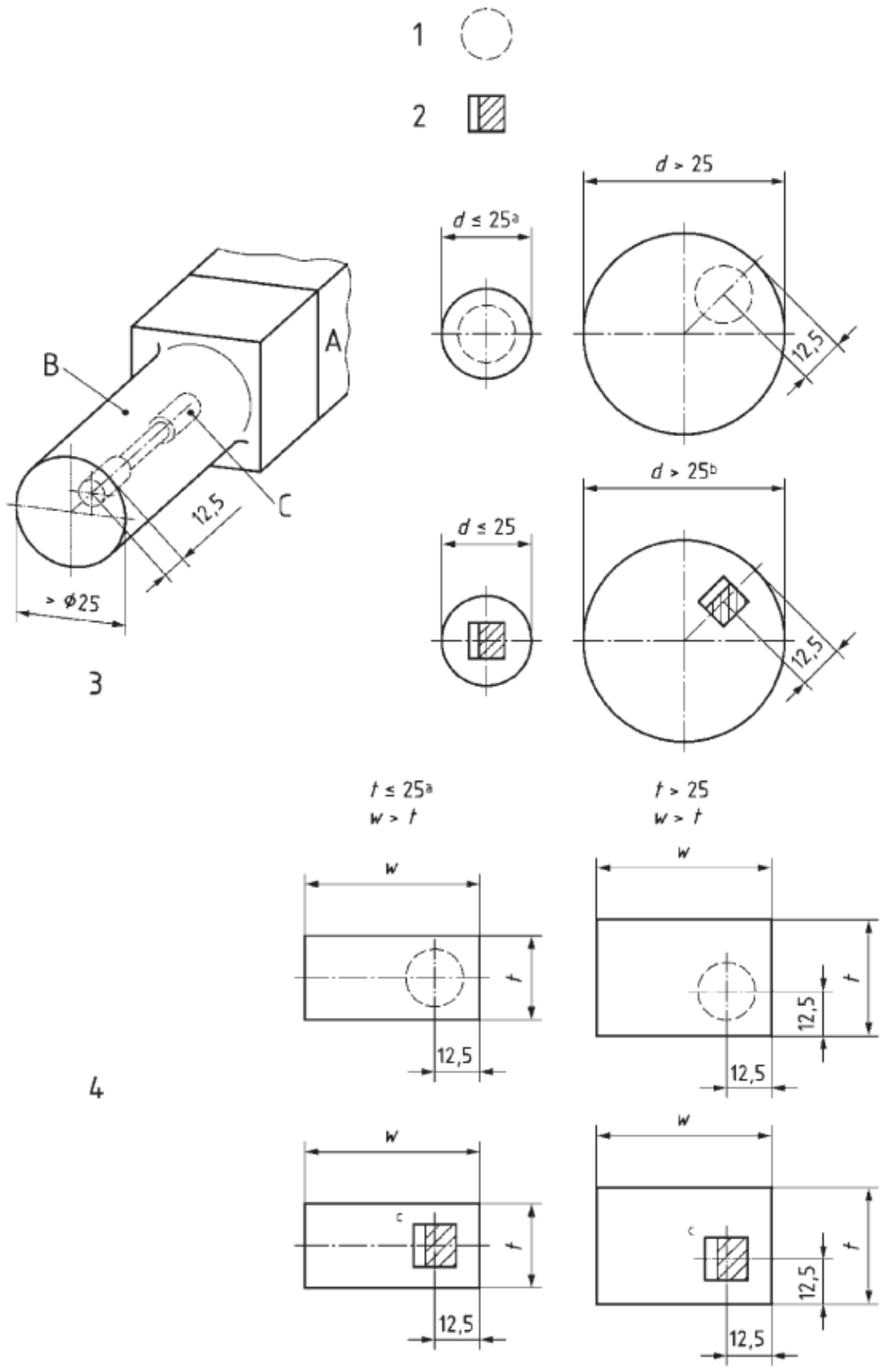
[b] Tests marked with an "m" (mandatory) shall be carried out as specific tests. In all cases, those marked with an "o" (optional) shall be carried out as specific tests only if agreed at ordering.

[c] For routine testing also other methods are 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 $L0 = 5{,}65\sqrt{S0}$, where S0 is the original cross-section area.

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

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 630-2, ISO 683-1, ISO 683-2, ISO 683-3, ISO 683-4 and ISO 16143-2

The chemical composition here is listed only for information. The chemical composition is according to the International Standards ISO 630-2, ISO 683-1, ISO 683-2, ISO 683-3, ISO 683-4 and ISO 16143-2.

Table A.1 — Steel grades and chemical composition (cast analysis) of general engineering bright steels (for information only – chemical composition as listed in **ISO 630-2**, **ISO 683-1**)

Steel name	**Steel grades according to** ISO 630-2 %, mass fraction[a]									
	C in % max. for nominal product thickness mm			Si	Mn	P	S[c]	N[d]	Cu[e]	Others
	$t \leq 16$	$16 < t \leq 40$	$40 < t \leq 100$							
S235B	0,17	0,17	0,20	–	1,40	0,040	0,040	0,012	0,55	–
S355D	0,20	0,20	0,22	0,55	1,60	0,030	0,030	–	0,55	–

Steel name	**Steel grades according to** ISO 683-1 %, mass fraction[a, b]									
	C	Si[f]	Mn	P	S	Cr	Mo	Ni	Cu	Cr+ Mo+Ni
C25	0,22 to 0,29	0,10 to 0,40	0,40 to 0,70	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C30	0,27 to 0,34	0,10 to 0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C35	0,32 to 0,39	0,10 to 0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C40	0,37 to 0,44	0,10 to 0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C45	0,42 to 0,50	0,10 to 0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C50	0,47 to 0,55	0,10 to 0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,30	0,63
C60	0,57 to 0,65	0,10 to 0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,30	0,63

Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions should be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

a Maximum values unless indicated otherwise.

b Steels with improved machinability either by higher sulfur levels up to about 0,10 % S (including controlled sulphide morphology) or lead additions may be available on request. In the first case, the upper limit of the Mn-content may be increased by 0,15 %.

c For long products, the max. S content may be increased for improved machinablility ba 0,005 % by agreement if the steel is treated to modify the sulphide morphology and if the chemical composition shows min 0,0020 % Ca.

d The maximum value for nitrogen does not apply if the chemical composition shows a minimum total Al content of 0,020 % or, alternatively, minimum 0,015 % acid soluble Al or if sufficient other N-binding elements are present. In this case, the N-binding elements shall be mentioned in the inspection document.

e Cu content above 0,40 % can cause hot shortness during hot forming.

f Steels may be supplied with a lower silicon content. In this case, alternative means of deoxidation shall be used.

Table A.2 — Steel grades and chemical composition (cast analysis) of free-cutting bright steels
(for information only – chemical composition as listed in **ISO 683-4**)

Steel name	%, mass fraction [a]					
	C	Si	Mn	P	S	Pb
Steels not intended for heat treatment						
9S20	0,13	0,05[b]	0,60 to 1,20	0,11d[c]	0,15 to 0,25	–
11SMn30	0,14	0,05[b]	0,90 to 1,30	0,11[c]	0,27 to 0,33	–
11SMnPb30						0,20 to 0,35
11SMn37	0,14	0,05[b]	1,00 to 1,50	0,11[c]	0,34 to 0,40	–
11SMnPb37						0,20 to 0,35
Case-hardening steels						
10S20	0,07 to 0,13	0,40	0,70 to 1,10	0,060	0,15 to 0,25	–
10SPb20						0,20 to 0,35
15SMn13	0,12 to 0,18	0,40	0,90 to 1,30	0,060	0,08 to 0,18	–
17SMn20	0,14 to 0,20	0,40	1,20 to 1,60	0,060	0,15 to 0,25	–
Steels for quenching and tempering						
35S20	0,32 to 0,39	0,40	0,70 to 1,10	0,060	0,15 to 0,25	–
35SPb20						0,15 to 0,35
36SMn14	0,32 to 0,39	0,40	1,30 to 1,70	0,060	0,10 to 0,18	–
36SMnPb14						0,15 to 0,35
35SMn20	0,32 to 0,39	0,40	0,90 to 1,40	0,060	0,15 to 0,25	–
35SMnPb20						0,15 to 0,35
38SMn28	0,35 to 0,40	0,40	1,20 to 1,50	0,060	0,24 to 0,33	–
38SMnPb28						0,15 to 0,35
44SMn28	0,40 to 0,48	0,40	1,30 to 1,70	0,060	0,24 to 0,33	–
44SMnPb28						0,15 to 0,35
46S20	0,42 to 0,50	0,40	0,70 to 1,10	0,060	0,15 to 0,25	–
46SPb20						0,15 to 0,35
Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition of such elements from scrap or other materials used in manufacture which affect the mechanical properties and applicability. However, if agreed, the manufacturer may add elements such as Ca, Se, Te, etc. for the purpose of improving the machinability. These elements have to be reported in the inspection document.						

a Maximum values unless otherwise indicated.

b Since silicon has an adverse effect on machinability, it is not intentionally added to specified limits, but if the formation of special oxides is guaranteed, a Si-content of 0,10 % to 0,40 % may be agreed.

c At the time of enquiry and order, it may be agreed that either a grade with 0,06 % to 0,11 % P or a grade with max. 0,05 % P shall be delivered.

Table A.3 — Steel grades and chemical composition (cast analysis) of bright steels for case hardening (for information only – chemical composition as listed in **ISO 683-3**)

Steel name	%, mass fraction[a, b, c]									
	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Others
Non-alloy steels for case hardening										
C10E	0,07 to 0,13	0,15 to 0,40	0,30 to 0,60	0,025	0,035	0,40	0,10	0,40	0,30	–
C10R					0,020 to 0,040					
C15E	0,12 to 0,18	0,15 to 0,40	0,30 to 0,60	0,025	0,035	0,40	0,10	0,40	0,30	–
C15R					0,020 to 0,040					
C16E	0,12 to 0,18	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,40	0,10	0,40	0,30	–
C16R					0,020 to 0,040					
Alloy steels for case hardening										
20Cr4	0,17 to 0,23	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	–	–	0,40	–
20CrS4					0,020 to 0,040					
16MnCr5	0,14 to 0,19	0,15 to 0,40	1,00 to 1,30	0,025	0,035	0,80 to 1,10	–	–	0,40	–
16MnCrS5					0,020 to 0,040					
20MnCr5	0,17 to 0,22	0,15 to 0,40	1,10 to 1,40	0,025	0,035	1,00 to 1,30	–	–	0,40	–
20MnCrS5					0,020 to 0,040					
24CrMo4[d]	0,20 to 0,27	0,10 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	0,40	–
24CrMoS4[d]					0,020 to 0,040					
20NiCrMo2–2	0,17 to 0,23	0,15 to 0,40	0,65 to 0,95	0,025	0,035	0,35 to 0,70	0,15 to 0,25	0,40 to 0,70	0,40	–
20NiCrMoS2–2					0,020 to 0,040					
18CrNiMo7–6	0,15 to 0,21	0,15 to 0,40	0,50 to 0,90	0,025	0,035	1,50 to 1,80	0,25 to 0,35	1,40 to 1,70	0,40	–

Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions should be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

[a] Maximum values unless indicated otherwise.

[b] Steels with improved machinability either by higher sulfur levels up to about 0,10 % S (including controlled sulphide morphology) or lead additions may be available on request. In the first case, the upper limit of the Mn-content may be increased by 0,15 %.

[c] Steels may be supplied with a lower silicon content. In this case, alternative means of deoxidation shall be used.

[d] This grade differs form 25CrMo4 for quenching and tempering concerning the chemical composition and the requirement on fine grain structure.

Table A.4 — Steel grades and chemical composition (cast analysis) of bright steels for quenching and tempering (for information only – chemical composition as listed in **ISO 683-1** and **ISO 683-2**)

Steel name	%, mass fraction[a, b]									
	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Cr+Mo+Ni
Non-alloy steels for quenching and tempering										
C25E	0,22 to 0,29	0,10 to 0,40	0,40 to 0,70	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C25R					0,020 to 0,040					
C30E	0,27 to 0,34	0,10 to 0,40	0,50 to 0,80	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C30R					0,020 to 0,040					
C35E	0,32 to 0,39	0,10 to 0,40	0,50 to 0,80	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C35R					0,020 to 0,040					
C40E	0,37 to 0,44	0,10 to 0,40	0,50 to 0,80	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C40R					0,020 to 0,040					
C45E	0,42 to 0,50	0,10 to 0,40	0,50 to 0,80	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C45R					0,020 to 0,040					
C50E	0,47 to 0,55	0,10 to 0,40	0,60 to 0,90	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C50R					0,020 to 0,040					
C60E	0,57 to 0,65	0,10 to 0,40	0,60 to 0,90	0,025	0,035	0,40	0,10	0,40	0,30	0,63
C60R					0,020 to 0,040					
28Mn6	0,25 to 0,32	0,10 to 0,40[c]	1,30 to 1,65	0,025	0,035	0,40	0,10	0,40	0,30	0,63
36Mn6	0,33 to 0,40	0,10 to 0,40[c]	1,30 to 1,65	0,025	0,035	0,40	0,10	0,40	0,30	0,63
42Mn6	0,39 to 0,46	0,10 to 0,40[c]	1,30 to 1,65	0,025	0,035	0,40	0,10	0,40	0,30	0,63
Alloy steels for quenching and tempering										
34Cr4	0,30 to 0,37	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	–	–	0,40	–
34CrS4					0,020 to 0,040					
37Cr4	0,34 to 0,41	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	–	–	0,40	–
37CrS4					0,020 to 0,040					
41Cr4	0,38 to 0,45	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	–	–	0,40	–
41CrS4					0,020 to 0,040					
25CrMo4	0,22 to 0,29	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	0,40	–
25CrMoS4					0,020 to 0,040					
34CrMo4	0,30 to 0,37	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	0,40	–
34CrMoS4					0,020 to 0,040					
42CrMo4	0,38 to 0,45	0,10 to 0,40[c]	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	0,40	–
42CrMoS4					0,020 to 0,040					
50CrMo4	0,46 to 0,54	0,10 to 0,40[c]	0,50 to 0,80	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	0,40	–
51CrV4	0,47 to 0,55	0,10 to 0,40[c]	0,60 to 1,00	0,025	0,025	0,80 to 1,10	–	–	0,40	V: 0,10 to 0,25
36CrNiMo4	0,32 to 0,40	0,10 to 0,40[c]	0,50 to 0,80	0,025	0,035	0,90 to 1,20	0,15 to 0,30	0,90 to 1,20	0,40	–
34CrNiMo6	0,30 to 0,38	0,10 to 0,40[c]	0,50 to 0,80	0,025	0,035	1,30 to 1,70	0,15 to 0,30	1,30 to 1,70	0,40	–

[a] Maximum values unless indicated otherwise.

[b] Steels with improved machinability either by higher sulfur levels up to about 0,10 % S (including controlled sulphide morphology) or lead additions may be available on request. In the first case, the upper limit of the Mn-content may be increased by 0,15 %.

[c] Steels may be supplied with a lower silicon content. In this case, alternative means of deoxidation shall be used.

Table A.4 *(continued)*

Steel name	%, mass fraction[a, b]									
	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Cr+Mo+Ni
30CrNiMo8	0,26 to 0,34	0,10 to 0,40[c]	0,50 to 0,80	0,025	0,035	1,80 to 2,20	0,30 to 0,50	1,80 to 2,20	0,40	–
Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions should be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.										

[a] Maximum values unless indicated otherwise.

[b] Steels with improved machinability either by higher sulfur levels up to about 0,10 % S (including controlled sulphide morphology) or lead additions may be available on request. In the first case, the upper limit of the Mn-content may be increased by 0,15 %.

[c] Steels may be supplied with a lower silicon content. In this case, alternative means of deoxidation shall be used.

Table A.5 — Steel grades and chemical composition (cast analysis) of stainless bright steels

(for information only – chemical composition as listed in **ISO 16143-2**)

Steel name		%, 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]
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)[c]	—	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	—
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
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	—
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
Austenic-ferritic steels											
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	—
X2CrNiMnMo-CuN24–4-3–2	4662–824–41-X	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	—
Ferritic steels											
X6Cr17	4016–430–00-I	0,08[d]	1,00	1,00	0,040	0,030	16,0 to 18,0	—	—	—	—
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	—	—	—

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 document, 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.5 — (continued)

Steel name		%, mass fraction[a]									
Name	ISO-number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
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	—	—	—
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 document, 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)

Ruling sections for mechanical properties

B.1 Definition

See 3.7.

B.2 Determination of the diameter of the equivalent ruling section

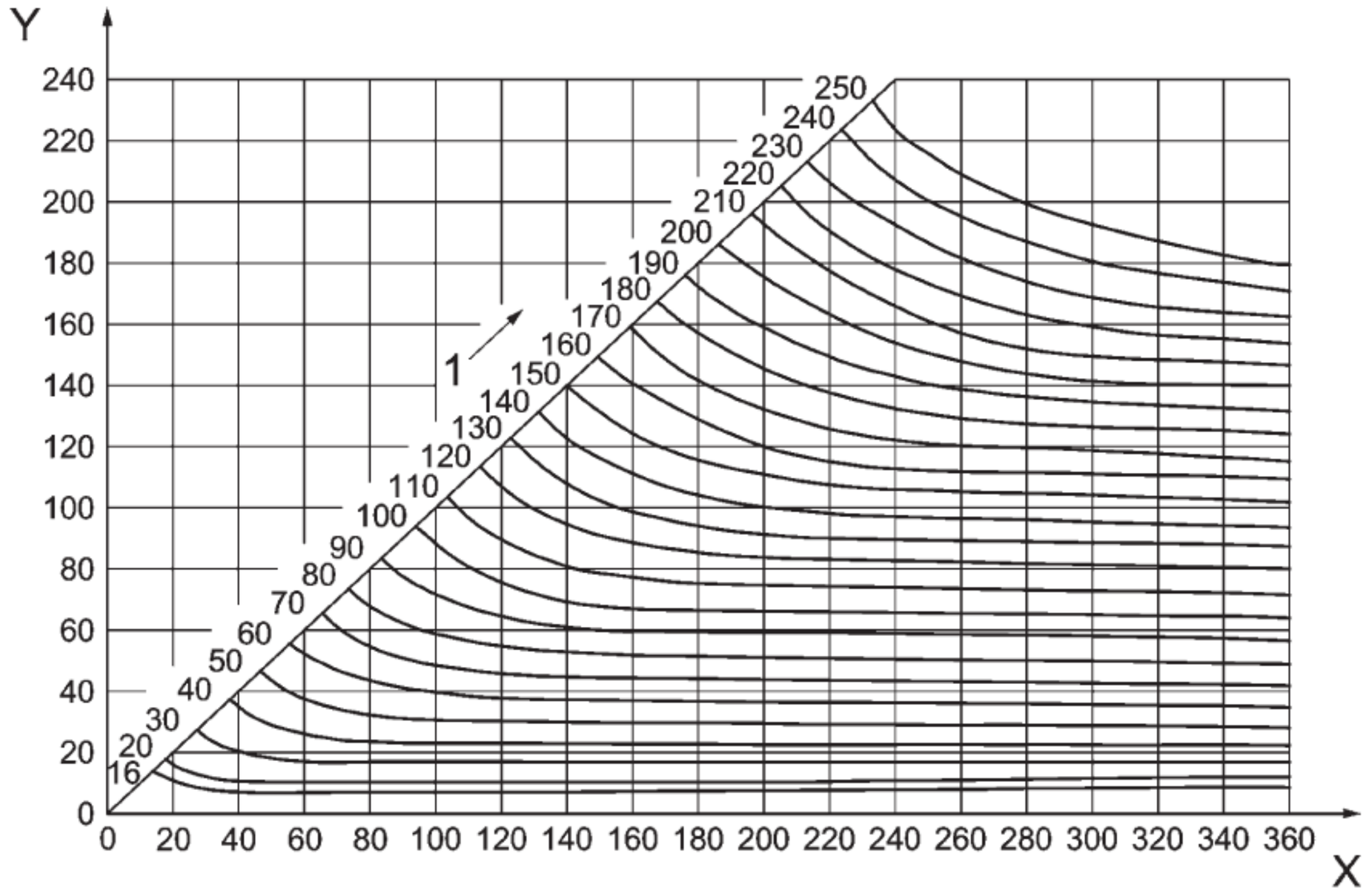
B.2.1 If the test pieces are taken from products with simple cross-sections and from positions with quasi two-dimensional heat flow, B.2.1.1 to B.2.1.3 shall apply.

B.2.1.1 For rounds, the nominal diameter of the product (not comprising the machining allowance) shall be taken as the diameter of the ruling section.

B.2.1.2 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.2.1.3 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

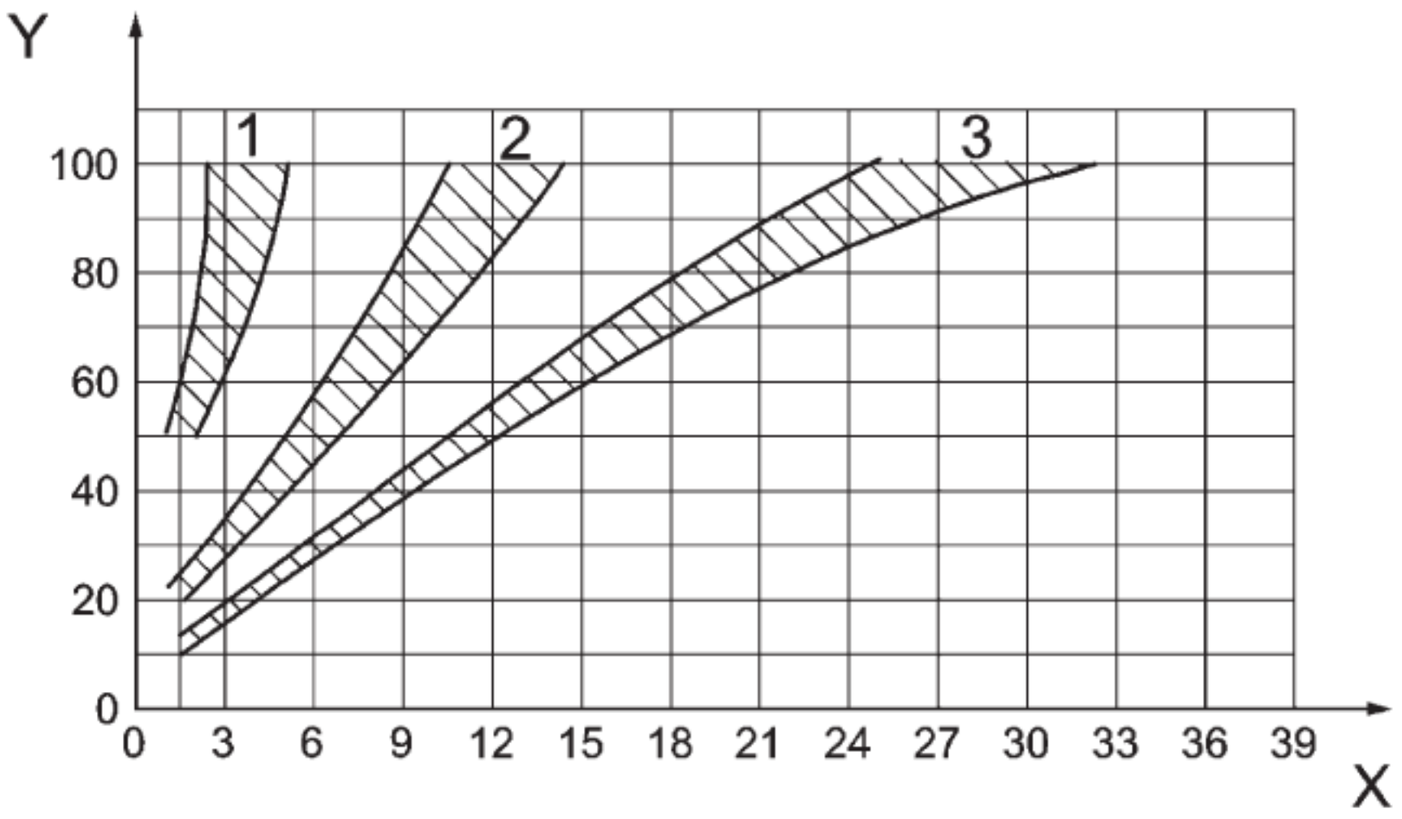
Figure B.1 — Diameter of the equivalent ruling section for square and rectangular sections for quenching in oil or water

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

B.2.2 For other product forms, the ruling section shall be agreed at the time of enquiry and order.

NOTE For this purpose, the following procedure may serve as a guideline. The product is hardened in accordance with usual practice. It is then cut so that the hardness and structure at the position of the ruling section provided for taking test pieces can be determined. From another product of the type under consideration and of the same cast, an end-quench piece is taken from the prescribed position and tested in the usual way. Then the distance is determined at which the end-quench test piece shows the same hardness and structure as the ruling section at the position provided for taking test pieces. On the basis of this distance, the diameter of the ruling section is then estimated using Figures B.2 and B.3.

Dimensions in millimetres



Key

X distance from the quenched end

Y bar diameter

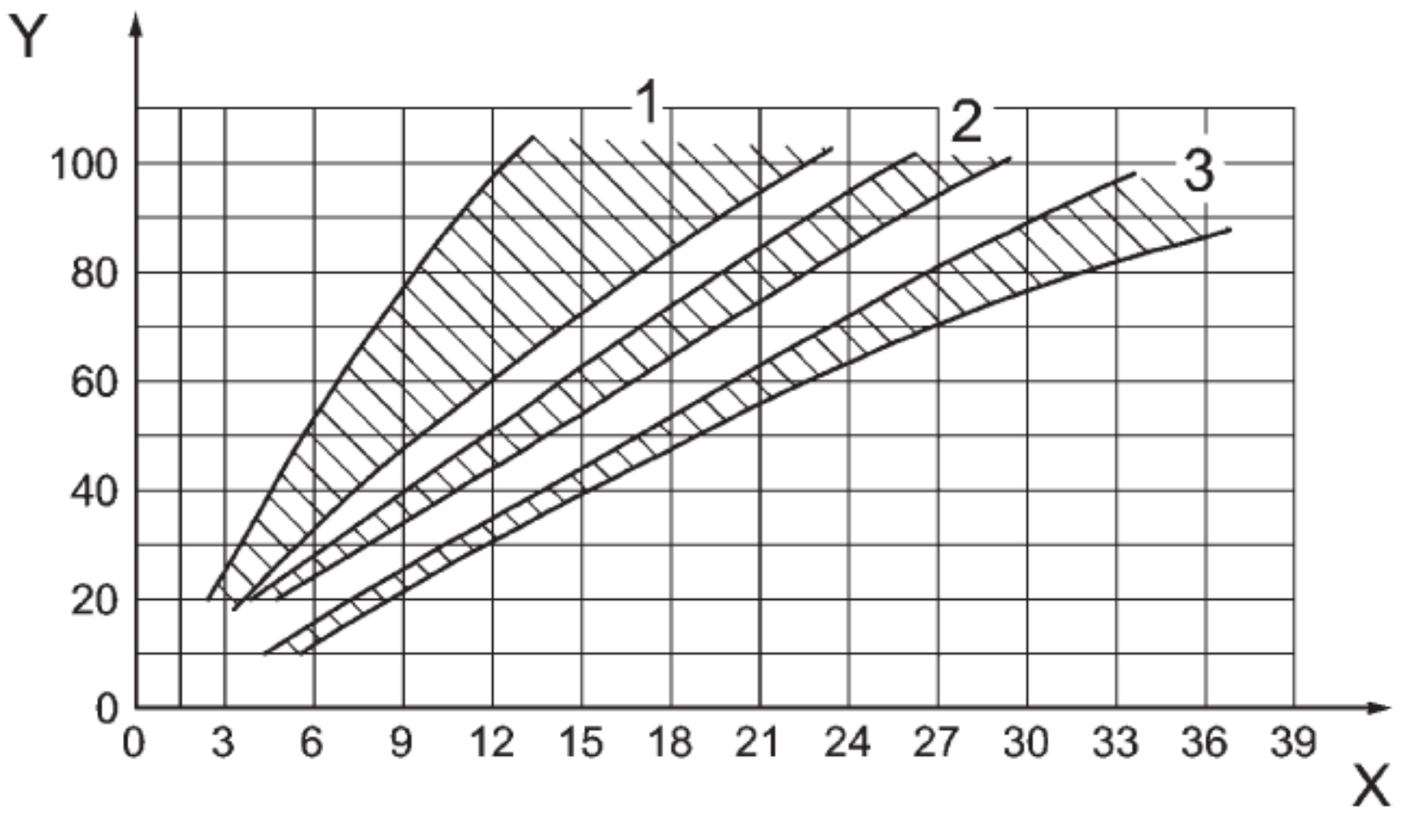
1 surface

2 3/4 radius

3 centre

Figure B.2 — Relationship between the cooling rates in end-quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated water (source: SAE J406c)

Dimensions in millimetres



Key

X distance from the quenched end

Y bar diameter

1 surface

2 3/4 radius

3 centre

Figure B.3 — Relationship between the cooling rates in end-quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated oil (source: SAE J406c)

Annex C
(normative)

Supplementary or special requirements

C.1 Introduction

One or more of the following supplementary or special requirements shall be applied but only when specified in the enquiry and order. Details of these requirements shall, when necessary, be agreed upon by the manufacturer and purchaser at the time of enquiry and order.

C.2 Mechanical properties of reference test pieces in the quenched and tempered condition

For deliveries in a condition other than quenched and tempered, the requirements for the mechanical properties in the quenched and tempered condition shall be verified on a reference test piece.

In the case of bars, the sample to be quenched and tempered shall, unless otherwise agreed, have the cross-section of the product. In all other cases the dimensions and the manufacture of the sample shall be agreed at the time of enquiry and order, where appropriate, while taking into consideration the indications for the determination of the ruling section given in Annex A. The samples shall be quenched and tempered in accordance with the conditions given in the table for the heat-treatment conditions or as agreed at the time of enquiry and order. The details of the heat treatment shall be given in the inspection document. Unless otherwise agreed, the test pieces shall be taken in accordance with Figure 1 for bars.

C.3 Fine grain steel

When tested in accordance with ISO 643, the steel shall have an austenite grain size of 5 or finer. If specific testing is ordered, the grain size requirement is to be verified by determining the aluminium content or micrographically. In the case of determining the grain size by the aluminium content for case hardening steels Al min is 0,018 % and for steels for quenching and tempering Al min is 0,007 %. The Al-content shall be given in the inspection document. For micrographical test according to ISO 643 for case hardening steels see ISO 683-3, and for steels for quenching and tempering see ISO 683-1 and ISO 683-2.

C.4 Non-destructive tests

The products shall be NDT tested under conditions and according to an acceptance standard agreed at the time of enquiry and order (see also ISO 683-1, ISO 683-2, ISO 683-3).

C.5 Disposition of tolerances

The disposition of tolerances about the nominal dimension of the product other than specified in 7.7 shall be one of the following as specified by the purchaser at the time of enquiry and order:

a) values all positive, i.e. + and lower tolerances all zero, i.e. −0

b) values equally disposed about the nominal dimension.

C.6 Condition of bar ends

The ends of the product shall be as specified by the purchaser at the time of enquiry and order, e.g.: chamfering, facing.

C.7 Product analysis

One product analysis shall be carried out per cast for the determination of all elements for which values are specified for the cast analysis of the steel type concerned.

The conditions for sampling shall be in accordance with ISO 14284. In cases of dispute, the analysis shall be carried out, if possible, in accordance with a reference method taken from one of the International Standards in ISO/TR 9769.

C.8 Reduction ratio and deformation ratio

If the central soundness of the hot-rolled or forged products is important, the purchaser must be aware that a minimum reduction ratio (referred to the cross-section) for long products, or a minimum thickness deformation ratio (referred to the thickness) for flat products is necessary. In this case a minimum reduction ratio or a minimum thickness deformation ratio of, for example, 4:1 may be agreed at the time of enquiry and order.

C.9 Temporary corrosion protection

A protective medium shall be applied by the manufacturer to give temporary and adequate protection during transport and storage. Where a special protective medium is required it shall be agreed at the time of enquiry and order.

C.10 Special agreements for marking

The products shall be marked in a way that is specially agreed at the time of enquiry and order.

Annex D
(normative)

Methods for evaluating straightness

D.1 Scope

This annex sets out two methods for the evaluation of the straightness of bright steel bars as provided for in 7.7. The method set out in D.2 is the recommended method and D.3 is an alternative method for round bars. The choice of method shall be as agreed at the time of enquiry and order.

D.2 Recommended method

D.2.1 The bar shall be supported on a suitable surface so as to eliminate or minimize sagging.

D.2.2 A 1 m long straight edge shall be placed on the surface of the bar at any position along its length as a chord in the arc of a circle or a straight-line segment between two parts on the arms of an angle. No part of the straight edge shall be within 150 mm of the ends of the bar.

D.2.3 Straightness shall be determined by measuring the maximum gap between the bar and the straight edge by suitable means, e.g. feeler gauge. The bar shall be deemed straight where the maximum gap does not exceed the values specified in Table 19.

D.3 Alternative method for round bars

D.3.1 The round bar shall be supported on a sufficient number of centres placed 1 m apart. No centre may be placed in between 150 mm from the bar ends.

D.3.2 Straightness shall be measured by means of a suitable dial or indicator gauge placed at any position between the supporting centres.

D.3.3 The bar shall be deemed to be straight when rotating the bar through 360° the total indicated reading (TIR) is not greater than twice the deviation specified in Table 19.

Annex E
(informative)

Designation of steels given in this part of ISO 683 and of comparable grades covered in various designation systems

Table E.1 — Designation of steels given in this part of ISO 683 and of comparable grades covered in various designation systems

Steel names according to[a]										
ISO-steel grade (ISO 683-18)	ISO-number	ASTM/SAE/UNS[b]		EN 10025–2, EN 10083, EN 10084, EN 10087, EN 10088–3 Number[c]			JIS[d]		GB/ISC[e]	
			i/n/w[f]		i/n/w[f]		i/n/w[f]		i/n/w[f]
General engineering steels										
S235B	–	–	–	S235JRC	1.0122	i	–	–	Q235B	n
S355D	–	–	–	S355J2C	1.0579	i	–	–	Q345D	w
C25	–	–	–	–	–	–	S25C	w	25	w
C30	–	–	–	–	–	–	S30C	w	30	w
C35	–	–	–	C35	1.0501	n	S35C	w	35	w
C40	–	–	–	C40	1.0511	n	S40C	w	40	w
C45	–	–	–	C45	1.0503	n	S45C	w	45	w
C50	–	–	–	–	–	–	S50C	n	50	w
C60	–	–	–	C60	1.0601	n	S58C	w	60	w
Free-cutting steels										
9S20	–	–	–	–	–	–	SUM21	n	Y08	n
11SMn30	–	SAE 1215	n	11SMn30	1.0715	i	SUM22	n	Y15	n
11SMnPb30	–	SAE 12L15	n	11SMnPb30	1.0718	i	SUM22L	n	–	-
11SMn37	–	–	–	11SMn37	1.0736	i			–	-
11SMnPb37	–	–	–	11SMnPb37	1.0737	i	–	–	–	-
10S20	–	–	–	10S20	1.0721	i	–	–	Y12	n
10SPb20	–	–	–	10SPb20	1.0722	i	–	–	–	–
15SMn13	–	–	–	15SMn13	1.0725	i	–	–	–	–
17SMn20	–	–	–	–	–	–	–	–	–	–
35S20	–	–	–	35S20	1.0726	i	–	–	Y30	n
35SPb20	–	–	–	35SPb20	1.0756	i	–	–	–	–
36SMn14	–	SAE 1137	n	36SMn14	1.0764	i	SUM41	n	–	–
36SMnPb14	–	SAE 11L37	n	36SMnPb14	1.0765	i	–	–	–	–
35SMn20	–	–	–	–	–	–	–	–	Y40Mn	n
35SMnPb20	–	–	–	–	–	–	–	–	–	–

Table E.1 — *(continued)*

Steel names according to[a]										
ISO-steel grade (ISO 683-18)	**ISO-number**	**ASTM/SAE/UNS**[b]		EN 10025–2, EN 10083, EN 10084, EN 10087, EN 10088–3 **Number**[c]		**JIS**[d]		**GB/ISC**[e]	
			i/n/w[f]		i/n/w[f]		i/n/w[f]		i/n/w[f]
Free-cutting steels										
38SMn28	–	–	–	38SMn28	1.0760	i	–	–	–	–
38SMnPb28	–	–	–	38SMnPb28	1.0761	i	–	–	–	–
44SMn28	–	SAE 1144	n	44SMn28	1.0762	i	SUM43	n	Y45Mn	n
44SMnPb28	–	SAE 11L44	n	44SMnPb28	1.0763	i	–	–	–	–
46S20	–	–	–	46SMn20	1.0727	i	–	–	Y45	n
46SPb20	–	–	–	46SPb20	1.0757	i	–	–	–	–
Non-alloy case-hardening steels										
C10E	–	–	–	C10E	1.1121	n	S10C	n	–	–
C10R	–	–	–	C10R	1.1207	n	–	–	–	–
C15E	–	–	–	C15E	1.1141	n	S15C	n	–	–
C15R	–	–	–	C15R	1.1140	n	–	–	–	–
C16E	–	–	–	C16E	1.1148	n	–	–	–	–
C16R	–	–	–	C16R	1.1208	n	–	–	–	–
Alloy case-hardening steels										
20Cr4	–	–	–	–	–	–	SCr420/ SCr420H	–	20CrH	n
20CrS4	–	–	–	–	–	–	–	–	–	–
16MnCr5	–	–	–	16MnCr5	1.7131	n	–	–	16Cr-MnH	i
16MnCrS5	–	–	–	16MnCrS5	1.7139	n	–	–	–	–
20MnCr5	–	–	–	20MnCr5	1.7147	n	–	–	20Cr-MnH	i
20MnCrS5	–	–	–	20MnCrS5	1.7149	n	–	–	–	–
24CrMo4	–	–	–	–	–	–	SCM425/ SCM425H	n	–	–
24CrMoS4	–	–	–	–	–	–	–	–	–	–
20NiCrMo2–2	–	–	–	20NiCrMo2–2	1.6523	n	SNCM220	w	20CrNi-MoH	i
20NiCrMoS2–2	–	–	–	20NiCr-MoS2–2	1.6526	n	–	–	–	–
18CrNiMo7–6	–	–	–	18CrNiMo7–6	1.6587	n	–	–	18Cr2-Ni2-MoH	i
Non-alloy steels for quenching and tempering										
C25E	–	–	–	C22E	1.1151	w	S25C	w	25	n
C25R	–	–	–	C22R	1.1149	w	–	–	–	–
C30E	–	–	–	–	–	–	S30C	w	30	n
C30R	–	–	–	–	–	–	–	–	–	–
C35E	–	–	–	C35E	1.1181	n	S35C	w	35	n
C35R	–	–	–	C35R	1.1180	n	–	–	–	–

Table E.1 — *(continued)*

Steel names according to[a]										
ISO-steel grade (ISO 683-18)	**ISO-number**	**ASTM/SAE/ UNS[b]**		EN 10025–2, EN 10083, EN 10084, EN 10087, EN 10088–3 **Number[c]**		**JIS[d]**		**GB/ISC[e]**	
			i/n/w[f]		i/n/w[f]		i/n/w[f]		i/n/w[f]
Non-alloy steels for quenching and tempering									
C40E	–	–	–	C40E	1.1186	n	S40C	w	40	n
C40R	–	–	–	C40R	1.1189	n	–	–	–	–
C45E	–	–	–	C45E	1.1191	n	S45C	w	45	n
C45R	–	–	–	C45R	1.1201	n	–	–	–	–
C50E	–	–	–	C50E	1.1206	n	S50C	n	50	n
C50R	–	–	–	C50R	1.1241	n	–	–	–	–
C60E	–	–	–	C60E	1.1221	n	S58C	w	60	n
C60R	–	–	–	C60R	1.1223	n	–	–	–	–
28Mn6	–	–	–	28Mn6	1.1170	n	SMn433	w	–	–
36Mn6	–	–	–	–	–	–	SMn438	w	–	–
42Mn6	–	–	–	42Mn6	(1.1055)	–	SMn443	w	–	–
Alloy steels for quenching and tempering										
34Cr4	–	–	–	34Cr4	1.7033	n	SCr435	w	–	–
34CrS4	–	–	–	34CrS4	1.7037	n	–	–	–	–
37Cr4	–	–	–	37Cr4	1.7034	n	–	–	35Cr	n
37CrS4	–	–	–	37CrS4	1.7038	n	–	–	–	–
41Cr4	–	–	–	41Cr4	1.7035	n	SCr440	n	40Cr	n
41CrS4	–	–	–	41CrS4	1.7039	n	–	–	–	–
25CrMo4	–	–	–	25CrMo4	1.7218	n	SCM425	n	30CrMo	w
25CrMoS4	–	–	–	25CrMoS4	1.7213	n	–	–	–	–
34CrMo4	–	–	–	34CrMo4	1.7220	n	SCM435	w	35CrMo	w
34CrMoS4	–	–	–	34CrMoS4	1.7226	n	–	–	–	–
42CrMo4	–	–	–	42CrMo4	1.7225	n	SCM440	n	42CrMo	n
42CrMoS4	–	–	–	42CrMoS4	1.7227	n	–	–	–	–
50CrMo4	–	–	–	50CrMo4	1.7228	n	–	–	–	–
51CrV4	–	–	–	51CrV4	1.8159	n	–	–	–	–
36CrNiMo4	–	–	–	–	–	–	–	–	40CrNiMo	w
34CrNiMo6	–	–	–	34CrNiMo6	1.6582	n	–	–	–	–
30CrNiMo8	–	–	–	30CrNiMo8	1.6580	n	–	–	–	–

Table E.1 — *(continued)*

Steel names according to[a]											
ISO-steel grade (ISO 683-18)	**ISO-number**	**ASTM/SAE/ UNS[b]**		EN 10025–2, EN 10083, EN 10084, EN 10087, EN 10088–3 **Number[c]**			**JIS[d]**		**GB/ISC[e]**		
			i/n/w[f]			i/n/w[f]		i/n/w[f]		i/n/w[f]
Austenitic stainless steels											
X2CrNi18–9	4307–304–03-I	S30403	w	–	1.4307	n	SUS304L	w	S30403	w
X10CrNiS18–9	4305–303–00-I	S30300	w	–	1.4305	w	SUS303	w	S30317	w
X5CrNi18–10	4301–304–00-I	S30400	w	–	1.4301	i	SUS304	w	S30408	w
X6CrNiTi18–10	4541–321–00-I	S32100	w	–	1.4541	i	SUS321	w	S32168	w
X2CrNi19–11	4306–304–03-I	S30403	w	–	1.4306	n	SUS304L	w	S30403	n
X2CrNiMo17–12–2	4404–316–03-I	S31603	w	–	1.4404	n	SUS316L	w	S31603	n
X5CrNiMo17–12–2	4401–316–00-I	S31600	w	–	1.4401	n	SUS316	w	S31608	n
X6CrNiMoTi17–12–2	4571–316–35-I	S31635	w	–	1.4571	n	SUS316Ti	w	S31668	w
X2CrNiMo17–12–3	4432–316–03-I	S31603	w	–	1.4432	i	SUS316L	w	S31603	w
X3CrNiMo17–12–3	4436–316–00-I	S31600	w	–	1.4436	i	SUS316	w	S31608	w
X1NiCrMoCu25–20–5	4539–089–04-I	N08904	w	–	1.4539	n	SUS890L	w	S39042	n
Austenitic-ferritic stainless steels											
X2CrNiMoN22–5-3	4462–318–03-I	S32205	n	–	1.4462	i	SUS329J3L	w	S22053	n
X2CrNiMnMo-CuN24–4-3–2	4662–824–41-X	—	—	–	1.4662	i	—	—	—	—
X3CrNiMoN27–5-2	4460–312–00-I	S31200	w	–	1.4460	i	–	–	S22553	w
Ferritic stainless steels											
X6Cr17	4016–430–00-I	S43000	w	–	1.4016	i	SUS430	w	S11710	w
X6CrMo17–1	4113–434–00-I	S43400	w	–	1.4113	n	SUS434	w	S11790	w

Table E.1 — *(continued)*

Steel names according to[a]										
ISO-steel grade (ISO 683-18)	**ISO-number**	**ASTM/SAE/ UNS[b]**		EN 10025–2, EN 10083, EN 10084, EN 10087, EN 10088–3 **Number[c]**		**JIS[d]**		**GB/ISC[e]**	
			i/n/w[f]		i/n/w[f]		i/n/w[f]		i/n/w[f]
Martensitic stainless steels										
X12Cr13	4006–410–00-I	S41000	w	–	1.4006	i	SUS410	w	S41010	w
X12CrS13	4005–416–00-I	S41600	w	–	1.4005	n	SUS416	w	S41617	n
X20Cr13	4021–420–00-I	S42000	w	–	1.4021	i	SUS420J1	n	S42020	n
X30Cr13	4028–420–00-I	S42000	w	–	1.4028	i	SUS420J2	w	S42030	n
X17CrNi16–2	4057–431–00-X	S43100	w	–	1.4057	i	SUS431	w	S43120	i
X14CrS17	4019–430–20-I	S43020	w	X14CrMoS17	1.4104	n	—	—	S11717	w
Precipitation-hardening stainless steels										
X5CrNiCuNb16–4	4542–174–00-I	S17400	w	–	1.4542	n	SUS630	w	S51740	w

[a] See sources in the Bibliography.

[b] US steel listed in ASTM A959 and in UNS – if the steel number is given in brackes then the steel has only a UNS-number.

[c] European steel listed in EN 10025–2, EN 10083, EN 10084, EN 10087 and EN 10088–3 and in the "Stahl-Eisen-Liste" – if the steel number is given in brackets then the steel is only listed in the "Stahl-Eisen-Liste".

[d] Japanese Industrial Standard.

[e] Chinese National Standard.

[f] I = identical steel to ISO-steel grade, n = steel grade with closer match of composition, but not identical, w = wider match.

Bibliography

[1] ISO 4954, *Steels for cold heading and cold extruding*

[2] ISO 4960, *Cold-reduced carbon steel strip with a mass fraction of carbon over 0,25 %*

[3] ISO 18265, *Metallic materials — Conversion of hardness values*

[4] EN 10204, *Metallic products —Types of inspection documents*

[5] EN 10247, *Micrographic examination of the non-metallic inclusion content of steels using standard pictures*

[6] JIS G 0415, *Steel and steel products - Inspection documents*

[7] JIS G 0555, *Microscopic testing method for the non-metallic inclusions in steel*

[8] SAE J406C, *Methods of Determining Hardenability of Steels*

[9] ASTM A959, *Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels*

[10] GB/T 699, *Quality carbon structural steels*

[11] GB/T 3077, *Alloy structures steels*

[12] GB/T 5216, *Structural steels subject to end-quench hardenability requirements*

[13] GB/T 8731, *Free-cutting structural steel*

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