INTERNATIONAL STANDARD

ISO 16143-2

Second edition
2014-05-15

Stainless steels for general purposes —

Part 2: Corrosion-resistant semi-finished products, bars, rods and sections

Aciers inoxydables pour usage général —

Partie 2: Demi-produits, barres, fils machine et profils en acier résistant à la corrosion

Reference number
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Contents

Page

Foreword

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

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

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 second edition cancels and replaces the first edition (ISO 16143-2:2004), which has been technically revised.

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

— *Part 1: Corrosion-resistant flat products*

— *Part 2: Corrosion-resistant semi-finished products, bars, rods and sections*

— *Part 3: Wire*

Stainless steels for general purposes —

Part 2: Corrosion-resistant semi-finished products, bars, rods and sections

1 Scope

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

NOTE 1 Throughout this part of ISO 16143, the term "general purposes" means purposes other than the special purposes mentioned in the Bibliography.

NOTE 2 Heat-resistant steel grades can be found in ISO 4955 and they can be used for corrosion-resistant purposes.

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

ISO 6892-1:2009, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

ISO 6929, *Steel products — Vocabulary*

ISO 9443, *Heat-treatable and alloy steels — Surface quality classes for hot-rolled round bars and wire rods — Technical delivery conditions*

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

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

ISO 15510, *Stainless steels — Chemical composition*

ISO 20723, *Structural steels — Surface condition of hot-rolled sections — Delivery requirements*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6929 and the following apply.

3.1
corrosion-resistant stainless steel
steel 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 form
shape of a product

Note 1 to entry: See ISO 6929 for different forms of products.

4 Designation

For the steel grades covered by this part of ISO 16143, the steel names as given in the tables are allocated in accordance with ISO/TS 4949.

For the steel grades covered by this part of ISO 16143, the steel numbers as given in the tables are allocated in accordance with ISO 15510.

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 part of ISO 16143. 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 C), the nominal dimensions, plus any choice of requirements;

d) the type of material (steel);

e) the number of this part of ISO 16143 (i.e. ISO 16143-2);

f) the steel name or steel number;

g) if, for the relevant steel in Tables 5 to 9 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 4);

i) if a verification of internal soundness is required, the requirements have to be agreed at the time of enquiry and order;

j) any further optional test agreed between the manufacturer and purchaser at the time of enquiry and order [see 8.2.3 b)];

k) the type of inspection document and its designation in accordance with ISO 10474 (see 8.2.1).

EXAMPLE 10 t round bar in accordance with ISO 1035-1 and ISO 1035-4 of 50 mm diameter made of a steel grade with name X5CrNi18-10 and number 4301-304-00-I as specified in ISO 16143-2 in process route 1D, inspection certificate 3.1 as specified in ISO 10474, is designated as follows:

10 t round bar ISO 1035-1 and -4 – 50
Steel ISO 16143-2 – X5CrNi18-10 + 1D
ISO 10474 – 3.1

or

10 t round bar ISO 1035-1 and -4 – 50
Steel ISO 16143-2 – 4301-304-00-I + 1D
ISO 10474 – 3.1

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, or

— 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 4 and, where different alternatives exist, to the treatment conditions given in Tables 5 to 9 (see also Annex A).

7.3 Chemical composition

7.3.1 The chemical composition requirements given in Table 2 apply with respect to the chemical composition of the cast analysis.

7.3.2 The product analysis can deviate from the limiting values for the cast analysis given in Table 2 by the values listed in Table 3.

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 5, 6, and 7 apply.

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 5 to 9 apply for the relevant specified heat-treatment condition. This does not apply to process route 1U (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 5 to 9 shall be obtainable from reference test pieces that have received the appropriate heat treatment (simulated heat treatment).

The values in Tables 10 to 14 apply for the 0,2 %- and 1 %-proof strength at elevated temperatures.

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 available surface finishes are given in Table 4. Slight surface imperfections, inherent to the production process, are permitted. Exact requirements concerning the maximum depth of acceptable discontinuities for bars, rods, and sections in the relevant conditions are given in Table 1.

Table 1 — Maximum depth of acceptable discontinuities for bars, rods, and sections

Conditions	Product forms	Permissible depth of discontinuities[a]	Max. % of delivered weight in excess of permissible depth of discontinuities
1U, 1C, 1E, 1D	Sections	To be agreed upon at the time of enquiry and order on the basis of ISO 20723.	
1U, 1C, 1E, 1D	Rounds and rod	Unless not specified otherwise at the time of enquiry and order, ISO 9443 class 1 za2.	
1X[b]	Rounds	— max. 0,2 mm for $d \leq 20$ mm — max. 0,01 d for 20 mm < $d \leq 75$ mm — max. 0,75 mm for $d > 75$ mm	1 %
	Hexagons	— max. 0,3 mm for $d \leq 15$ mm — max. 0,02 d for 15 mm < $d \leq 63$ mm	2 %
	Other bars	— max. 0,3 mm for $d \leq 15$ mm — max. 0,02 d for 15 mm < $d \leq 63$ mm	4 %
1G	Rounds	Technically defect free by manufacture.	0,2 %

[a] Depth of discontinuities is understood as being the distance, measured normally to the surface, between the bottom of the discontinuities and that surface.

[b] At the time of enquiry and order, it can be agreed that the product shall be delivered with a surface that is technically defect free by manufacture. In this case, also the maximum % of delivered weight in excess of permissible depth of discontinuities shall be agreed.

For further information, see Table 4.

7.7 Internal soundness

For internal soundness, where appropriate, any requirements, together with the conditions for their verification, can 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 C.

8 Inspection, testing, and conformance of products

8.1 General

The manufacturer shall carry out appropriate process control, inspection, and testing to ensure 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 Products complying with this part of ISO 16143 shall be ordered and delivered with one of the inspection documents as 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.

8.2.2 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 and

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 or 3.2 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 15 by an “m” and

b) the results of any optional test or inspections agreed upon when ordering marked in the second column of Table 15 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 15.

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 to 3.

The samples shall be taken from products in the as-delivered condition. If agreed, samples from bars can 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.

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 shall be carried out in accordance with ISO 6892-1 and it shall be performed under controlled conditions in accordance with Clause 5 of ISO 6892-1:2009.

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 can be agreed upon to determine the hardness instead.

If a tensile test at elevated temperature has been ordered, this shall be carried out in accordance with ISO 6892-2. If the proof strength is to be verified, the 0,2 %-proof strength shall be determined, for ferritic, martensitic, precipitation-hardening, and austenitic-ferritic steels. In the case of austenitic steels, the 0,2 %- and the 1 %-proof strength shall be determined.

8.4.3 If an impact test has been ordered, it shall be carried out in accordance with ISO 148-1 on test pieces with a V-notch and a 2 mm hammer. The average obtained from three test pieces is considered to be the test result (see also ISO 404).

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

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

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

8.5 Retests

See ISO 404.

9 Marking

9.1 The products shall be marked with the manufacturer's trademark or symbol and the steel name or number. The product shall also be marked with the cast number, thickness, or dimension, as well as an identification number related to an appropriate inspection certificate.

9.2 Unless otherwise agreed, the method of marking and the material of marking shall be at the option of the manufacturer. Its quality shall be such that it shall be durable for at least one year, can withstand normal handling, and can be stored in unheated storage under cover. The corrosion resistance of the product shall not be impaired by the marking.

9.3 Each unit shall be marked:

— for semi-finished 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;

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

Table 2 — Chemical composition (cast analysis)

Steel designation		% (mass fraction)[a]									
Name	ISO number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
Austenitic steels											
X10CrNi18-8	4310-301-00-I	0,05 to 0,15	2,00	2,00	0,045	0,030	16,0 to 19,0	0,80	6,0 to 9,5	0,10	—
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[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]
X2CrNiN18-9	4311-304-53-I	0,030	1,00	2,00	0,045	0,030	17,5 to 19,5	—	8,0 to 10,0	0,12 to 0,22	—
X3CrNiCu18-9-4	4567-304-30-I	0,04	1,00	2,00	0,045	0,030	17,0 to 19,0	—	8,0 to 10,5	0,10	Cu: 3,0 to 4,0
X6CrNiCuS18-9-2	4570-303-31-I	0,08	1,00	2,00	0,045	≥0,15	17,0 to 19,0	0,60	8,0 to 10,0	0,10	Cu: 1,40 to 1,80
X5CrNiN19-9	4315-304-51-I	0,08	1,00	2,50	0,045	0,030	18,0 to 20,0	—	7,0 to 10,5	0,10 to 0,30	—[d]
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[b]	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[b]	—	Ti: 5 × C to 0,70
X6CrNiNb18-10	4550-347-00-I	0,08	1,00	2,00	0,045	0,030	17,0 to 19,0	—	9,0 to 12,0[b]	—	Nb: 10 × C to 1,00
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[b]	0,10	—
X6CrNi18-12	4303-305-00-I	0,08	1,00	2,00	0,045	0,030	17,0 to 19,0	—	10,5 to 13,0	0,10	—

Table 2 — *(continued)*

Steel designation		% (mass fraction)[a]									
Name	ISO number	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
X8CrMnCuN17-8-3	4597-204-76-I	0,10	2,00	6,5 to 9,0	0,040	0,030	15,0 to 18,0	1,00	3,00	0,10 to 0,30	Cu: 2,00 to 3,5
X3CrMnNiCu15-8-5-3g	4615-201-75-Eg	0,030	1,00	7,0 to 9,0	0,040	0,010	14,0 to 16,0	0,80	4,5 to 6,0	0,02 to 0,06	Cu: 2,0 to 4,0
X12CrMnNiN18-9-5	4373-202-00-I	0,15	1,00	7,5 to 10,0	0,060	0,030	17,5 to 19,0	—	4,0 to 6,0	0,15 to 0,30	—
X11CrNiMnN19-8-6	4369-202-91-I	0,07 to 0,15	0,50 to 1,00	5,0 to 7,5	0,030	0,015	17,5 to 19,5	—	6,5 to 8,5	0,20 to 0,30	—
X1CrNi25-21	4335-310-02-I	0,020	0,25	2,00	0,025	0,010	24,0 to 26,0	0,20	20,0 to 22,0	0,10	—
Austenitic steels with Mo											
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[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[b]	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[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[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[b]	0,10	—
X2CrNiMoN17-12-3	4429-316-53-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[b]	0,12 to 0,22	—
X2CrNiMo18-14-3	4435-316-91-I	0,030	1,00	2,00	0,045	0,015	17,0 to 19,0	2,50 to 3,00	12,5 to 15,0	0,10	—
X2CrNiMoN18-12-4	4434-317-53-I	0,030	1,00	2,00	0,045	0,030	16,5 to 19,5	3,0 to 4,0	10,5 to 14,0[b]	0,10 to 0,20	—
X2CrNiMoN17-13-5	4439-317-26-E	0,030	1,00	2,00	0,045	0,015	16,5 to 18,5	4,0 to 5,0	12,5 to 14,5	0,12 to 0,22	—
X1CrNiMoCuN20-18-7	4547-312-54-I	0,020	0,70	1,00	0,035	0,015	19,5 to 20,5	6,0 to 7,0	17,5 to 18,5	0,18 to 0,25	Cu: 0,50 to 1,00