SLOVENSKI STANDARD
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Stainless steels for springs - Part 1: Wire (ISO 6931-1:2016)

Nichtrostende Stähle für Federn - Teil 1: Draht (ISO 6931-1:2016)

Aciers inoxydables pour ressorts - Partie 1: Fils (ISO 6931-1:2016)

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ICS:

77.140.25	Vzmetna jekla	Spring steels
77.140.65	Jeklene žice, jeklene vrvi in verige	Steel wire, wire ropes and link chains

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INTERNATIONAL STANDARD

ISO 6931-1

Third edition
2016-05-15

Stainless steels for springs —

Part 1: Wire

Aciers inoxydables pour ressorts —

Partie 1: Fils

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.

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 third edition cancels and replaces the second edition (ISO 6931-1:1994), which has been technically revised.

ISO 6931 consists of the following parts, under the general title *Stainless steels for springs*:

— *Part 1: Wire*

— *Part 2: Narrow strip*

Stainless steels for springs —

Part 1:
Wire

1 Scope

This part of ISO 6931 specifies the grades of stainless steels which are generally used in the cold drawn condition in the form of wire of circular cross-section up to 10,00 mm in diameter, for the production of springs and spring parts exposed to corrosive effects and sometimes to slightly increased temperatures (see Annex A).

Certain steel grades covered by ISO 16143-2 are also used for springs, although to a much lesser extent. In these cases, the mechanical properties (tensile strength, etc.) will be agreed between purchaser and supplier. Similarly, diameters between 10,00 mm and 15,00 mm can be ordered according to the specifications of this part of ISO 6931, in which case the parties will agree upon the required mechanical characteristics.

In addition to the specifications of this part of ISO 6931, the general technical delivery requirements of ISO 404 are applicable.

2 Normative references

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

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

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

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

ISO 15510, *Stainless steels — Chemical composition*

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

ISO 22034-1, *Steel wire and wire products — Part 1: General test methods*

ISO 22034-2, *Steel wire and wire products — Part 2: Tolerances on wire dimensions*

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

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

3 Information to be supplied by the purchaser

The purchaser shall clearly state in his enquiry or order the product and following information:

a) the desired quantity;

b) the term spring steel wire or straightened and cut lengths;

c) the number of this part of ISO 6931: ISO 6931-1;

d) the steel grade (see Table 1) and for grade 4301-304-00-I, 4310-301-00-I and 4462-318-03-I also the tensile strength level (see Table 2);

e) the nominal wire diameter and the class for the diameter tolerance (see Table 5) and additional for cut length the length and the length tolerance class (see Table 6);

f) the surface finish (see 4.3, i.e. coating);

g) the form of delivery (see 4.2);

h) the type of inspection document to be supplied (see 5.1);

i) any particular agreement made.

EXAMPLE 2 t stainless steel spring wire according to this part of ISO 6931, grade 4310-301-00-I, normal tensile strength level and nominal diameter 2,50 mm, diameter tolerance class T15, in coils with inspection document 3.1 according to ISO 10474:

2 t spring steel wire ISO 6931-1 – 4310-301-00-I – NS – 2,50 T15 – in coils, ISO 10474 – 3.1

4 Requirements

4.1 Manufacturing process

Unless otherwise agreed in the order, the manufacturing process used in the making of the stainless steel wire is left to the discretion of the manufacturer. The starting condition (+AT: solution annealed) of the wire (rod) is specified in ISO 16143-2.

4.2 Form of delivery

The wire shall be supplied in coils, on spools, on coreless spools or on carriers. Several coils may be assembled on a carrier. Unless otherwise specified, the form of delivery shall be at the manufacturer's discretion. They shall, however, inform the purchaser about the form of delivery.

The delivery requirements are specified in 4.7. Wire in straight lengths is normally supplied in bundles.

4.3 Surface finish

The wire may be coated or not. The specific coating and finish for stainless steel spring wire shall be agreed upon at the time of enquiry and order, e. g. uncoated, polished finish, nickel coated.

4.4 Chemical composition

4.4.1 The requirements for the chemical composition given in Table 1 apply to the cast analysis.

4.4.2 The permissible deviation of the product analysis from the values specified in Table 1 shall be in accordance with the provision in ISO 16143-2. For a single heat, the deviation of an element in the product analysis may be only below the minimum or only above the maximum value of the range specified for the heat analysis but not both at the same time.

Table 1 — Chemical composition (cast analysis)

Steel grade		% by mass [a, b]								
Name[c]	Number[c]	C	Si	Mn	P	S	Cr	Mo	Ni	Other elements
Austenitic steels										
X10CrNi18-8	4310-301-00-I	0,05 to 0,15	2,00	2,00	0,045	0,015[f]	16,0 to 19,0	0,80	6,0 to 9,5	N: 0,10
X9CrNi18-9	4325-302-00-E	0,030 to 0,15	1,00	2,00	0,045	0,030	17,0 to 19,0	-	8,0 to 10,0	N: 0,10
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	N: 0,10 to 0,30 Nb: 0,15
X5CrNi18-10	4301-304-00-I	0,07	1,00	2,00	0,045	0,015[f]	17,5 to 19,5	-	8,0 to 10,5	N: 0,10
X5CrNiMo17-12-2[d]	4401-316-00-I[d]	0,07	1,00	2,00	0,045	0,015[f]	16,5 to 18,5	2,00 to 3,0	10,0 to 13,0	N: 0,10
X1NiCrMoCu25-20-5	4539-089-04-I	0,020	0,75	2,00	0,035	0,015	19,0 to 22,0	4,0 to 5,0	23,5 to 26,0	N: 0,15 Cu: 1,20 to 2,00
Austenitic-ferritic (duplex) steel										
X2CrNiMoN22-5-3	4462-318-03-I	0,030	1,00	2,00	0,035	0,015	21,0 to 23,0	2, 50 to 3,5	4,5 to 6,5	N: 0,10 to 0,22
Precipitation hardening steel										
X7CrNiAl17-7	4568-177-00-I	0,09	0,70	1,00	0,040	0,015	16,0 to 18,0	-	7,0 to 8,5[e]	Al: 0,70 to 1,50

[a] Maximum values unless indicated otherwise.

[b] Alternative compositions may be used by agreement.

[c] "Name" and "Number" are derived in accordance with ISO/TS 4949 and ISO 15510, respectively.

[d] Steel 4436-316-00-I may be used to provide increased corrosion resistance compared with 4401-316-00-I, with the specification of this part of ISO 6931-1 applicable for steel 4401-316-00-I.

[e] In ISO 15510 and ISO 16143, this steel grade is given with 6,5 % to 7,8 % Ni; for spring application, these values are raised to the values in the table.

[f] These steels are given in ISO 15510 and ISO 16143 with S max. 0,030; for spring application, this value is diminished to the value in the table.

4.5 Mechanical properties

4.5.1 For the tensile strength in the as drawn condition, the data of Table 2 shall apply.

Table 2 — Tensile strength in the as drawn condition

Nominal diameter mm[f]	Tensile strength (MPa) [a b c d e f] for the following steel grades																			
	4310-301-00-I				4325-302-00-E 4315-304-51-I		4301-304-00-I			4401-316-00-I		4539-089-04-I		4462-318-03-I				4568-177-00-I[g]	
	Normal tensile strength (NS)		High tensile strength (HS)				Normal tensile strength (NS)	High tensile strength (HS)						Normal tensile strength (NS) -		High tensile strength (HS) -			
	min.	max.	min.	max.	min.	max.	min.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
$d \leq 0{,}20$	2 200	2 530	2 350	2 710	2 150	2 400	2 000	2 150	2 300	1 725	1 990	1 600	1 840	2 150	2 480	2 370	2 730	1 975	2 280
$0{,}20 < d \leq 0{,}30$	2 150	2 480	2 300	2 650	2 050	2 300	1 975	2 050	2 280	1 700	1 960	1 550	1 790	2 100	2 420	2 370	2 730	1 950	2 250
$0{,}30 < d \leq 0{,}40$	2 100	2 420	2 250	2 590	2 050	2 300	1 925	2 050	2 220	1 675	1 930	1 550	1 790	2 000	2 300	2 370	2 730	1 925	2 220
$0{,}40 < d \leq 0{,}50$	2 050	2 360	2 200	2 530	1 950	2 200	1 900	1 950	2 190	1 650	1 900	1 500	1 750	2 000	2 300	2 370	2 730	1 900	2 190
$0{,}50 < d \leq 0{,}65$	2 000	2 300	2 150	2 480	1 900	2 150	1 850	1 950	2 130	1 625	1 870	1 450	1 670	1 900	2 190	2 370	2 730	1 850	2 130
$0{,}65 < d \leq 0{,}80$	1 950	2 250	2 100	2 420	1 850	2 100	1 800	1 850	2 070	1 600	1 840	1 450	1 670	1 900	2 190	2 230	2 570	1 825	2 100
$0{,}80 < d \leq 1{,}00$	1 900	2 190	2 050	2 360	1 850	2 100	1 775	1 850	2 050	1 575	1 820	1 400	1 610	1 800	2 070	2 140	2 470	1 800	2 070
$1{,}00 < d \leq 1{,}25$	1 850	2 130	2 000	2 300	1 750	2 000	1 725	1 750	1 990	1 550	1 790	1 350	1 560	1 800	2 070	2 090	2 410	1 750	2 020
$1{,}25 < d \leq 1{,}50$	1 800	2 070	1 950	2 250	1 700	1 950	1 675	1 750	1 930	1 500	1 730	1 350	1 560	1 700	1 960	2 090	2 410	1 700	1 960
$1{,}50 < d \leq 1{,}75$	1 750	2 020	1 900	2 190	1 650	1 900	1 625	1 650	1 870	1 450	1 670	1 300	1 500	1 700	1 960	2 000	2 300	1 650	1 900
$1{,}75 < d \leq 2{,}00$	1 700	1 960	1 850	2 130	1 650	1 900	1 575	1 650	1 820	1 400	1 610	1 300	1 500	1 700	1 960	2 000	2 300	1 600	1 840
$2{,}00 < d \leq 2{,}50$	1 650	1 900	1 750	2 020	1 550	1 800	1 525	1 550	1 760	1 350	1 560	1 300	1 500	1 550	1 790	1 900	2 190	1 550	1 790
$2{,}50 < d \leq 3{,}00$	1 600	1 840	1 700	1 960	1 450	1 700	1 475	1 550	1 700	1 300	1 500	1 300	1 500	1 550	1 790	1 860	2 140	1 500	1 730
$3{,}00 < d \leq 3{,}50$	1 550	1 790	1 650	1 900	1 450	1 700	1 425	1 450	1 640	1 250	1 440	1 300	1 500	1 550	1 790	1 850	2 050	1 450	1 670
$3{,}50 < d \leq 4{,}25$	1 500	1 730	1 600	1 840	1450	1 700	1 400	1 450	1 610	1 225	1 410	1 250	1 440	1 450	1 670	1 750	1 950	1 400	1 610
$4{,}25 < d \leq 5{,}00$	1 450	1 670	1 550	1 790	1 350	1 600	1 350	1 350	1 560	1 200	1 380	1 250	1 440	1 450	1 670	1 700	1 900	1 350	1 560

Grade 4310-301-00-I and 4462-318-03-I can be delivered in normal tensile strength (NS) or high tensile strength (HS).

For steel 4568-177-00-I, the characteristics of the springs are not only determined by the characteristics of the drawn wire but also by the heat-treatment of the spring (see A.2). Therefore, the steel should be of a quality such that by the heat treatment after drawing the mechanical properties are met.

a Tensile strength calculated on actual diameter.

b The range of tensile strength values within a production batch of the same heat shall be a maximum of 9 % of the minimum values in this table.

c After straightening, it is recognized that the tensile strength may reduce by up to 10 % but the minimum values of this table have to be fulfilled.

d When better formability is required, lower tensile strength values may be agreed upon.

e The wire is supplied in the cold drawn condition. The tensile strength in the finished spring may be substantially influenced by a heat treatment; particularly, precipitation hardening of grade 4568-177-00-I results in substantially higher tensile strength (see A.5.2 and Table A.3).

f Larger diameters may be specified in which case the parties shall agree the tensile strength at the time of enquiry and order.

g When the tensile test of 4568-177-00-I is performed on test piece after precipitation hardening heat treatment (air cooling after heating at 470 ± 20 °C for up to 1 h) as agreed upon between the purchaser and supplier, the increment in tensile strength shall be 250 MPa or over. This requirement applies for nominal diameters ≤6,0 mm.

Table 2 *(continued)*

Nominal diameter mm[f]	Tensile strength (MPa) [a b c d e f] for the following steel grades																		
	4310-301-00-I				4325-302-00-E 4315-304-51-I		4301-304-00-I			4401-316-00-I		4539-089-04-I		4462-318-03-I				4568-177-00-I[g]	
	Normal tensile strength (NS)		High tensile strength (HS)				Normal tensile strength (NS)	High tensile strength (HS)						Normal tensile strength (NS) -		High tensile strength (HS) -			
	min.	max.	min.	max.	min.	max.	min.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
5,00 < *d* ≤ 6,00	1 400	1 610	1 500	1 730	1 350	1 600	1 300	1 350	1 500	1 150	1 330	1 250	1 440	1 350	1 560	–	–	1 300	1 500
6,00 < *d* ≤ 7,00	1 350	1 560	1 450	1 670	1 270	1 520	1 250	1 300	1 440	1 125	1 300	1 200	1 380	1 350	1 560	–	–	1 250	1 440
7,00 < *d* ≤ 8,50	1 300	1 500	1 400	1 610	1 130	1 380	1 200	1 300	1 380	1 075	1 240	1 150	1 330	–	–	–	–	1 250	1 440
8,50 < *d* ≤ 10,00	1 250	1 440	1 350	1 560	980	1 230	1 175	1 250	1 360	1 050	1 210	–	–	–	–	–	–	1 250	1 440

Grade 4310-301-00-I and 4462-318-03-I can be delivered in normal tensile strength (NS) or high tensile strength (HS).

For steel 4568-177-00-I, the characteristics of the springs are not only determined by the characteristics of the drawn wire but also by the heat-treatment of the spring (see A.2). Therefore, the steel should be of a quality such that by the heat treatment after drawing the mechanical properties are met.

a Tensile strength calculated on actual diameter.

b The range of tensile strength values within a production batch of the same heat shall be a maximum of 9 % of the minimum values in this table.

c After straightening, it is recognized that the tensile strength may reduce by up to 10 % but the minimum values of this table have to be fulfilled.

d When better formability is required, lower tensile strength values may be agreed upon.

e The wire is supplied in the cold drawn condition. The tensile strength in the finished spring may be substantially influenced by a heat treatment; particularly, precipitation hardening of grade 4568-177-00-I results in substantially higher tensile strength (see A.5.2 and Table A.3).

f Larger diameters may be specified in which case the parties shall agree the tensile strength at the time of enquiry and order.

g When the tensile test of 4568-177-00-I is performed on test piece after precipitation hardening heat treatment (air cooling after heating at 470 ± 20 °C for up to 1 h) as agreed upon between the purchaser and supplier, the increment in tensile strength shall be 250 MPa or over. This requirement applies for nominal diameters ≤6,0 mm.