INTERNATIONAL STANDARD

ISO 16143-2

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2004-09-01

Stainless steels for general purposes —

Part 2: Semi-finished products, bars, rods and sections

Aciers inoxydables pour usage général —

Partie 2: Demi-produits, barres, fils machine et profils

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16143-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

ISO 16143 consists of the following parts, under the general title *Stainless steels for general purposes*:

— *Part 1: Flat products*

— *Part 2: Semi-finished products, bars, rods and sections*

— *Part 3: Wire*

Stainless steels for general purposes —

Part 2:
Semi-finished products, bars, rods and sections

1 Scope

This part of ISO 16143 specifies the technical delivery conditions for semi-finished products, hot or cold formed bars, rods and sections for general purposes made of the most important corrosion-resistant stainless steel grades.

NOTE Throughout this part of ISO 16143, the term "general purposes" means purposes other than the special purposes mentioned in the Bibliography.

In addition to this part of ISO 16143, the general technical delivery requirements of ISO 404 are applicable.

This part of ISO 16143 does not apply to components manufactured by further processing the product forms listed in the first paragraph above with quality characteristics altered as a result of such further processing.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO/TS 4949, *Steel names based on letter symbols*

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

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 6929, *Steel products — Definitions and classification*

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

ISO 10474:1991, *Steel and steel products — Inspection documents*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
corrosion resistant stainless steels
steels with at least 10,5 % (mass fraction) Cr and a maximum of 1,2 % (mass fraction) C for which resistance to corrosion is of primary importance

3.2
product forms
See ISO 6929.

4 Designation

The steel names given in Tables 1, 4, 5, 6, 7 and 8, Tables B.1 to B.5 and Table C.1 are allocated in accordance with ISO/TS 4949.

5 Information to be supplied by the purchaser

It shall be the responsibility of the purchaser to specify all requirements that are necessary for products under this specification. Such requirements to be considered include, in the order listed but not limited to, the following:

a) the desired quantity;

b) the product form (e.g., square bar or round rod);

c) the number of the appropriate dimensional standard (see Annex A), the nominal dimensions, plus any choice of requirements;

d) the type of material (steel);

e) the number of this International Standard, i.e. ISO 16143-2;

f) the steel name;

g) if, for the relevant steel in the Tables 4 to 8 for the mechanical properties, more than one treatment condition is covered, the symbol for the desired heat treatment;

h) the desired process route (see symbols in Table 3);

i) if an inspection document is required, its designation in accordance with ISO 10474.

EXAMPLE 10 t round bar of a steel grade with the name X5CrNi18-9 as specified in ISO 16143-2 of 50 mm diameter with dimensional tolerances as specified in ISO 1035-4, in process route 3D, inspection certificate 3.1.B as specified in ISO 10474 is designated as follows:

10 t round bar ISO 1035-4-50
Steel ISO 16143-2 - X5CrNi18-9 + 3D
3.1.B

6 Classification of grades

Corrosion resistant stainless steels covered by this part of ISO 16143 are classified according to their structure into:

— austenitic steels;

— austenitic-ferritic steels;

— ferritic steels;

— martensitic steels;

— precipitation-hardening steels.

7 Requirements

7.1 Manufacturing process

Unless a special steelmaking process is agreed upon when ordering, the steelmaking process shall be at the discretion of the manufacturer.

When he so requests, the purchaser shall be informed what steelmaking process is being used.

7.2 Delivery condition

The products shall be supplied in the delivery condition agreed in the order by reference to the process route given in Table 3 and, where different alternatives exist, to the treatment conditions given in Tables 4 to 8 (see also Annex B).

7.3 Chemical composition

7.3.1 The chemical composition requirements given in Table 1 apply with respect to the chemical composition of the cast analysis.

7.3.2 The product analysis may deviate from the limiting values for the cast analysis given in Table 1 by the values listed in Table 2.

7.4 Susceptibility to intergranular corrosion

Referring to resistance to intergranular corrosion as defined in ISO 3651-2, for austenitic, austenitic-ferritic and ferritic steels the specifications in Tables 4 to 6 apply.

NOTE The susceptibility of stainless steels to intergranular corrosion is dependent on the type of environment and therefore cannot always be clearly ascertained through standard laboratory tests. The selection of the test or tests to be agreed upon should be based on experience with the use of the selected grade of steel in the intended environment.

7.5 Mechanical properties

The mechanical properties at room temperature as specified in Tables 4 to 8 apply for the relevant specified heat-treatment condition. This does not apply to process route 3U (hot rolled, not heat treated, not descaled). If, by agreement at the time of ordering, the products are to be supplied in a non-heat-treated condition, the mechanical properties specified in Tables 4 to 8 shall be obtainable from reference test pieces that have received the appropriate heat treatment (simulated heat treatment).

NOTE Austenitic steels are insensitive to brittle fracture in the solution annealed condition. Because they do not have a pronounced transition temperature, which is characteristic of other steels, they are also useful for application at cryogenic temperatures.

7.6 Surface quality

The general surface appearance, with respect to soundness and surface finish, shall be consistent with good production practice for the grade and quality ordered, as determined by visual inspection.

Where necessary, precise requirements on surface quality may be agreed upon at the time of enquiry and order.

7.7 Internal soundness

For internal soundness, where appropriate, any requirements, together with the conditions for their verification, may be agreed upon at the time of enquiry and order.

7.8 Dimensions, tolerances on dimensions and shape

The dimensions and the tolerances on dimensions and shape are to be agreed upon at the time of enquiry and order, as far as possible with reference to the dimensional standards listed in Annex A.

8 Inspection, testing and conformance of products

8.1 General

The manufacturer shall carry out appropriate process control, inspection and testing to assure himself that the delivery complies with the requirements of the order.

This includes the following:

— a suitable frequency of verification of the dimensions of the products;

— an adequate intensity of visual examination of the surface quality of the products;

— an appropriate frequency and type of test to ensure that the correct grade of steel is delivered.

The nature and frequency of these verifications, examinations and tests are determined by the manufacturer, based on the degree of consistency that has been determined by the evidence of his quality system. In view of this, verifications by specific tests for these requirements are not necessary unless otherwise agreed upon.

8.2 Inspection and testing procedures and types of inspection documents

8.2.1 For each delivery, the issue of any inspection document in accordance with ISO 10474 may be agreed upon at the time of enquiry and order.

8.2.2 If, in accordance with the agreements made at the time of enquiry and order, a test report is to be provided, this shall cover:

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

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

8.2.3 If, in accordance with the agreements in the order, an inspection certificate 3.1.A, 3.1.B or 3.1.C or an inspection report 3.2 (see ISO 10474:1991) is to be provided, the specific inspections and tests described in 8.3 shall be carried out and their results shall be certified in the document.

In addition to 8.2.2 the document shall cover

a) the results of the mandatory tests marked in the second column of Table 9 by an “m”;

b) the results of any optional test or inspections agreed upon when ordering marked in the second column of Table 9 by an “o”.

8.3 Specific inspection and testing

8.3.1 Extent of testing

The tests to be carried out, either mandatorily (m) or by agreement (o) and the composition and size of the test units, and the number of sample products, samples and test pieces to be taken are given in Table 9.

8.3.2 Selection and preparation of samples and test pieces

8.3.2.1 The general conditions for selection and preparation of samples and test pieces shall be in accordance with ISO 377 and ISO 14284.

8.3.2.2 The samples for the tensile test shall be taken in accordance with Figures 1 and 2.

The samples shall be taken from products in the as-delivered condition. If agreed, samples from bars may be taken before straightening. For martensitic and precipitation-hardened grades being delivered in the annealed condition, a test to demonstrate the capability of further treatment to one of the specified conditions shall be conducted by the manufacturer on a sample taken from the product in the as-delivered condition and further treated in accordance with a listed production route. Unless specified in the order, that final condition and details of conditions of further treatment shall be at the option of the manufacturer.

8.3.2.3 Samples for the hardness test and for the resistance to intergranular corrosion test, where requested, shall be taken from the same locations as those for the mechanical tests.

Dimensions in millimeters

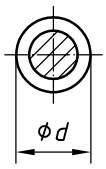
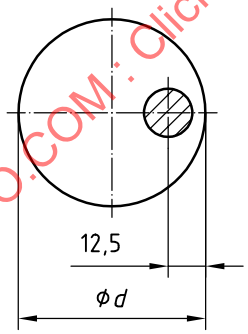
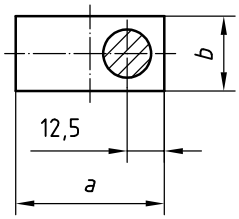
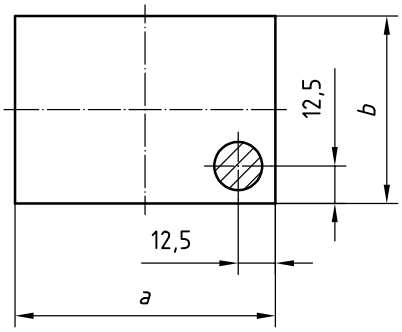
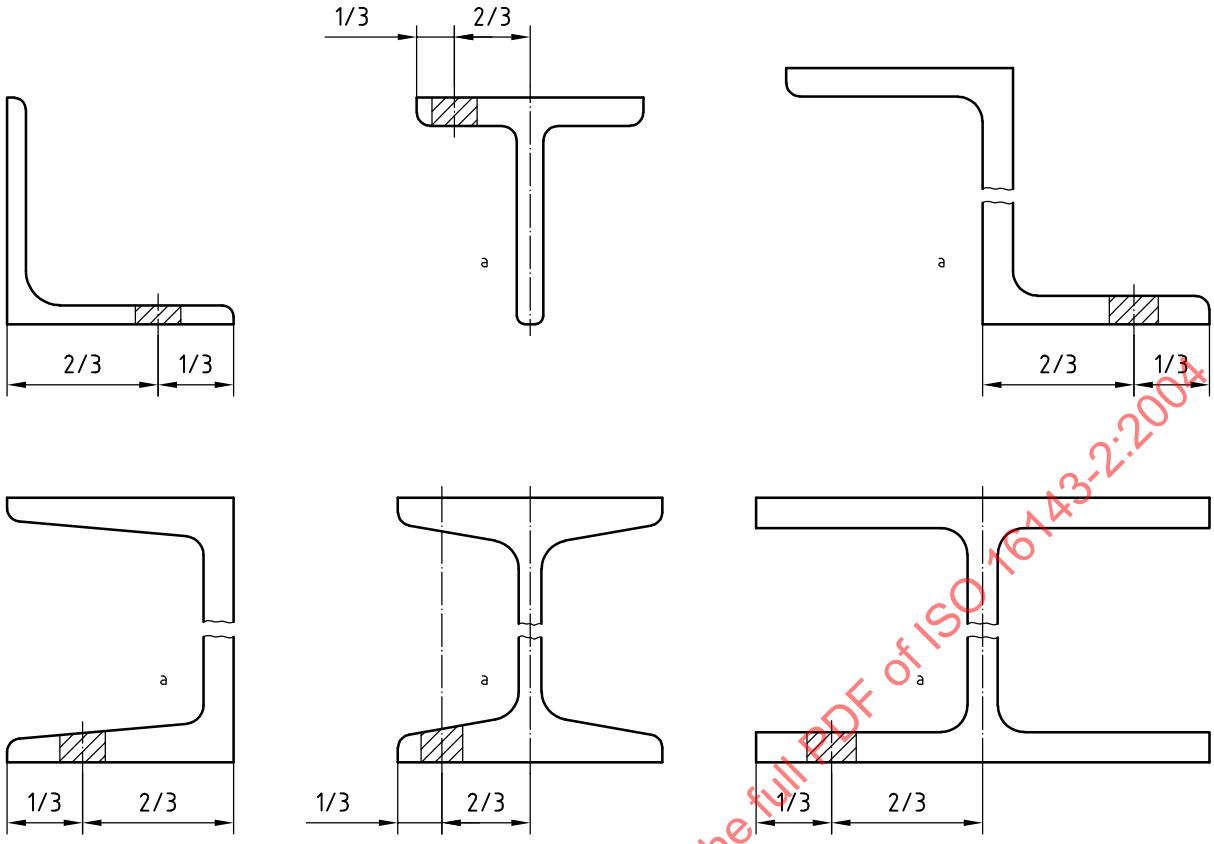
Type of test	Round cross-section products		Rectangular cross-section products	
Tensile	$d \leqslant 25$ [a]	$25 < d \leqslant 160$	$b \leqslant 25$ $a \geqslant b$	$25 < b \leqslant 160$ $a \geqslant b$
				
[a] Samples of product may alternatively be tested unmachined.				

Figure 1 — Position of test pieces for steel bars and rods $\leqslant$ 160 mm diameter or thickness (longitudinal test pieces)



[a] By agreement, the sample can be taken from the web, at a quarter of the total height.

Figure 2 — Position of test pieces (hatched) for beams, channels, angles, T sections and Z sections

8.4 Test methods

8.4.1 Unless otherwise agreed when ordering, the choice of a suitable physical or chemical method of analysis to determine the product analysis is at the discretion of the manufacturer. In cases of dispute, the analysis shall be carried out by a laboratory approved by the two parties. In these cases, the reference method of analysis shall be agreed upon, where possible, with reference to ISO/TR 9769.

8.4.2 The tensile test at room temperature shall be carried out in accordance with ISO 6892.

Unless otherwise agreed, the tensile strength and elongation after fracture shall be determined and, in addition, for ferritic, martensitic, precipitation-hardening, austenitic free-cutting and austenitic-ferritic steels, the 0,2 % proof strength, and for austenitic steels, the 0,2 % and 1 % proof strength.

For bars made of resulfurized grades it may be agreed upon to determine the hardness instead.

8.4.3 The Brinell hardness test shall be carried out in accordance with ISO 6506-1.

8.4.4 The resistance to intergranular corrosion shall be tested in accordance with ISO 3651-2, unless otherwise agreed.

8.4.5 Dimensions and dimensional tolerances of the products shall be tested in accordance with the requirements of the relevant dimensional standards given in Annex A.

8.5 Retests

See ISO 404.

9 Marking

9.1 Marking shall be durable. If the marking is to be applied by inking or adhesive label, the inks or adhesives shall be especially selected, in order to avoid corrosion of the product.

9.2 Unless otherwise agreed, the requirements listed in Table 10 apply.

9.3 Unless otherwise agreed, the products shall be marked as follows:

— semifinished products, bars and sections by means of labels attached to the bundle or, by agreement at the time of enquiry and order, by inking, adhesive labels, electrolytic etching or stamping;

— rods by means of a label attached to the coil.

Table 1 — Chemical composition (cast analysis)

Designation	Line No. of ISO/TS 15510:2003	% (mass fraction)									
Name		C	Si	Mn	P max.	S	N	Cr	Mo	Ni	Others
Austenitic steels											
X2CrNi18-9	1	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	17,5 to 19,5	—	8,0 to 10,0 (10,5) [a]	—
X2CrNi19-11	2	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	18,0 to 20,0	—	10,0 to 12,0 (13,0) [a]	—
X2CrNiN18-9	3	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	0,12 to 0,22	17,5 to 19,5	—	8,0 to 10,0	—
X5CrNi18-9	6	max. 0,07	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	17,5 to 19,5	—	8,0 to 10,5	—
X6CrNi18-12	8	max. 0,08	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	17,0 to 19,0	—	10,5 to 13,0	—
X5CrNiN19-9	10	max. 0,07	max. 1,00	max. 2,50	0,045	max. 0,030	0,10 to 0,16	18,0 to 20,0	—	8,0 to 11,0	—
X10CrNi18-8	11	0,05 to 0,15	max. 2,00	max. 2,00	0,045	max. 0,030	max. 0,11	16,0 to 19,0	max. 0,80	6,0 to 9,5	—
X1CrNi25-21	12	max. 0,020	max. 0,25	max. 2,00	0,025	max. 0,010	max. 0,11	24,0 to 26,0	max. 0,20	20,0 to 22,0	—
X10CrNiS18-9	14	max. 0,12	max. 1,00	max. 2,00	0,060	min. 0,15	max. 0,11	17,0 to 19,0	—	8,0 to 10,0	Cu: [b]
X3CrNiCu18-9-4	15	max. 0,04	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	17,0 to 19,0	—	8,0 to 10,5	Cu: 3,0 to 4,0
X6CrNiTi18-10	16	max. 0,08	max. 1,00	max. 2,00	0,045	max. 0,030	—	17,0 to 19,0	—	9,0 to 12,0 (13,0) [a]	Ti: 5 × C to 0,70
X6CrNiNb18-10	19	max. 0,08	max. 1,00	max. 2,00	0,045	max. 0,030	—	17,0 to 19,0	—	9,0 to 12,0 (13,0) [a]	Nb: 10 × C to 1,00
X2CrNiMo17-12-2	21	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0 (14,5) [a]	—
X2CrNiMo17-12-3	22	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 (14,5) [a]	—
X2CrNiMo18-14-3	23	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,015	max. 0,11	17,0 to 19,0	2,50 to 3,00	12,5 to 15,0	—
X2CrNiMoN17-12-3	26	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	0,12 to 0,22	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 (14,0) [a]	—
X2CrNiMoN18-12-4	27	max. 0,030	max. 1,00	max. 2,00	0,045	max. 0,030	0,10 to 0,20	16,5 to 19,5	3,0 to 4,0	10,5 to 14,0 (15,0) [a]	—
X1CrNiMoN25-22-2	29	max. 0,020	max. 0,70	max. 2,00	0,025	0,010	0,10 to 0,16	24,0 to 26,0	2,00 to 2,50	21,0 to 23,0	—
X5CrNiMo17-12-2	30	max. 0,07	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0	—
X3CrNiMo17-12-3	31	max. 0,05	max. 1,00	max. 2,00	0,045	max. 0,030	max. 0,11	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 (14,0) [a]	—

Table 1 (*continued*)

Designation	Line No. of ISO/TS 15510:2003	% (mass fraction)									
Name		C	Si	Mn	P max.	S	N	Cr	Mo	Ni	Others
X6CrNiMoTi17-12-2	32	max. 0,08	max. 1,00	max. 2,00	0,045	max. 0,030	—	16,5 to 18,5	2,00 to 2,50	10,5 to 13,5 (14,0) [a]	Ti: 5 × C to 0,70
X1CrNiMoCuN20-18-7	34	max. 0,020	max. 0,70	max. 1,00	0,035	max. 0,015	0,18 to 0,25	19,5 to 20,5	6,0 to 7,0	17,5 to 18,5	Cu: 0,50 to 1,00
X1NiCrMoCu25-20-5	35	max. 0,020	max. 0,75	max. 2,00	0,035	max. 0,015	max. 0,15	19,0 to 22,0	4,0 to 5,0	23,5 to 26,0	Cu: 1,20 to 2,00
X1NiCrMoCu31-27-4	36	max. 0,020	max. 0,70	max. 2,00	0,030	max. 0,010	max. 0,11	26,0 to 28,0	3,0 to 4,0	30,0 to 32,0	Cu: 0,70 to 1,50
X1NiCrMoCuN25-20-7	37	max. 0,020	max. 0,75	max. 2,00	0,035	max. 0,015	0,15 to 0,25	19,0 to 21,0	6,0 to 7,0	24,0 to 26,0	Cu: 0,50 to 1,50
X1CrNiMoCuN24-22-8	38	max. 0,020	max. 0,50	2,0 to 4,0	0,030	max. 0,005	0,45 to 0,55	23,0 to 25,0	7,0 to 8,0	21,0 to 23,0	Cu: 0,30 to 0,60
X8CrMnNiN18-9-5	39	0,05 to 0,10	0,30 to 0,60	9,0 to 10,0	0,035	max. 0,030	0,25 to 0,32	17,5 to 18,5	max. 0,50	5,0 to 6,0	Cu: max. 0,40
X8CrMnCuN17-8-3	40	max. 0,10	max. 2,00	6,5 to 8,5	0,040	max. 0,030	0,15 to 0,30	16,0 to 18,0	max. 1,00	max. 2,00	Cu: 2,00 to 3,5
X1CrNiMoCuNW24-22-6	41	max. 0,020	max. 0,70	2,0 to 4,0	0,030	max. 0,010	0,35 to 0,50	23,0 to 25,0	5,5 to 6,5	21,0 to 23,0	Cu: 1,00 to 2,00 W: 1,50 to 2,50
X2CrNiMnMoN25-18-6-5	42	max. 0,030	max. 1,00	5,0 to 7,0	0,030	max. 0,015	0,30 to 0,60	24,0 to 26,0	4,0 to 5,0	16,0 to 19,0	Nb: max. 0,15
X11CrNiMnN19-8-6	43	0,07 to 0,15	0,50 to 1,00	5,0 to 7,5	0,030	max. 0,015	0,20 to 0,30	17,5 to 19,5	—	6,5 to 8,5	—
X6CrNiCuS18-9-2	44	max. 0,08	max. 1,00	max. 2,00	0,045	min. 0,15	max. 0,11	17,0 to 19,0	max. 0,60	8,0 to 10,0	Cu:1,40 to 1,80
Austenic-ferritic steels											
X2CrNiN23-4	51	max. 0,030	max. 1,00	max. 2,00	0,035	max. 0,015	0,05 to 0,20	22,0 to 24,0	0,10 to 0,60	3,5 to 5,5	Cu: 0,10 to 0,60
X2CrNiMoN22-5-3	52	max. 0,030	max. 1,00	max. 2,00	0,035	max. 0,015	0,10 to 0,22	21,0 to 23,0	2,5 to 3,5	4,5 to 6,5	—
X2CrNiMoCuN25-6-3	53	max. 0,030	max. 0,70	max. 2,00	0,035	max. 0,015	0,15 to 0,30	24,0 to 26,0	2,5 to 4,0	5,0 to 7,5	Cu: 1,00 to 2,50
X2CrNiMoN25-7-4	54	max. 0,030	max. 1,00	max. 2,00	0,035	max. 0,015	0,24 to 0,35	24,0 to 26,0	3,0 to 4,5	6,0 to 8,0	—
X3CrNiMoN27-5-2	55	max. 0,050	max. 1,00	max. 2,00	0,035	max. 0,015	0,05 to 0,20	25,0 to 28,0	1,30 to 2,00	4,5 to 6,5	—
X2CrNiMoCuWN25-7-4	56	max. 0,030	max. 1,00	max. 1,00	0,035	max. 0,015	0,20 to 0,30	24,0 to 26,0	3,0 to 4,0	6,0 to 8,0	Cu: 0,50 to 1,00 W: 0,50 to 1,00
Ferritic steels											
X6Cr17	67	max. 0,08 [c]	max. 1,00	max. 1,00	0,040	max. 0,030	—	16,0 to 18,0	—	—	—
X7CrS17	68	max. 0,09	max. 1,50	max. 1,50	0,040	min. 0,15	—	16,0 to 18,0	max. 0,60	—	—
X6CrMo17-1	69	max. 0,08	max. 1,00	max. 1,00	0,040	max. 0,030	—	16,0 to 18,0	0,90 to 1,40	—	—
X3CrNb17	73	max. 0,05	max. 1,00	max. 1,00	0,040	max. 0,015	—	16,0 to 18,0	—	—	Nb: 12 × C to 1,00

Table 1 (*continued*)

Designation		% (mass fraction)									
Name	Line No. of ISO/TS 15510:2003	C	Si	Mn	P max.	S	N	Cr	Mo	Ni	Others
X2CrMoTiS18-2	74	max. 0,030	max. 1,00	max. 0,50	0,040	min. 0,15	—	17,5 to 19,0	2,00 to 2,50	—	Ti: 0,30 to 0,80 (C + N): max. 0,040
Martensitic steels											
X3CrNiMo13-4	81	max. 0,05	max. 0,70	0,50 to 1,00	0,040	max. 0,015	—	12,0 to 14,0	0,30 to 1,00	3,5 to 4,5	—
X12Cr13	82	0,08 to 0,15	max. 1,00	max. 1,50	0,040	max. 0,030	—	11,5 to 13,5	—	max. 0,75	—
X12CrS13	83	0,08 to 0,15	max. 1,00	max. 1,50	0,040	min. 0,15	—	12,0 to 14,0	max. 0,60	—	—
X20Cr13	84	0,16 to 0,25	max. 1,00	max. 1,50	0,040	max. 0,030	—	12,0 to 14,0	—	—	—
X30Cr13	85	0,26 to 0,35	max. 1,00	max. 1,50	0,040	max. 0,030	—	12,0 to 14,0	—	—	—
X14CrS17	90	0,10 to 0,17	max. 1,00	max. 1,50	0,040	min. 0,15	—	16,0 to 18,0	max. 0,60	—	—
X17CrNi16-2	91	0,12 to 0,22	max. 1,00	max. 1,50	0,040	max. 0,030	—	15,0 to 17,0	—	1,50 to 2,50	—
X39CrMo17-1	92	0,33 to 0,45	max. 1,00	max. 1,50	0,040	max. 0,015	—	15,5 to 17,5	0,80 to 1,30	max. 1,00	—
X105CrMo17	93	0,95 to 1,20	max. 1,00	max. 1,00	0,040	max. 0,015	—	16,0 to 18,0	0,40 to 0,80	—	—
Precipitation hardening steels											
X5CrNiCuNb16-4	101	max. 0,07	max. 0,70	max. 1,50	0,040	max. 0,030	—	15,0 to 17,0	max. 0,60	3,0 to 5,0	Cu: 3,0 to 5,0 Nb: 5 × C to 0,45
X7CrNiAl17-7	102	max. 0,09	max. 0,70	max. 1,00	0,040	max. 0,015	—	16,0 to 18,0	—	6,5 to 7,8 [d]	Al: 0,70 to 1,50

[a] 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.

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

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

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

Table 2 — Permissible deviations between the product analysis and the limiting values given in Table 1 for the cast analysis

Element	Permissible maximum content in the cast analysis % (mass fraction)	Permissible deviation [a] % (mass fraction)
Carbon	⩽ 0,030 > 0,030 ⩽ 0,20 > 0,20 ⩽ 0,50 > 0,50 ⩽ 1,20	+ 0,005 ± 0,01 ± 0,02 ± 0,03
Silicon	⩽ 1,00 > 1,00 ⩽ 2,00	± 0,04 + 0,07
Manganese	⩽ 1,00 > 1,00 ⩽ 2,00 > 2,00 ⩽ 10,0	± 0,04 + 0,07 ± 0,1
Phosphorus	⩽ 0,060	+ 0,005
Sulfur	⩽ 0,015 > 0,015 ⩽ 0,030 ⩾ 0,15	+ 0,003 ± 0,005 – 0,02
Nitrogen	⩾ 0,03 ⩽ 0,11 > 0,11 ⩽ 0,60	± 0,01 ± 0,02
Chromium	⩾ 10,5 ⩽ 28,0	± 0,2
Molybdenum	⩽ 0,60 > 0,60 < 1,75 ⩾ 1,75 ⩽ 8,0	± 0,03 ± 0,07 ± 0,1
Nickel	⩽ 1,00 > 1,00 ⩽ 5,0 > 5,0 ⩽ 32,0	± 0,04 ± 0,1 ± 0,2
Copper	⩽ 1,00 > 1,00 ⩽ 5,0	± 0,04 ± 0,1
Niobium	⩽ 1,00	± 0,05
Titanium	⩽ 0,80	± 0,03
Tungsten	⩽ 2,50	± 0,05

[a] ± means that in one cast the deviation may occur over the upper value or under the lower value of the specified range in Table 1, but not both at the same time.

Table 3 — Types of process routes and surface finish of long products [a]

Condition	Abbre-viation [b]	Type of process route	Surface finish	Product form			Notes
				Rods	Bars, sections	Semi finished	
Hot formed	3U	Hot formed, not heat treated, not descaled	Covered with scale; (spot ground if necessary)	X	X	X	Suitable for products to be further hot formed. For semi-finished products, ground on all sides can be specified
	3C	Hot formed, heat treated [c], not descaled	Covered with scale; (spot ground if necessary)	X	X	X	Suitable for products to be further processed. For semi-finished products, ground on all sides can be specified
	3E	Hot formed, heat treated [c], mechanically descaled	Largely free of scale (but some black spots may remain)	X	X	X	The type of mechanical descaling, e.g. grinding, peeling or shot blasting, is left to the manufacturer's discretion unless otherwise agreed. Suitable for products to be further processed
	3D	Hot formed, heat treated [c], pickled	Free of scale	X	X	—	Tolerance $\geqslant$ IT 14 [d, e]
	3X	Hot formed, heat treated [c], rough machined (peeled or rough turned)	Metallically clean	—	X	—	Tolerance $\geqslant$ IT 12 [d, e]
Cold processed	4H	Heat treated [c], mechanically or chemically descaled, cold processed [f]	Smooth and bright. Substantially smoother than finishes 3E, 3D or 3X	—	X	—	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. Tolerance IT 9 to IT 11 [d, e]
	4D	Cold processed, heat treated [c], pickled (skin-passed)	Smoother than finishes 3E or 3D	—	X	—	Finish for good ductility (cold heading)
	4B	Heat treated, machined (peeled), mechanically smoothed	Smoother and brighter than finishes 3E, 3D or 3X	—	X	—	Pre-finish for close ISO-tolerances. Tolerance IT 9 to IT 11 [d, e]
Special finishing process	3G or 4G	Centreless ground	Uniform finish. Type and degree of grinding to be agreed	—	X	—	Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 3E, 3D, 4H or 4B. Tolerance $\leqslant$ IT 8 [d, e]
	3P or 4P	Polished	Smoother and brighter than finish 3G or 4G. Type and degree of polishing to be agreed	—	X	—	Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 3E, 3D, 4B, 3G or 4H. Tolerance $\leqslant$ IT 11 [d, e]

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

[b] First digit, 3 = hot formed, 4 = cold processed.

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

[d] For information: IT = international tolerance, as defined in ISO 286-1, and in other dimensional tolerance standards.

[e] Specific tolerance within the ranges shall be agreed upon at the time of enquiry and order.

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

Table 4 — Mechanical properties at room temperature for austenitic steels in the solution-annealed condition (+AT) (see Table B.1)

Designation		Thickness	Proof strength [a]		Tensile strength	Elongation after fracture [a, b]	Resistance to intergranular corrosion [c]	
Name	Line number of ISO/TS 15510:2003	mm max.	$R_{p0,2}$ MPa min.	$R_{p1,0}$ MPa min.	R_m MPa	A % min.	in the delivery condition	in the sensitized condition [d]
X2CrNi18-9	1	160 [e]	180	220	480 to 680	40 [f]	yes	yes
X2CrNi19-11	2	160 [e]	180	220	480 to 680	40 [f]	yes	yes
X2CrNiN18-9	3	160 [e]	270	310	550 to 750	40 [f]	yes	yes
X5CrNi18-9	6	160 [e]	200	240	510 to 710	40 [f]	yes	no [g]
X6CrNi18-12	8	h	—	—	480 to 680	—	yes	no [g]
X5CrNiN19-9	10	h	—	—	550 to 750	—	yes	no [g]
X10CrNi18-8	11	h	—	—	500 to 700	—	no	no
X1CrNi25-21	12	h	—	—	470 to 670	—	yes	yes
X10CrNiS18-9	14	160 [e]	190	i	500 to 700	35 [f]	no	no
X3CrNiCu18-9-4	15	h	—	—	450 to 650	—	yes	yes
X6CrNiTi18-10	16	160 [e]	200	240	510 to 710	40 [f]	yes	yes
X6CrNiNb18-10	19	160 [e]	205	240	510 to 740	40 [f]	yes	yes
X2CrNiMo17-12-2	21	160 [e]	205	245	520 to 720	40 [f]	yes	yes
X2CrNiMo17-12-3	22	160 [e]	205	245	520 to 720	40 [f]	yes	yes
X2CrNiMo18-14-3	23	160 [e]	200	235	500 to 700	40 [f]	yes	yes
X2CrNiMoN17-12-3	26	160 [e]	280	315	580 to 800	40 [f]	yes	yes
X2CrNiMoN18-12-4	27	h	—	—	540 to 740	—	yes	yes
X1CrNiMoN25-22-2	29	160 [e]	250	290	540 to 740	35 [f]	yes	yes
X5CrNiMo17-12-2	30	160 [e]	205	245	520 to 720	40 [f]	yes	no [g]
X3CrNiMo17-12-3	31	160 [e]	205	245	520 to 720	40 [f]	yes	no [g]
X6CrNiMoTi17-12-2	32	160 [e]	205	245	520 to 720	40 [f]	yes	yes
X1CrNiMoCuN20-18-7	34	h	—	—	650 to 850	—	yes	yes
X1NiCrMoCu25-20-5	35	160 [c]	220	260	530 to 730	35 [d]	yes	yes
X1NiCrMoCu31-27-4	36	h	—	—	500 to 750	—	yes	yes
X1NiCrMoCuN25-20-7	37	160 [e]	300	340	650 to 850	40 [f]	yes	yes
X1CrNiMoCuN24-22-8	38	50 [e]	430	470	750 to 1 050	40 [f]	yes	yes
X8CrMnNiN18-9-5	39	10 [e]	350	380	700 to 900	35 [f]	yes	no
X8CrMnCuN17-8-3	40	160 [e]	270	305	560 to 760	40 [f]	yes	no
X1CrNiMoCuNW24-22-6	41	160 [e]	420	460	800 to 1 000	50 [f]	yes	yes
X2CrNiMnMoN25-18-6-5	42	160 [e]	420	460	800 to 1 000	35 [f]	yes	yes
X11CrNiMnN19-8-6	43	15 [e]	340	370	750 to 950	35 [f]	yes	no
X6CrNiCuS18-9-2	44	160 [e]	185	220	500 to 710	35 [f]	no	no

NOTE 1 MPa = 1 N/mm^2.

[a] Elongation and proof strength are not valid for rod.
[b] Longitudinal test pieces.
[c] When tested in accordance with ISO 3651-2.
[d] See NOTE to 7.4.
[e] For larger thicknesses, the values shall be agreed upon.
[f] The minimum elongation value may be lowered to 20 % for sections and bars ⩽ 35 mm thickness having a final cold deformation.
[g] Sensitization treatment of 15 min at 700 °C followed by cooling in air.
[h] For rod only.
[i] Maximum HWB = 262. This value may be raised by 60 units or the maximum tensile strength value may be raised by 150 MPa and the minimum elongation be lowered to 10 % for sections and bars ⩽ 35 mm thickness having undergone final cold deformation.

Table 5 — Mechanical properties at room temperature for austenitic-ferritic steels in the solution annealed condition (+AT) (see Table B.2)

Designation		Thickness	Hardness[a] HWB	0,2 % proof strength $R_{p0,2}$ [b]	Tensile strength, R_m [b]	Elongation after fracture, A [b, c]	Resistance to intergranular corrosion [d]	
Name	Line number of ISO/TS 15510:2003	mm max.	max.	MPa min.	MPa min.	% min.	in the delivery condition	in the sensitized condition[e]
X2CrNiN23-4	51	160 [f]	260	400	600	25	yes	yes
X2CrNiMoN22-5-3	52	160 [f]	290	450	650	25	yes	yes
X2CrNiMoCuN25-6-3	53	160 [f]	270	500	700	25	yes	yes
X2CrNiMoN25-7-4	54	160 [f]	290	530	730	25	yes	yes
X3CrNiMoN27-5-2	55	160 [f]	260	450	620	20	yes	yes
X2CrNiMoCuWN25-7-4	56	160 [f]	290	530	730	25	yes	yes

NOTE 1 MPa = 1 N/mm^2.

[a] Only for guidance.
[b] For rods, only the tensile strength values apply.
[c] At the option of the manufacturer, it is permitted to use transverse test specimens provided that the same requirement be met.
[d] When tested in accordance with ISO 3651-2.
[e] See NOTE to 7.4.
[f] For larger thicknesses, the values shall be agreed upon.

Table 6 — Mechanical properties at room temperature for ferritic steels in the heat-treated condition (see Table B.3)

Designation		Thickness	Heat treatment [a]	Hardness [b] HWB	0,2 % proof strength $R_{p0,2}$	Tensile strength [b] R_m	Elongation after fracture [b, c] A	Resistance to intergranular corrosion [d]	
Name	Line number of ISO/TS 15510:2003	mm max.		max.	MPa min.	MPa min.	% min.	in the delivery condition	in the welded condition
X6Cr17	67	75 [e]	+A	200	240	400	20	yes	no
X7CrS17	68	75 [e]	+A	262	250	430	20	no	no
X6CrMo17-1	69	[f]	+A	—	—	440	—	yes	no
X3CrNb17	73	100 [e]	+A	—	230	420	20	yes	yes
X2CrMoTiS18-2	74	100 [e]	+A	200	280	430	15	yes	no

NOTE 1 MPa = 1 N/mm^2.

[a] +A: soft annealed.
[b] The maximum HWB values may be raised by 60 units or the maximum tensile strength value may be raised by 150 MPa and the minimum elongation value be lowered to 10 % for sections and bars ⩽ 35 mm thickness having undergone final cold deformation.
[c] Longitudinal test pieces.
[d] When tested in accordance with ISO 3651-2.
[e] For larger thicknesses, the values have to be agreed.
[f] For rod only.

Table 7 — Mechanical properties at room temperature for martensitic steels in the heat treated condition (see Table B.4)

Designation		Thickness	Heat treatment [a]	Hardness [b]	0,2 % proof strength	Tensile strength		Elongation after fracture [c]
Name	Line number of ISO/TS 15510:2003	mm max.		HWB max.	$R_{p0,2}$ MPa min.	R_m MPa min.	R_m MPa max.	A % min.
X3CrNiMo13-4	81	—	+A	320	—	—	1 100	—
		160 [d]	+QT1	—	520	700	800	15
		160 [d]	+QT2	—	620	780	980	15
		160 [d]	+QT3	—	800	900	1 100	12
X12Cr13	82	—	+A	223	—	—	—	—
		75 [d]	+QT	—	345	540	—	15
X12CrS13	83	—	+A	262	—	—	880	—
		160 [d]	+QT	—	450	650	—	12
X20Cr13	84	—	+A	230	—	—	900	—
		160 [d]	+QT1	—	600	800	950	12
		160 [d]	+QT2	—	500	700	850	13
X30Cr13	85	—	+A	245	—	—	—	—
		75 [d]	+QT	—	540	740	—	12
X14CrS17	90	—	+A	262	—	—	880	—
		160 [d]	+QT	—	500	650	850	12 [e]
X17CrNi16-2	91	—	+A	295	—	—	950	—
		160 [d]	+QT1	—	700	900	1 050	12 [e]
		160 [d]	+QT2	—	600	800	950	14 [f]
X39CrMo17-1	92	—	+A	280	—	—	900	—
		160 [d]	+QT	—	550	750	950	12
X105CrMo17	93	100 [d]	+A	285	—	—	—	—

NOTE 1 MPa = 1 N/mm^2.

[a] +A: soft annealed; +QT: quenched and tempered.

[b] The maximum HWB values may be raised by 60 units or the maximum tensile strength value may be raised by 150 MPa and the minimum elongation value be lowered to 10 % for sections and bars $\leqslant$ 35 mm thickness having undergone final cold deformation.

[c] Longitudinal test pieces.

[d] For larger thicknesses, the values shall be agreed upon.

[e] A = 10 % for thicknesses > 60 mm.

[f] A = 12 % for thicknesses > 60 mm.

Table 8 — Mechanical properties at room temperature for the precipitation-hardening steel in the heat-treated condition (see Table B.5)

Designation		Hardness	Heat treatment [a]	0,2 % proof strength	Tensile strength	Elongation after fracture
Name	Line number of ISO/TS 15510:2003	HWB max.		$R_{p0,2}$ MPa min.	R_m MPa	A % min.
X5CrNiCuNb16-4	101	363	+AT	—	⩽ 1 200	—
		—	+P1	1 175	⩾ 1 310	10
		—	+P2	1 000	⩾ 1 070	12
		—	+P3	860	⩾ 1 000	13
		—	+P4	725	⩾ 930	16
X7CrNiAl17-7	102	—	+AT	—	⩽ 850 [b]	—

NOTE 1 MPa = 1 N/mm^2.

[a] +AT = solution annealed; +P = precipitation hardened.

[b] For rod only.

Table 9 — Tests to be carried out, test units and extent of testing in specific testing

Test	[a]	Test unit	Product form: rods, bars and sections	Number of test pieces per sample
Chemical analysis	m	Cast	The cast analysis is given by the manufacturer [b]	
Tensile test at room temperature or hardness test at room temperature	m	Batch [c]	One sample per 25 t; maximum of two per test unit	1
Resistance to intergranular corrosion	o [d]		To be agreed at the time of ordering if intergranular corrosion is a hazard	1

[a] 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 the time of ordering.

[b] A product analysis may be agreed at the time of ordering; the extent of testing shall be specified at the same time.

[c] Each batch consists of products coming from the same cast. The products must have been subjected to the same heat-treatment cycle in the same furnace. In the case of a continuous furnace or in process annealing a batch is the lot heat treated without interruption with the same process parameters.

The shape and size of cross sections of products in a single batch may be different providing that the ratio of the largest to the smallest cross-sectional areas be equal to or less than three.

[d] The test for resistance to intergranular corrosion is normally not carried out.

Table 10 — Marking of the products

Marking	Products	
	With specific testing [a]	Without specific testing [a]
Manufacturer's name, trademark or logo	+	+
Steel name	+	+
Cast number	+	+
Identification number [b]	+	(+)
Inspector's mark	(+)	–

[a] The symbols in the table mean:

+ the marking shall be applied;
(+) the marking shall be applied if so agreed, or at the manufacturer's discretion;
– no marking necessary.

[b] If specific tests are to be carried out, the numbers or letters used for identification shall allow the product(s) to be related to the relevant inspection certificate or inspection report.

Annex A
(informative)

Applicable dimensional standards

ISO 286-1, *Geometrical product specifications (GPS) — ISO coding system for tolerances of linear sizes — Part 1: Bases of tolerances and fits*

NOTE The notes in Table 3 contain information concerning tolerances for bright bars; special agreements are necessary if such information should become obligatory.

ISO 1035-1, *Hot-rolled steel bars — Part 1: Dimensions of round bars*

ISO 1035-2, *Hot-rolled steel bars — Part 2: Dimensions of square bars*

ISO 1035-3, *Hot-rolled steel bars — Part 3: Dimensions of flat bars*

ISO 1035-4, *Hot-rolled steel bars — Part 4: Tolerances*

ISO 16124, *Steel wire rod — Dimensions and tolerances*

ASTM A 484M-03, *Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings*

ASTM A 555M-97 (2002), *Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods*

EN 10058, *Hot-rolled flat steel bars for general purposes — Dimensions and tolerances on shape and dimensions*

EN 10059, *Hot rolled square steel bars for general purposes — Dimensions and tolerances on shape and dimensions*

EN 10060, *Hot rolled round steel bars — Dimensions and tolerances on shape and dimensions*

EN 10061, *Hot rolled hexagon steel bars — Dimensions and tolerances on shape and dimensions*

EN 10278, *Dimensions and tolerances of bright steel products*

Annex B
(informative)

Guidelines for further treatment (including heat treatment) in fabrication

B.1 The guidelines given in Tables B.1 to B.5 are intended for hot forming and heat treatment.

B.2 Because the corrosion resistance of stainless steels is only ensured when the surface is metallically clean, layers of scale and annealing colours produced during hot forming, heat treatment or welding should be removed as far as possible before use. Resistance to corrosion by finished parts made of steels with approximately 13 % Cr is increased by the presence of a smooth, clean surface.

Table B.1 — Guidelines on the temperatures for hot forming and heat treatment [a] of austenitic corrosion-resistant stainless steels

Designation		Hot forming		Heat treatment symbol	Solution annealing [b]	
Name	Line No. of ISO/TS 15510:2003	Temperature °C	Type of cooling		Temperature [c] °C	Type of cooling
X2CrNi18-9	1	1 200 to 900	Air	+AT	1 000 to 1 100	Water, air [d]
X2CrNi19-11	2				1 000 to 1 100	
X2CrNiN18-9	3				1 000 to 1 100	
X5CrNi18-9	6				1 000 to 1 100	
X6CrNi18-12	8				1 010 to 1 150	
X5CrNiN19-9	10	1 150 to 850			1 000 to 1 100	
X10CrNi18-8	11	1 200 to 900			1 000 to 1 100	
X1CrNi25-21	12	1 150 to 850			1 030 to 1 110	
X10CrNiS18-9	14	1 200 to 900			1 000 to 1 100	
X3CrNiCu18-9-4	15				1 000 to 1 100	
X6CrNiTi18-10	16				1 020 to 1 120	
X6CrNiNb18-10	19	1 150 to 850			1 020 to 1 120	
X2CrNiMo17-12-2	21	1 200 to 900			1 020 to 1 120	
X2CrNiMo17-12-3	22				1 020 to 1 120	
X2CrNiMo18-14-3	23				1 020 to 1 120	
X2CrNiMoN17-12-3	26				1 020 to 1 120	
X2CrNiMoN18-12-4	27	1 150 to 850			1 070 to 1 150	
X1CrNiMoN25-22-2	29				1 070 to1 150	
X5CrNiMo17-12-2	30	1 200 to 900			1 020 to 1 120	
X3CrNiMo17-12-3	31				1 020 to 1 120	
X6CrNiMoTi17-12-2	32				1 020 to 1 120	
X1CrNiMoCuN20-18-7	34	1 200 to 1 000			1 140 to 1 200	
X1NiCrMoCu25-20-5	35	1 200 to 900			1 050 to 1 150	
X1NiCrMoCu31-27-4	36	1 150 to 850			1 050 to 1 150	
X1NiCrMoCuN25-20-7	37	1 200 to 950			1 120 to 1 180	
X1CrNiMoCuN24-22-8	38	1 200 to 1 000			1 150 to 1 200	
X8CrMnNiN18-9-5	39	1 150 to 850			1 000 to 1 100	
X8CrMnCuN17-8-3	40	1 150 to 850			1 000 to 1 100	
X1CrNiMoCuNW24-22-6	41	1 150 to 850			1 140 to 1 200	
X2CrNiMnMoN25-18-6-5	42	1 200 to 950			1 120 to 1 170	
X11CrNiMnN19-8-6	43	1 150 to 850			1 000 to 1 100	
X6CrNiCuS18-9-2	44	1 150 to 900			1 000 to 1 100	

[a] The temperatures of solution annealing shall be agreed upon for simulated heat-treated test pieces.

[b] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.

[c] The lower end of the range specified for solution annealing should be aimed at for heat treatment as part of further processing, because otherwise the mechanical properties might be affected. If the temperature of hot forming does not drop below the lower temperature for solution annealing, a temperature of 980 °C is adequate as a lower limit for Mo-free steels; a temperature of 1 000 °C for steels with Mo contents up to 3 %; a temperature of 1 020 °C for steels with Mo contents exceeding 3 %.

[d] Rapid cooling.

Table B.2 — Guidelines on the temperatures for hot forming and heat treatment [a] of austenitic-ferritic corrosion-resistant stainless steels

Designation		Hot forming		Heat treatment symbol	Solution annealing [b]	
Name	Line number of ISO/TS 15510:2003	Temperature °C	Type of cooling		Temperature °C	Type of cooling
X2CrNiN23-4	51	1 200 to 1 000	Air	+AT	950 to 1 050	Water, air [c]
X2CrNiMoN22-5-3	52	1 200 to 950			1 020 to 1 100	
X2CrNiMoCuN25-6-3	53	1 200 to 1 000			1 040 to 1 120	Water
X2CrNiMoN25-7-4	54	1 200 to 1 000			1 040 to 1 120	Water
X3CrNiMoN27-5-2	55	1 200 to 950			1 020 to 1 100	Water, air [c]
X2CrNiMoCuWN25-7-4	56	1 200 to 1 000			1 040 to 1 120	Water

[a] The temperatures of solution annealing shall be agreed upon for simulated heat-treated test pieces.
[b] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.
[c] Rapid cooling.

Table B.3 — Guidelines on the temperatures for hot forming and heat treatment [a] of ferritic corrosion-resistant stainless steels

Designation		Hot forming		Heat treatment symbol	Annealing	
Name	Line number of ISO/TS 15510:2003	Temperature °C	Type of cooling		Temperature [b] °C	Type of cooling
X6Cr17	67	1 100 to 800	Air	+A	750 to 850	Air
X7CrS17	68					
X6CrMo17-1	69					
X3CrNb17	73					
X2CrMoTiS18-2	74				1 000 to 1 050	

[a] The temperatures of annealing shall be agreed upon for simulated heat-treated test pieces.
[b] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.