INTERNATIONAL STANDARD

ISO 16143-3

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Stainless steels for general purposes —

Part 3: **Wire**

Aciers inoxydables pour usage général —

Partie 3: Fil

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 16143-3 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 3: Wire

1 Scope

This part of ISO 16143 specifies requirements for stainless steel wire for common use for which no product standard exists. It includes round, flat and shaped wire (such as square, hexagonal or rectangular wire), made of the most commonly used types of stainless steels for general corrosion resistance and high-temperature service. The wire may be supplied in coils or in straightened and cut lengths.

NOTE Steel wire made of corrosion resistant stainless steel is manufactured from steels mentioned in ISO 16143-2, and steel wire intended for high-temperature purposes is manufactured from steels mentioned in ISO 4955.

Excluded from this part of ISO 16143 are

— wire for cold heading;

— welding wire, and

— any wire for which a specific product standard exists.

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 404:1992, *Steel and steel products — General technical delivery requirements*

ISO/TS 4949:2003, *Steel names based on letter symbols*

ISO 4955:2005, *Heat-resistant steels*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis*

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

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 16143-2:2004, *Stainless steels for general purposes — Part 2: Semi-finished products, bars, rods and sections*

3 Terms and definitions

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

3.1
stainless steel
steel with at least 10,5 % Cr and maximum 1,2 % C

3.2
wire
cold-worked product generally of constant cross-section throughout its length, the dimensions of the section being very small compared with the length

NOTE 1 The cold working is accomplished by drawing rod through a reducing die or by passing under pressure between driven rolls and recoiling the drawn product. The cross-section is generally circular, sometimes oval, rectangular, square, hexagonal, octagonal or another shape (other than strip).

NOTE 2 Adapted from the definition in ISO 6929:1987.

4 Designation

4.1 The steel names given in the relevant tables are in accordance with ISO/TS 4949.

4.2 The standard designation for wire in accordance with this part of ISO 16143 shall state, in the following order:

— the term “wire” or “straightened and cut wire”;

— the diameter or, for non-round wire, the characteristic dimension;

— the tolerances in accordance with Table 5, (N) for normal tolerances and (R) for restricted tolerances;

— for non-round wire, the desired tolerances on dimensions;

— the number of this part of ISO 16143 (ISO 16143-3);

— the designation of the steel grade and the standard manufacturing condition of the wire (see 6.2);

— the tensile-strength level in accordance with Table 4 (for hard-drawn wire).

EXAMPLE Round stainless steel wire 1,50 mm, normal tolerance (N) in accordance with Table 5 of ISO 16143-3, steel grade X6CrNi18-12 (line 8), standard manufacturing condition +AT:

Wire 1,50 N
ISO 16143-3 – X6CrNi18-12 +AT

5 Information to be supplied by the purchaser

The purchaser shall clearly state, at the time of ordering, the following information:

— the desired quantity;

— the designation for wire (see 4.2);

— the type of coiling;

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

EXAMPLE 1 2 t stainless steel wire of 2,00 mm diameter with normal tolerances (N), of a steel grade X20Cr13 (line 84), as specified in ISO 16143-3, standard manufacturing condition +A, in coils of about 500 kg, inspection document 3.1.B as specified in ISO 10474:

2 t wire 2,00 N
ISO 16143-3 – X20Cr13+A in coils of about 500 kg
inspection document ISO 10474 - 3.1.B

EXAMPLE 2 5 t stainless steel wire of 3,00 mm diameter with restricted tolerances (R), of a steel grade X6CrNi18-12 (line 8), as specified in ISO 16143-3, hard drawn with a tensile strength 1 600–1 900 MPa, on spools of about 300 kg, inspection document 3.1.B as specified in ISO 10474

5 t wire 3,00 R
ISO 16143-3 – X6CrNi18-12+C1600 on spools of about 300 kg
inspection document ISO 10474 - 3.1.B

6 Manufacturing conditions

6.1 General

If not stated otherwise, the manufacturing procedure is at the discretion of the manufacturer.

6.2 Treatment conditions

The wire shall be specified in one of the following conditions, depending on the structure.

Condition +A: The wire is annealed as final heat treatment. Note that this material may be slightly deformed by straightening, cold work, size control or finish. This will result in a slight increase of the tensile strength.

Condition +AT: The wire is solution annealed as final heat treatment. Note that this material may be slightly deformed by straightening, cold work, size control or finish. This will result in a slight increase of the tensile strength.

Condition +C: The wire is hard drawn as the last operation, in order to achieve higher strength.

6.3 Surface finish

If not specified otherwise, the surface finish of the wire is one of the following, depending on previous processing steps.

6.3.1 Cold drawn

This is the natural finish resulting from the drawing to final size, generally with cold-drawing lubricant left on. The finish will be duller for dry drawn wire or shinier for wire that is wet drawn. Fine sizes are commonly wet drawn, whereas coarser sizes are commonly dry drawn. Special bright finishes, lubricant removal etc. required for special end-use must be negotiated with the manufacturer.

6.3.2 Annealed

A dull matt appearance, necessarily associated with the dead soft condition of annealed wire when no final drawing is permitted. With an additional surface treatment, a bright appearance can be realized.

6.3.3 Polished finish

A smooth and uniform bright finish of cold processed (+C) material obtained by mechanical smoothing, burnishing, abrading or grinding.

7 Requirements

7.1 Manufacturing process

The steel-making process for products according to this part of ISO 16143 shall be in accordance with ISO 4955 and ISO 16143-2. The wire processing, insofar as it is not specified in this part of ISO 16143 or agreed between the parties, shall be at the discretion of the wire drawer.

7.2 Delivery condition

The product shall be supplied as described in Clause 6 and agreed in the order.

7.3 Chemical analysis

7.3.1 Cast analysis

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

7.3.2 Product analysis

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 Mechanical properties

7.4.1 Mechanical properties for annealed wire

The tensile strength and elongation shall satisfy the requirements of Table 3. It specifies the mechanical properties at room temperature in the annealed condition. For ferritic and martensitic steels, this is in the condition +A; for austenitic, austenitic-ferritic and precipitiation-hardening steels, the wire is in the condition +AT.

7.4.2 Mechanical properties of hard-drawn wire

This wire is in condition (+C). The tensile strength will depend on the degree of work hardening, the specific type of steel and the processing of the material. The tensile strength is specified by a minimum and maximum. Not all the tensile strength levels listed in Table 4 can be achieved for all steel grades. Therefore, the required tensile-strength level shall be agreed between the manufacturer and the purchaser at the time of ordering.

Table 4 gives an overview of the standardized tensile-strength levels and the corresponding minimum and maximum.

7.5 Tolerances on dimension

For round wire, the purchaser shall specify normal tolerance (N) or restricted tolerance (R), as defined in Table 5. For non-round wire, tolerances shall be agreed upon at the time of ordering.

The out of roundness is the difference between the largest and the smallest diameter in the same cross-section of the wire. The cross-section shall be perpendicular to the longitudinal wire axis. The out-of-roundness shall not exceed half the total diameter tolerance specified for coils.

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.

8.2 Inspection and testing procedures and types of inspection documents

8.2.1 For each delivery, the issue of any inspection document according to ISO 10474 may be agreed upon at the time of ordering.

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

a) the 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 of 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 tests of Table 6;

b) the results of any optional test or inspection agreed when ordering.

8.3 Specific inspection and testing

8.3.1 Extent of testing

The tests to be carried out, 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 6.

8.3.2 Selection and preparation of samples and test pieces

The general conditions for selection and preparation of samples and test pieces shall be in accordance with ISO 14284. The samples shall be taken from products in the delivery condition.

8.4 Test methods

8.4.1 Product analysis

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, where possible, with reference to ISO/TR 9769.

8.4.2 Tensile test

The tensile test shall be performed in accordance with ISO 6892. The tensile strength (R_m) shall be measured and, for annealed material only, the elongation (A).

8.4.3 Measurement of the wire diameter

The diameter of the round wire shall be measured in a cross-section perpendicular to the wire axis with a micrometer of appropriate precision. Any dimensional measurement methods to be used on non-round wire shall be agreed upon at the time of ordering.

8.5 Retests

Retests shall be in accordance with ISO 404.

9 Marking

Each unit shall be marked. The labels shall withstand normal handling; they shall show the information listed below:

a) designation;

b) the name of the manufacturer;

c) the nominal size;

d) the cast number;

e) the steel grade;

f) the manufacturing condition of the wire;

g) the identification number;

h) the tensile level (for hard-drawn wire).

10 Packing

Each unit shall be marked and identified so as to permit traceability and reference to the inspection document.

Packing shall be such that it permits normal handling and shipping without damage. The dimensions of the units shall be agreed between the manufacturer and the purchaser at the time of ordering.

Table 1 — Chemical composition (cast analysis) for austenitic, austenitic-ferritic, ferritic, martensitic and precipitation hardening stainless steels

Designation		% (mass fraction)									
Steel name	Line number	C	Si max.	Mn max.	P max.	S max.	N	Cr	Mo	Ni	Others
Austenitic steels											
X2CrNi18-9	1	⩽ 0,030	1,00	2,00	0,045	0,030	⩽ 0,11	17,5 to 19,5	—	8,0 to 10,0 [a]	—
X2CrNi19-11	2	⩽ 0,030	1,00	2,00	0,045	0,030	⩽ 0,11	18,0 to 20,0	—	10,0 to 12,0 [a]	—
X5CrNi18-9	6	⩽ 0,07	1,00	2,00	0,045	0,030	⩽ 0,11	17,5 to 19,5	—	8,0 to 10,5	—
X7CrNi18-9	H10 [b]	0,04 to 0,10	1,00	2,00	0,045	0,030	—	17,0 to 19,0	—	8,0 to 11,0	—
X6CrNi18-12	8	⩽ 0,08	1,00	2,00	0,045	0,030	⩽ 0,11	17,0 to 19,0	—	10,5 to 13,0	—
X5CrNiN19-9	10	⩽ 0,07	1,00	2,50	0,045	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	2,00	2,00	0,045	0,030	⩽ 0,11	16,0 to 19,0	⩽ 0,80	6,0 to 9,5	—
X1CrNi25-21	12	⩽ 0,020	0,25	2,00	0,025	0,010	⩽ 0,11	24,0 to 26,0	⩽ 0,20	20,0 to 22,0	—
X10CrNiS18-9	14	⩽ 0,12	1,00	2,00	0,060	⩾ 0,15	⩽ 0,11	17,0 to 19,0	—	8,0 to 10,0	Cu: ⩽ 1,00
X3CrNiCu18-9-4	15	⩽ 0,040	1,00	2,00	0,045	0,030	⩽ 0,11	17,0 to 19,0	—	8,0 to 10,5	Cu: 3,0 to 4,0
X6CrNiTi18-10	16	⩽ 0,08	1,00	2,00	0,045	0,030	—	17,0 to 19,0	—	9,0 to 12,0 [a]	Ti: 5xC to 0,70
X2CrNiMo17-12-2	21	⩽ 0,030	1,00	2,00	0,045	0,030	⩽ 0,11	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0 [a]	—
X2CrNiMo17-12-3	22	⩽ 0,030	1,00	2,00	0,045	0,030	⩽ 0,11	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 [a]	—
X2CrNiMo18-14-3	23	⩽ 0,030	1,00	2,00	0,045	0,015	⩽ 0,11	17,0 to 19,0	2,50 to 3,00	12,5 to 15,0	—
X2CrNiMoN18-12-4	27	⩽ 0,030	1,00	2,00	0,045	0,030	0,10 to 0,20	16,5 to 19,5	3,0 to 4,0	10,5 to 14,0 [a]	—
X1CrNiMoN25-22-2	29	⩽ 0,020	0,70	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	⩽ 0,07	1,00	2,00	0,045	0,030	⩽ 0,11	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0	—

Table 1 (*continued*)

Designation		% (mass fraction)									
Steel name	**Line number**	**C**	**Si** max.	**Mn** max.	**P** max.	**S** max.	**N**	**Cr**	**Mo**	**Ni**	**Others**
Austenitic steels											
X3CrNiMo17-12-3	31	⩽ 0,05	1,00	2,00	0,045	0,030	⩽ 0,11	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0 [a]	—
X6CrNiMoTi17-12-2	32	⩽ 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 [a]	Ti: 5xC to 0,70
X1CrNiMoCuN20-18-7	34	⩽ 0,020	0,70	1,00	0,035	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	⩽ 0,020	0,75	2,00	0,035	0,015	⩽ 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	⩽ 0,020	0,70	2,00	0,030	0,010	⩽ 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	⩽ 0,020	0,75	2,00	0,035	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
X8CrMnNiN18-9-5	39	0,05 to 0,10	0,30 to 0,60	9,0 to 10,0	0,035	0,030	0,25 to 0,32	17,5 to 18,5	⩽ 0,50	5,0 to 6,0	Cu: ⩽ 0,40
X8CrMnCuN17-8-3	40	⩽ 0,10	2,00	6,5 to 8,5	0,040	0,030	0,15 to 0,30	16,0 to 18,0	⩽ 1,00	⩽ 2,00	Cu: 2,00 to 3,5
X7CrNiSiNCe21-11	H14 [b]	0,05 to 0,10	1,40 to 2,00	0,80	0,040	0,030	0,14 to 0,20	20,0 to 22,0	—	10,0 to 12,0	Ce: 0,03 to 0,08
X12CrNi23-13	H15 [b]	⩽ 0,15	1,00	2,00	0,045	0,015	⩽ 0,11	22,0 to 24,0	—	12,0 to 14,0	—
X8CrNi25-21	H16 [b]	⩽ 0,10	1,50	2,00	0,045	0,015	⩽ 0,11	24,0 to 26,0	—	19,0 to 22,0	—
X8NiCrAlTi32-21	H17 [b]	0,05 to 0,10	1,00	1,50	0,015	0,015	—	19,0 to 23,0	—	30,0 to 34,0	Al: 0,15 to 0,60 Ti: 0,15 to 0,60 Cu: ⩽ 0,70
X11CrNiMnN19-8-6	43	0,07 to 0,15	0,50 to 1,00	5,0 to 7,5	0,030	0,015	0,20 to 0,30	17,5 to 19,5	—	6,5 to 8,5	—
X6CrNiCuS18-9-2	44	⩽ 0,08	1,00	2,00	0,045	⩾ 0,15	⩽ 0,11	17,0 to 19,0	⩽ 0,60	8,0 to 10,0	Cu: 1,40 to 1,80
Austenitic-ferritic (duplex) steels											
X2CrNiN23-4	51	⩽ 0,030	1,00	2,00	0,035	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	⩽ 0,030	1,00	2,00	0,035	0,015	0,10 to 0,22	21,0 to 23,0	2,5 to 3,5	4,5 to 6,5	—
X2CrNiMoN25-7-4	54	⩽ 0,030	1,00	2,00	0,035	0,015	0,24 to 0,35	24,0 to 26,0	3,0 to 4,5	6,0 to 8,0	—

Table 1 (*continued*)

Designation		% (mass fraction)									
Steel name	**Line number**	**C**	**Si** max.	**Mn** max.	**P** max.	**S** max.	**N**	**Cr**	**Mo**	**Ni**	**Others**
Ferritic steels											
X6Cr17	67	⩽ 0,08 [c]	1,00	1,00	0,040	0,030	—	16,0 to 18,0	—	—	—
X7CrS17	68	⩽ 0,09	1,50	1,50	0,040	⩾ 0,15	—	16,0 to 18,0	⩽ 0,60	—	—
X6CrMo17-1	69	⩽ 0,08	1,00	1,00	0,040	0,030	—	16,0 to 18,0	0,90 to 1,40	—	—
X3CrNb17	73	⩽ 0,05	1,00	1,00	0,040	0,015	—	16,0 to 18,0	—	—	Nb: 12xC to 1,00
X15CrN26	H7[b]	⩽ 0,20	1,00	1,00	0,040	0,030	0,15 to 0,25	24,0 to 28,0	—	⩽ 1,00	—
X2CrMoTiS18-2	74	⩽ 0,030	1,00	0,50	0,040	⩾ 0,15	—	17,5 to 19,0	2,00 to 2,50	—	Ti: 0,30 to 0,80 (C+N): ⩽ 0,040
Martensitic steels											
X12Cr13	82	0,08 to 0,15	1,00	1,50	0,040	0,030	—	11,5 to 13,5	—	⩽ 0,75	—
X12CrS13	83	0,08 to 0,15	1,00	1,50	0,040	⩾ 0,15	—	12,0 to 14,0	⩽ 0,60	—	—
X20Cr13	84	0,16 to 0,25	1,00	1,50	0,040	0,030	—	12,0 to 14,0	—	—	—
X30Cr13	85	0,26 to 0,35	1,00	1,50	0,040	0,030	—	12,0 to 14,0	—	—	—
X14CrS17	90	0,10 to 0,17	1,00	1,50	0,040	⩾ 0,15	—	16,0 to 18,0	⩽ 0,60	—	—
X17CrNi16-2	91	0,12 to 0,22	1,00	1,50	0,040	0,030	—	15,0 to 17,0	—	1,50 to 2,50	—
Precipitation hardening steels											
X7CrNiAl17-7	102	⩽ 0,09	0,70	1,00	0,040	0,015	—	16,0 to 18,0	—	6,5 to 7,8	Al: 0,70 to 1,50

NOTE All of the grades defined in TS 15510 may be used for the production of wire for general application. The mechanical properties shall be agreed upon at the time of ordering.

[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 by the following amounts:

by 0,50 % for steels in lines 1 and 32;

by 1,00 % for steels in lines 2, 16, 27 and 31;

by 1,50 % for steels in lines 21 and 22.

[b] In accordance with ISO 4955.

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

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	+ 0,005
	> 0,030	⩽ 0,20	± 0,01
	> 0,20	⩽ 0,35	± 0,02
Silicon		⩽ 1,00	± 0,04
	> 1,00	⩽ 2,00	± 0,07
Manganese		⩽ 1,00	+ 0,04
	> 1,00	⩽ 2,00	± 0,07
	> 2,00	⩽ 10,0	± 0,10
Phosphorus		⩽ 0,060	+ 0,005
Sulfur		⩽ 0,015	+ 0,003
	> 0,015	⩽ 0,030	± 0,005
	⩾ 0,15		− 0,02
Nitrogen	⩾ 0,03	⩽ 0,11	± 0,01
	> 0,11	⩽ 0,35	± 0,02
Chromium	⩾ 10,5	⩽ 28,0	± 0,20
Molybdenum		⩽ 0,60	± 0,03
	> 0,60	⩽ 1,75	± 0,07
	> 1,75	⩽ 7,0	± 0,10
Nickel		⩽ 1,00	+ 0,04
	> 1,00	⩽ 5,0	± 0,10
	> 5,0	⩽ 34,0	± 0,20
Aluminium	⩾ 0,15	⩽ 1,50	± 0,10
Cerium		⩽ 0,08	± 0,01
Copper		⩽ 1,00	± 0,04
	> 1,00	⩽ 4,0	± 0,10
Niobium		⩽ 1,00	± 0,05
Titanium		⩽ 0,80	± 0,03

[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 — Mechanical properties at room temperature for steel grades in the form of round wire [a] in the solution annealed (+AT) or annealed (+A) condition

Name	Line number	Wire diameter [b] mm	R_m [c] max. MPa *	Elongation [c, d] min. %
Austenitic steels (+AT)				
All austenitic steels except X3CrNiCu18-9-4 and X8CrMnCuN17-8-3		$0{,}050 < d \leqslant 0{,}10$ $0{,}10 < d \leqslant 0{,}20$ $0{,}20 < d \leqslant 0{,}50$ $0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	1 100 1 070 1 020 970 920 870 820	20 20 30 30 30 35 35
X3CrNiCu18-9-4 X8CrMnCuN17-8-3	15 40	$0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	850 820 780 750	30 30 35 35
Austenitic-ferritic (duplex) steels (+AT)				
All austenitic-ferritic steels		$0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	1 050 1 000 950 900	20 20 25 25
Ferritic steels (+A)				
All ferritic steels		$0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	850 800 760 740	15 15 15 20
Martensitic steels (+A)				
X12Cr13 X12CrS13	82 83	$0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	950 900 840 800	10 10 10 15
X20Cr13 X30Cr13 X14CrS17 X17CrNi16-2	84 85 90 91	$0{,}50 < d \leqslant 1{,}00$ $1{,}00 < d \leqslant 3{,}00$ $3{,}00 < d \leqslant 5{,}00$ $5{,}00 < d \leqslant 16{,}00$	1 000 950 920 850	10 10 10 15
Precipitation hardening steel (+AT)				
X7CrNiAl17-7	102		850	

a Properties for non-round wire to be agreed upon at the time of ordering.

b Other sizes may be specified, after agreement between the manufacturer and the purchaser at the time of ordering.

c Without skin pass.

d For $d < 4$ mm, the gauge length shall be 100 mm, and

for $d \geqslant 4$ mm, the gauge length shall be $5 \times d$.

* 1 MPa = 1 N/mm^2

Table 4 — Tensile-strength levels and corresponding tensile-strength ranges

Steel grades	Tensile-strength level	Range of tensile strength MPa *
Austenitic steels	+C600	600-800
	+C700	700-900
	+C800	800-1 000
	+C900	900-1 100
	+C1 000	1 000-1 250
	+C1 100	1 100-1 350
	+C1 200	1 200-1 450
	+C1 400	1 400-1 650
	+C1 600	1 600-1 900
	+C1 800	1 800-2 100
	+C2 000	2 000-2 300
Austenitic-ferritic (duplex) steels	+C700	700-900
	+C800	800-1 000
	+C1 000	1 000-1 250
	+C1 200	1 200-1 450
	+C1 400	1 400-1 650
	+C1 600	1 600-1 900
	+C1 800	1 800-2 100
	+C2 000	2 000-2 300
Ferritic and martensitic steels	+C500	500-700
	+C600	600-800
	+C700	700-900
	+C800	800-1000
	+C900	900-1 100
	+C1 000	1 000-1 250
Precipitation hardening steels	a	a

a Not relevant.

* 1 MPa = 1 N/mm^2

Table 5 — Size tolerance for round wire

Dimensions in millimetres

Diameter d	Normal tolerances (N)			Restricted tolerances (R)		
	Wire in coils	Wire in cut lengths		Wire in coils	Wire in cut lengths	
		Minus tolerance	Plus tolerance		Minus tolerance	Plus tolerance
$0{,}050 < d \leqslant 0{,}070$	± 0,003	0,003	—	± 0,002	0,002	—
$0{,}070 < d \leqslant 0{,}10$	± 0,004	0,004	—	± 0,003	0,003	—
$0{,}10 < d \leqslant 0{,}16$	± 0,005	0,005	—	± 0,004	0,004	—
$0{,}16 < d \leqslant 0{,}25$	± 0,006	0,006	0,008	± 0,004	0,004	0,006
$0{,}25 < d \leqslant 0{,}40$	± 0,008	0,008	0,010	± 0,006	0,006	0,010
$0{,}40 < d \leqslant 0{,}60$	± 0,010	0,010	0,015	± 0,008	0,008	0,010
$0{,}60 < d \leqslant 0{,}70$	± 0,010	0,010	0,015	± 0,008	0,008	0,015
$0{,}70 < d \leqslant 0{,}80$	± 0,015	0,015	0,020	± 0,010	0,010	0,020
$0{,}80 < d \leqslant 1{,}00$	± 0,015	0,015	0,025	± 0,010	0,010	0,020
$1{,}00 < d \leqslant 1{,}20$	± 0,020	0,020	0,030	± 0,015	0,015	0,025
$1{,}20 < d \leqslant 1{,}60$	± 0,020	0,020	0,035	± 0,015	0,015	0,030
$1{,}60 < d \leqslant 1{,}70$	± 0,030	0,030	0,040	± 0,015	0,015	0,030
$1{,}70 < d \leqslant 2{,}40$	± 0,030	0,030	0,050	± 0,015	0,015	0,035
$2{,}40 < d \leqslant 2{,}80$	± 0,030	0,030	0,060	± 0,015	0,015	0,040
$2{,}80 < d \leqslant 3{,}50$	± 0,040	0,040	0,070	± 0,020	0,020	0,050
$3{,}50 < d \leqslant 4{,}50$	± 0,040	0,040	0,080	± 0,020	0,020	0,060
$4{,}50 < d \leqslant 5{,}00$	± 0,040	0,040	0,090	± 0,020	0,020	0,070
$5{,}00 < d \leqslant 5{,}50$	± 0,050	0,050	0,100	± 0,025	0,025	0,080
$5{,}50 < d \leqslant 6{,}35$	± 0,050	0,050	0,110	± 0,025	0,025	0,090
$6{,}35 < d \leqslant 6{,}50$	± 0,050	0,050	0,110	± 0,030	0,030	0,090
$6{,}50 < d \leqslant 7{,}50$	± 0,050	0,050	0,120	± 0,030	0,030	0,100
$7{,}50 < d \leqslant 9{,}00$	± 0,050	0,050	0,130	± 0,030	0,030	0,110
$9{,}00 < d \leqslant 11{,}00$	± 0,060	0,060	0,150	± 0,035	0,035	0,130
$11{,}00 < d \leqslant 12{,}00$	± 0,060	0,060	0,180	± 0,035	0,035	0,150
$12{,}00 < d \leqslant 16{,}00$	± 0,070	0,070	0,200	± 0,040	0,040	0,170

Table 6 — Tests to be carried out, test units and extent of testing in specific testing

Test	Test unit	Product per test unit	Number of samples per product	Number of test pieces per sample
Chemical analysis	Cast	The cast analysis is given by the manufacturer [a]		
Tensile test at room temperature	Batch [b]	10 % [c]	1	1

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

[b] Each batch consists of products coming from the same cast. The products must have been subject 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 intermission 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 areas shall be equal to or less than three.

[c] 10 % of the wire units in the production batch, at least 2 but no more than 10 coils.

Bibliography

[1] ISO 4954:1993, *Steels for cold heading and cold extruding*

[2] ISO 6929:1987, *Steel products — Definitions and classification*

[3] ISO 6931-1:1994, *Stainless steels for springs — Part 1: Wire*

[4] ISO/TS 15510:2003, *Stainless steels — Chemical composition*

[5] ISO 16143-1:2004, *Stainless steels for general purposes — Part 1: Flat products*

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