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ISO 6931-2

Second edition
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Stainless steels for springs —

Part 2:
Narrow strip

Aciers inoxydables pour ressorts —

Partie 2: Feuillard

Reference number
ISO 6931-2:2005(E)

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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 6931-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

This second edition cancels and replaces the first edition (ISO 6931-2:1989), 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 2: Narrow strip

1 Scope

This part of ISO 6931 applies to cold-rolled narrow strip of thicknesses up to and including 3 mm, in rolled widths less than 600 mm, made from the stainless steel grades listed in Table 1. The steels are used in the conditions given in Tables 4, 5 and 6 for the production of springs and spring parts that are exposed to corrosive effects and, sometimes, slightly elevated temperatures.

Steel grades other than those listed in Table 1, but covered by ISO/TS 15510, can be supplied in the above conditions after agreement between the manufacturer and purchaser (see also Annex A).

The general technical delivery conditions specified in ISO 404 apply, in addition to the specifications of this part of ISO 6931, unless otherwise specified in this part of ISO 6931.

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 377:1997+Cor.1:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (including Technical Corrigendum 1:1997)*

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

ISO 4885:1996, *Ferrous products – Heat treatment — Vocabulary*

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

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test method*

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

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

ISO 7438:1985, *Metallic materials — Bend test*

ISO 9445:2002, *Continuously cold-rolled stainless steel narrow strip, wide strip, plate/sheet and cut lengths — Tolerances on dimensions and form*

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/TS 15510:2003, *Stainless steels — Chemical composition*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 404, ISO 4885, ISO 6929, ISO 14284, ISO 16143-1 and the following apply.

3.1
spool
strip spirally wound onto a supporting centre

NOTE Strip on a spool may also be welded together end-to-end.

4 Classification and designation

4.1 Classification

Steels covered in this part of ISO 6931 are classified according to their structure into:

— austenitic steels;

— ferritic steels;

— martensitic steels;

— precipitation-hardening steels.

4.2 Designation

4.2.1 Steel names

For the steel grades covered by this part of ISO 6931, the steel names as given in the relevant tables are allocated in accordance with ISO/TS 4949.

4.2.2 Steel numbers

For the steel grades covered by this part of ISO 6931, the steel numbers as given in the relevant tables are allocated in accordance with the line numbers in ISO/TS 15510.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) the quantity to be delivered;

b) the designation of the product form (e.g. strip or cut length);

c) the number of the dimensional standard (ISO 9445);

d) the dimensions and tolerances on thickness, width and length according to ISO 9445 and, if applicable, letters denoting relevant special tolerances (see 7.5);

e) the internal coil diameter according to ISO 9445 (see 7.5);

f) the number and the part of this document (ISO 6931-2);

g) steel name or steel number (see 4.2);

h) the delivery condition (see 6.2.2),

i) the type of inspection document in accordance with ISO 10474 (see 8.2).

EXAMPLE

5 tons narrow strip according to ISO 9445 of nominal thickness 0,80 mm ordered with precision thickness tolerances (P), nominal width of 250 mm with precision tolerances on width (P) in steel X5CrNi18-9 (line 6 of Table 1 in ISO/TS 15510:2003) in the cold-worked condition +C850, process route 2H, as specified in this part of ISO 6931 and an inspection certificate 3.1.B according to ISO 10474.

5 t narrow strip ISO 9445-0,80P×250P
Steel ISO 6931-2-X5CrNi18-9+C850+2H
ISO 10474-3.1.B

or

5 t narrow strip ISO 9445-0,80P×250P
Steel ISO 6931-2-ISO/TS 15510 line 6+C850+2H
ISO 10474-3.1.B

5.2 Options

A number of options are specified in this part of ISO 6931 and listed below. If the purchaser does not indicate his wish to implement one of these options, the manufacturer shall supply, in accordance with the basic specification of this part of ISO 6931 (see 5.1):

a) any requirement concerning the manufacturing process of the steel and of the products (see 6.1);

b) any requirement concerning the form of delivery (see 6.2.1.1);

c) any requirement concerning the condition of the edges (see 6.2.1.2);

d) any requirement concerning special treatment conditions (see 6.2.2.1 and Table A.3);

e) any requirement concerning special technological properties (see 7.3.1, Table 7 and 7.3.3);

f) any requirement concerning surface finish (see 7.3.2);

g) any requirement concerning bending limit of strip differing from Table 7 (see 7.3.1 and 8.3.3.2.3);

h) any requirement concerning testing of internal soundness (see 7.4);

i) any requirement concerning additional specific testing (see 8.1);

j) any requirement concerning tensile testing for checking the uniformity of tensile strength (see 8.3.1 and Table 8);

k) any requirement concerning determination of product analysis (see 8.3.2.2 and Table 8);

l) any requirement concerning carrying out of bending ability tests (see 8.3.2.3 and Table 8);

m) any requirement concerning tolerances on flatness, edge waviness and edge camber (see 8.3.3.3);

n) any requirement concerning measurement of coil set, including the relevant values (see 8.3.3.3).

6 Manufacturing process

6.1 General

Unless otherwise agreed at the time of enquiry and order, the steelmaking process and manufacturing process of the products are left to the discretion of the manufacturer.

6.2 Delivery

6.2.1 Delivery form

6.2.1.1 Strip is usually supplied in coils. Thin strip may be wound on a supporting centre, made of steel, cardboard or other material, in order to avoid the collapse of the centre. Strip may also be supplied as a spool (see 3.1), in order to increase coil weight, whilst minimizing coil outside diameter. In the latter case, any welds shall be clearly marked.

Alternatively, strip may be supplied in cut lengths. These may be in a box, or on a pallet, and perhaps strapped together in bundles.

Several coils, or bundles of cut lengths, may be assembled on a carrier.

Unless otherwise agreed at the time of enquiry and order, the choice of delivery form is left to the discretion of the manufacturer.

6.2.1.2 Unless otherwise agreed at the time of enquiry and order, cold-rolled strip for springs is delivered with slit edges. By special agreement, strip can also be supplied with mill edges or with special edges, e.g. machined edges, deburred edges or edges dressed to produce a regular form, usually square or round.

6.2.2 Delivery condition

6.2.2.1 The condition in which the strip is to be delivered shall always be specified by the purchaser.

The delivery conditions possible are those given in Tables 3, 4, 5 and 6. Either a tensile strength range from Tables 3 and 4, or a hardness range from Table 5 or Table 6, shall be specified.

In special cases, products may, if this is agreed, also be delivered in the treatment conditions given in Table A.3 which are normally reserved for finished springs.

6.2.2.2 In the condition +C, strip shall be delivered with a bright surface (2H), or a rough, matt surface (see 7.3.2).

Strip of steel types X20Cr13 (line 84), X30Cr13 (line 85), X39Cr13 (line 86) and X7CrNiAl17-7 (line 102) in the conditions “annealed” or “solution-annealed” may be delivered, at the manufacturer's choice, with a bright annealed (2R), pickled (2D), pickled and skin passed (2B) or matt (2F) surface according to ISO 16143-1.

7 Requirements

7.1 Chemical composition

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

To improve fatigue strength for springs, for austenitic steel grades a maximum mass content of 0,015 % sulfur is recommended.

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

7.2 Mechanical properties

7.2.1 For the tensile strength of spring-hard rolled strip, the data in Table 3 and Table 4 apply.

7.2.2 Regardless of the mass of the coil and for spools (see 3.1) of mass 500 kg or less, the maximum difference in tensile strength between the two ends of a coil or spool shall be 100 MPa (see 8.3.1). For spools with masses above 500 kg, the maximum difference in tensile strength shall be agreed at the time of enquiry and order.

7.2.3 For the hardness range of spring-hard rolled ferritic and austenitic strip, the data in Table 5 apply.

7.2.4 For the hardness range of martensitic strip, the data in Table 6 apply.

7.2.5 Regardless of the mass of the coil and for spools (see 3.1) of mass 500 kg or less, the maximum difference in hardness between the two ends of a coil or spool shall be 30 HV (see 8.3.1). For spools with masses above 500 kg, the maximum difference in hardness shall be agreed at the time of enquiry and order.

7.3 Technological properties and surface condition

7.3.1 The strip shall have adequate bending ability. Unless otherwise agreed, the guidance data given in Table 7 apply. Cracks visible with the naked eye are not permitted.

7.3.2 The surface of the strip shall be one of those mentioned in 6.2.2 and defined in ISO 16143-1. Oil films from cold-rolling are permitted. Pits, grooves, scars and scratches are only permitted to the extent that they do not impair the performance of the spring. See also A.6.3.

7.3.3 If, for strip which is intended for high-duty springs, the requirements according to 7.3.1 and 7.3.2 are not sufficient, particular agreements shall be made at the time of enquiry and order.

7.4 Internal soundness

The products shall be free from internal defects that could impair their application to a significant extent. Tests appropriate for an assessment of the internal characteristics may be agreed upon at the time of enquiry and order.

7.5 Dimensions and tolerances on dimensions

The tolerances on thickness, width and length shall be specified in accordance with ISO 9445.

The internal coil diameter shall be agreed in accordance with ISO 9445.

8 Inspection and testing

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 used.

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

8.2 Types and contents of inspection documents

8.2.1 At the time of enquiry and order, the issue of one of the inspection documents in accordance with ISO 10474 shall be agreed for each delivery.

8.2.2 If the issuing of an inspection certificate 3.1.A, 3.1.B or 3.1.C according to ISO 10474:1991 or of an inspection report 3.2 according to ISO 10474:1991 has been agreed, specific inspections according to 8.3 are to be carried out and the following information shall be given in the inspection document:

a) the results of the cast analysis;

b) the results of the mandatory tests marked in the second column of Table 8 by an “m” ;

c) the result of any optional test or inspections agreed at the time of enquiry and order.

8.3 Specific inspection and testing

8.3.1 Extent of testing

The data in Table 8 apply for the composition of test units and for the number of tests per test unit, subject to the following exception for tensile strength or Vickers hardness:

If proof of uniformity of tensile strength (in accordance with 7.2.2) or of Vickers hardness (in accordance with 7.2.5) is agreed upon at the time of enquiry and order, a test piece shall be taken from both ends of each coil or spool (see 3.1). If, from one coil of hot-rolled or cold-rolled material, several coils or spools of cold-rolled strip are produced and if these are numbered in sequence, it is only necessary to take a test piece from the beginning of each consecutively produced coil or spool.

8.3.2 Selection and preparation of samples and test pieces

8.3.2.1 General

The general conditions given in ISO 377 and ISO 14284 for the selection and preparation of samples and test pieces shall apply.

8.3.2.2 Product analysis

For product analysis, the selection and preparation of samples shall be carried out in conformity with the requirements of ISO 14284.

8.3.2.3 Tensile, hardness and bending tests

The test pieces for the tensile, hardness and bending test shall be taken in accordance with Figure 2 and prepared in accordance with ISO 6892, ISO 6507-1 and 8.3.3.2.3, respectively.

8.3.3 Methods of test

8.3.3.1 Chemical analysis

In cases of dispute, the reference method used for chemical analysis shall be in accordance with one of the International Standards listed in ISO/TR 9769.

8.3.3.2 Tensile, hardness and bending tests

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

8.3.3.2.2 The Vickers hardness test shall be carried out in accordance with ISO 6507-1.

8.3.3.2.3 By analogy with the process of spring manufacture, to check the bending ability, a test strip, if possible 20 mm in width, is bent through 90° under a press around a mandrel with a radius matched to the thickness of the test piece (see Table 7). Bending is carried out perpendicular to the longitudinal axis of the test piece, i.e. transverse to the direction of rolling in the case of longitudinal test pieces, and parallel to the direction of rolling in the case of transverse test pieces.

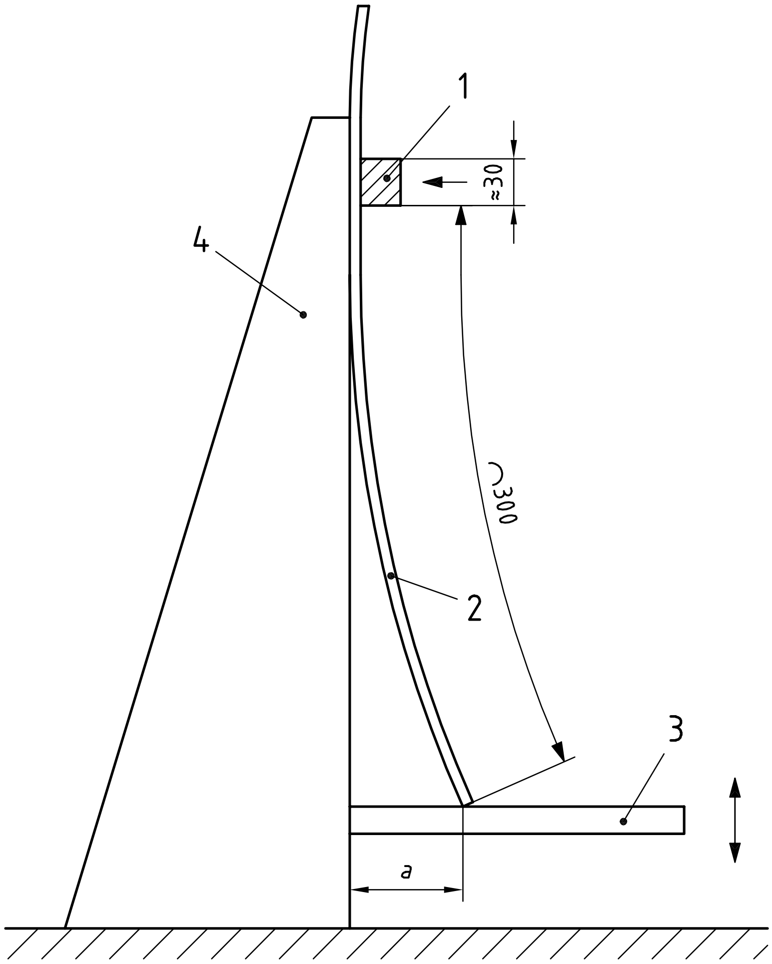
In addition, the general specifications in ISO 7438 apply.

8.3.3.3 Tolerances on shape

The methods of control of flatness, edge waviness and edge camber and their tolerances may be agreed at the time of enquiry and order.

The measurement of coil set may be agreed at the time of enquiry and order. If agreed, the relevant values for the coil set, measured as the deflection a (see Figure 1), shall also be specified at the time of enquiry and order.

Dimensions in millimetres



Key

1 holder

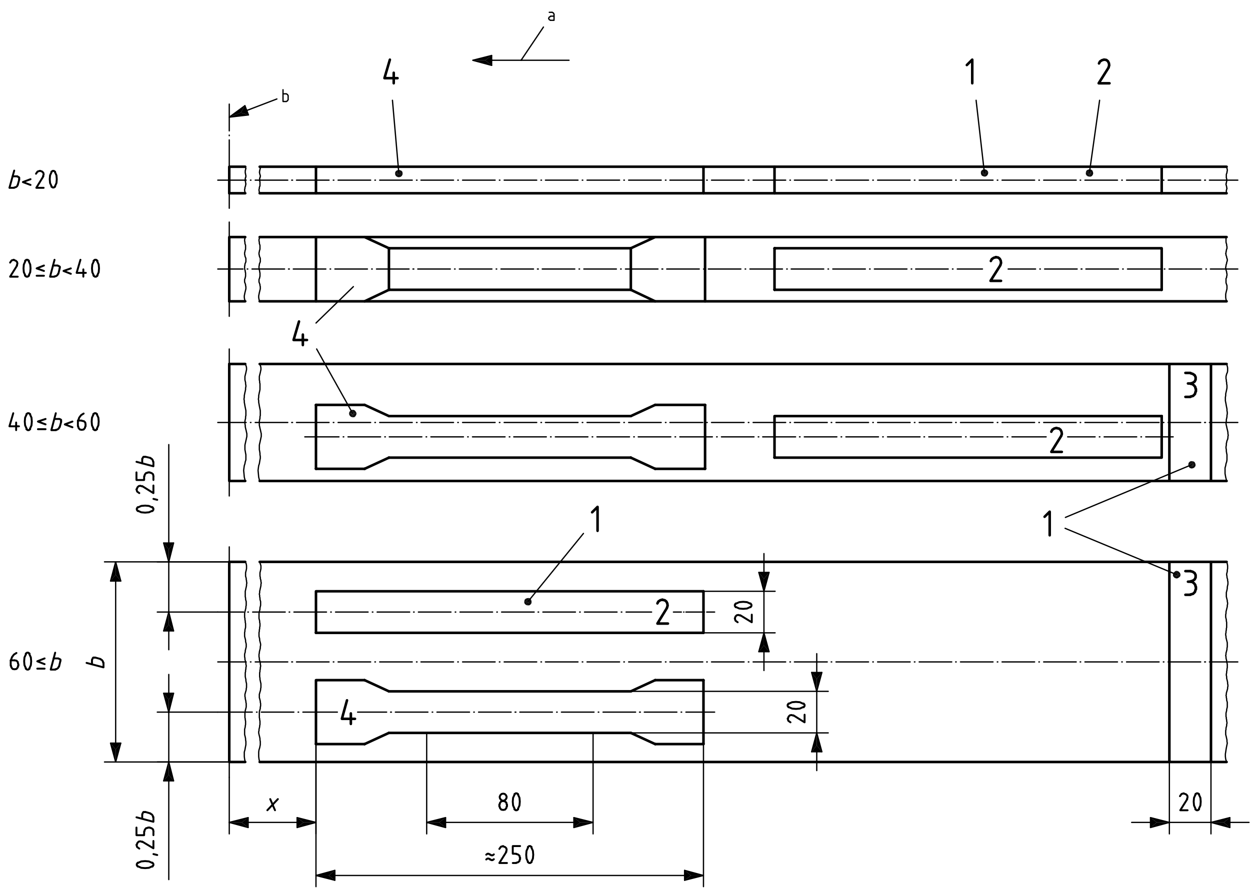
2 strip

3 scale

4 stand

Figure 1 — Coil set, measured as the deflection a, for a test length of 300 mm

Dimensions in millimetres



Key

1 bending test piece, as far as possible with a width of 20 mm

2 longitudinal test piece for bending transverse to rolling direction

3 transverse test piece for bending parallel to rolling direction

4 tensile test piece: a test piece having a gauge length of L_0 = 80 mm and a width of 20 mm, or L_0 = 50 mm and a width of 12,5 mm. Also, for $b > 200$ mm, transverse test pieces may be used

b Strip width

x In cases of dispute, the samples shall be taken at a distance of at least one lap from the inner or outer end of the coil

a Rolling direction

b Outer strip edge

Figure 2 — Test pieces

Table 1 — Chemical composition (cast analysis) of the steels

Steel designation		Chemical composition % (mass fraction)									
Name	Line number in ISO/TS 15510:2003	C	Si	Mn	P max.	S max.	N	Cr	Mo	Ni	Others
Austenitic steels											
X5CrNi18-9	6	⩽ 0,07	⩽ 1,00	⩽ 2,00	0,045	0,030 [a, d]	⩽ 0,11	17,5 to 19,5	—	8,0 to 10,5	—
X10CrNi18-8	11	0,05 to 0,15	⩽ 2,00	⩽ 2,00	0,045	0,030 [a, d]	⩽ 0,11	16,0 to 19,0	⩽ 0,80	6,0 to 9,5	—
X12CrMnNiN17-7-5	13	⩽ 0,15	⩽ 1,00	5,5 to 7,5	0,045	0,030 [a, d]	0,05 to 0,25	16,0 to 18,0	—	3,5 to 5,5	—
X5CrNiMo17-12-2	30	⩽ 0,07	⩽ 1,00	⩽ 2,00	0,045	0,030 [a, d]	⩽ 0,11	16,5 to 18,5	2,00 to 3,00	10,0 to 13,0	—
X11CrNiMnN19-8-6	43	0,07 to 0,15	0,50 to 1,00	5,0 to 7,5	0,030	0,015 [d]	0,20 to 0,30	17,5 to 19,5	—	6,5 to 8,5	—
Ferritic steel											
X6Cr17	67	⩽ 0,08 [c]	⩽ 1,00	⩽ 1,00	0,040	0,030 [a]	—	16,0 to 18,0	—	—	—
Martensitic steels											
X20Cr13	84	0,16 to 0,25	⩽ 1,00	⩽ 1,50	0,040	0,030 [a]	—	12,0 to 14,0	—	—	—
X30Cr13	85	0,26 to 0,35	⩽ 1,00	⩽ 1,50	0,040	0,030 [a]	—	12,0 to 14,0	—	—	—
X39Cr13	86	0,36 to 0,42	⩽ 1,00	⩽ 1,00	0,040	0,030 [a]	—	12,5 to 14,5	—	—	—
Precipitation hardening steel											
X7CrNiAl17-7	102	⩽ 0,09	⩽ 0,70	⩽ 1,00	0,040	0,015	—	16,0 to 18,0	—	6,5 to 7,8 [b]	Al:0,70 to 1,50

NOTE Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser, except for finishing the cast. All appropriate precautions are to be taken, to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

a Particular ranges of sulfur content may provide improvement of particular properties. For machinability, a controlled sulfur content of 0,015 % to 0,030 % is recommended. For weldability, a controlled sulfur content of 0,008 % to 0,020 % may be beneficial. For polishability, a controlled sulfur content of 0,015 % maximum is recommended.

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

c For certain applications, e.g. weldability, a maximum of 0,12 % C may be agreed upon.

d To improve fatigue strength for springs, for austenitic steel grades, a maximum mass content of 0,015 % sulfur is recommended.

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

Element	Cast analysis (specified limits) % (mass fraction)		Permissible deviation [a] % (mass fraction)
Carbon		⩽ 0,20	± 0,01
	> 0,20	⩽ 0,42	± 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	⩽ 7,5	± 0,10
Phosphorus		⩽ 0,045	+ 0,005
Sulfur		⩽ 0,015	+ 0,003
	> 0,015	⩽ 0,030	+ 0,005
Nitrogen	⩾ 0,03	⩽ 0,11	± 0,01
	> 0,11	⩽ 0,30	± 0,02
Chromium	⩾ 12,0	⩽ 19,5	± 0,20
Molybdenum		< 1,75	+ 0,07
	⩾ 1,75	⩽ 3,00	± 0,10
Nickel		⩽ 5,0	± 0,10
	> 5,0	⩽ 13,0	± 0,20
Aluminium	⩾ 0,70	⩽ 1,50	± 0,10

[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 — Tensile strength in the cold-worked condition

Designation	Tensile strength [a,b] MPa [c]
+C700	700 to 850
+C850	850 to 1000
+C1000	1 000 to 1 150
+C1150	1 150 to 1 300
+C1300	1 300 to 1 500
+C1500	1 500 to 1 700
+C1700	1 700 to 1 900
+C1900	1 900 to 2 200

[a] Intermediate tensile strength values may be agreed upon. Alternatively, the steels may be specified in terms of minimum 0,2 % proof strength or hardness, but only one parameter can be specified in one order (see Tables 5 and 6).

[b] The maximum available thickness for each tensile strength level and the remaining elongation decrease with the increase in tensile strength. Both depend on the work-hardening behaviour of the steel and the cold-working conditions. Consequently, more exact information may be requested from the manufacturer.

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

Table 4 — Availability of steel grades in the cold-worked condition

Steel designation		Available tensile strength levels							
Name	Line number in ISO/TS 15510:2003	+C700	+C850	+C1000	+C1150	+C1300	+C1500	+C1700	+C1900
Austenitic steels									
X5CrNi18-9	6	x	x	x	x	x	—	—	—
X10CrNi18-8	11	—	x	x	x	x	x	x	x
X12CrMnNiN17-7-5	13	—	x	x	x	x	x	—	—
X5CrNiMo17-12-2	30	x	x	x	x	x	—	—	—
X11CrNiMnN19-8-6	43	—	x	x	x	x	x [c]	—	—
Ferritic steel									
X6Cr17	67	x	x	—	—	—	—	—	—
Martensitic steels									
X20Cr13 [a]	84 [a]	x	x	—	—	—	—	—	—
X30Cr13 [a]	85 [a]	x	x	—	—	—	—	—	—
X39Cr13 [a]	86 [a]	x	x	—	—	—	—	—	—
Precipitation hardening steel									
X7CrNiAl17-7 [b]	102 [b]	—	—	x	x	x	x	x	—

[a] Also available in the annealed condition, with tensile strength ranges, R_m, as follows: X20Cr13: 500 MPa to 700 MPa; X30Cr13: 540 MPa to 740 MPa; X39Cr13: 560 MPa to 760 MPa, and in the quenched and tempered condition (see Figures A.4 to A.6 and Table 6).

[b] Also available in the solution-annealed condition with the tensile strength range (R_m) of 800 MPa to 1 000 MPa.

[c] Strip with tensile strength up to +C1500 can be supplied depending on requested thickness.

Table 5 — Vickers hardness levels available in the cold-rolled condition for austenitic and ferritic steels (see A.2 and A.3)

Steel designation		Total available HV range [a] for the aim value	Tolerance on HV aim value
Name	Line number in ISO/TS 15510:2003		
Austenitic steels			
X5CrNi18-9	6	220 to 450	± 25HV
X10CrNi18-8	11	250 to 450 451 to 600	± 25HV ± 30HV
X12CrMnNiN17-7-5	13	250 to 450 451 to 500	± 25HV ± 30HV
X5CrNiMo17-12-2	30	220 to 400	± 25HV
X11CrNiMnN19-8-6	43	300 to 450 451 to 475	± 25HV ± 30HV
Ferritic steel			
X6Cr17	67	200 to 300	± 20HV

[a] Steels can be supplied to any Vickers hardness (HV) aim value within the range, taking into account the tolerance on HV aim value.

Table 6 — Vickers hardness levels available in martensitic steels

Steel designation		Vickers hardness levels (HV) in the supply condition (see A.4)		
Name	**Line number** in ISO/TS 15510:2003	**Annealed**	**Lightly cold-rolled**	**Quenched and tempered** [a]
X20Cr13	84	190 to 240	240 to 290	480 to 520
X30Cr13	85	190 to 240	270 to 320	500 to 540
X39Cr13	86	200 to 250	270 to 320	520 to 560

[a] Hardness ranges typical when tempered at 300 °C. See A.4 and Figures A.4 to A.6 for more information

Table 7 — Data for the bending ability of strip

Steel designation		Delivery condition	Bending ability for a strip, thickness in millimetres							
			> 0,05 to 0,25		above 0,25 to 0,50		above 0,50 to 0,75		above 0,75 to 1,00 [a]	
			For a direction of the axis of bend							
Name	Line number in ISO/TS 15510:2003		transverse	longitudinal [b]	transverse	longitudinal [b]	transverse	longitudinal [b]	transverse	longitudinal [b]
Austenitic steels										
X5CrNi18-9	6	+C700	⩽ 0,5	⩽ 1,0	⩽ 0,5	⩽ 2,0	⩽ 1,0	⩽ 3,0	⩽ 1,5	⩽ 5,0
		+C850	⩽ 0,5	⩽ 2,0	⩽ 1,0	⩽ 3,0	⩽ 1,5	⩽ 5,0	⩽ 2,5	⩽ 7,0
		+C1000	⩽ 1,0	⩽ 3,0	⩽ 1,5	⩽ 5,0	⩽ 2,5	⩽ 7,0	⩽ 3,0	⩽ 9,0
		+C1150	⩽ 2,0	⩽ 5,0	⩽ 2,5	⩽ 7,0	⩽ 3,0	⩽ 9,0	⩽ 4,5	⩽ 11,0
		+C1300	⩽ 2,5	⩽ 7,0	⩽ 3,0	⩽ 9,0	⩽ 4,5	⩽ 11,0	⩽ 6,0	⩽ 13,0
X10CrNi18-8 and X12CrMnNiN17-7-5	11 / 13	+C850	⩽ 0,5	⩽ 1,0	⩽ 0,5	⩽ 1,5	⩽ 0,5	⩽ 2,5	⩽ 1,0	⩽ 3,0
		+C1000	⩽ 0,5	⩽ 2,0	⩽ 0,5	⩽ 2,5	⩽ 1,0	⩽ 3,0	⩽ 2,0	⩽ 4,0
		+C1150	⩽ 0,5	⩽ 2,5	⩽ 1,0	⩽ 3,0	⩽ 2,0	⩽ 4,0	⩽ 2,5	⩽ 5,0
		+C1300	⩽ 1,5	⩽ 3,0	⩽ 2,0	⩽ 4,0	⩽ 2,5	⩽ 5,0	⩽ 3,0	⩽ 7,0
		+C1500	⩽ 2,0	⩽ 4,5	⩽ 2,5	⩽ 5,0	⩽ 3,0	⩽ 7,0	⩽ 3,5	⩽ 9,5
		+C1700 [c]	⩽ 2,5	⩽ 9,0	⩽ 3,0	⩽ 9,5	< 3,5	⩽ 11,0	—	—
		+C1900 [c]	⩽ 3,0	⩽ 12,0	⩽ 3,5	⩽ 13,0	—	—	—	—
X5CrNiMo17-12-2	30	+C700	⩽ 0,5	⩽ 3,0	⩽ 1,0	⩽ 4,0	⩽ 1,5	⩽ 6,0	⩽ 2,0	⩽ 8,0
		+C850	⩽ 1,0	⩽ 4,0	⩽ 1,5	⩽ 6,0	⩽ 2,5	⩽ 8,0	⩽ 3,0	⩽ 11,0
		+C1000	⩽ 1,5	⩽ 6,0	⩽ 2,0	⩽ 8,0	⩽ 3,0	⩽ 11,0	⩽ 4,5	⩽ 14,0
		+C1150	⩽ 2,5	⩽ 8,0	⩽ 3,0	⩽ 11,0	⩽ 4,5	⩽ 14,0	—	—
		+C1300	⩽ 3,0	⩽ 11,0	⩽ 3,5	⩽ 13,0	—	—	—	—
X11CrNiMnN19-8-6	43	+C1150	⩽ 0,5	⩽ 3,0	⩽ 2,0	⩽ 5,0	⩽ 3,0	⩽ 6,5	⩽ 4,0	⩽ 9,0
		+C1300	⩽ 2,0	⩽ 5,0	⩽ 3,0	⩽ 9,0	⩽ 4,0	⩽ 10,0	⩽ 6,0	⩽ 11,0
		+C1500	⩽ 3,0	⩽ 10,0	⩽ 4,0	⩽ 14,0	⩽ 6,0	⩽ 16,0	⩽ 9,0	⩽ 18,0
Precipitation hardening steel										
X7CrNiAl17-7	102	+C1150	⩽ 0,5	⩽ 3,0	⩽ 2,0	⩽ 5,0	⩽ 3,0	⩽ 6,5	⩽ 4,0	⩽ 9,0
		+C1300	⩽ 2,0	⩽ 5,0	⩽ 3,0	⩽ 9,0	⩽ 4,0	⩽ 10,0	⩽ 6,0	⩽ 11,0
		+C1500	⩽ 3,0	⩽ 10,0	⩽ 4,0	⩽ 14,0	⩽ 6,0	⩽ 16,0	⩽ 9,0	⩽ 18,0
		+C1700	⩽ 6,0	⩽ 18,0	⩽ 7,0	⩽ 19,0	⩽ 9,0	⩽ 20,0	⩽ 11,0	⩽ 21,0

NOTE 1 Bending ability *r/t* (*r* = mandrel radius, *t*= strip thickness) at an angle of 90°.

NOTE 2 Specific data are not currently available for ferritic and martensitic steels and for grade X11CrNiMnN19-8-6 in conditions +C850 and +C1000.

[a] For greater strip thickness, no values can as yet be given.

[b] At present, unless otherwise agreed, the value shall be regarded as guidance data until more experience is obtained.

[c] The values for conditions +C1700 and +C1900 are valid for grade X10CrNi18-8 (line 11) only.

Table 8 — Tests to be carried out, test units and extent of testing in specific testing

Quality requirement [a]	[b]	Test unit	Number of products per test unit	Number of samples per product	Number of test pieces per sample
Product analysis [c]	o	Cast	[d]	1	1
Tensile or hardness test [g] without checking the uniformity of tensile strength or hardness	m	Cast and production batch [e]	1 per 10 delivered coils or spools, or part thereof	1	1
Tensile or hardness test [g] for checking the uniformity of tensile strength or hardness	o	Cast and production batch [e]	[f]	[f]	[f]
Bending ability	o	Cast and production batch [e]	To be agreed at the time of enquiry and order		
Coil set	o	Cast and production batch [e]	To be agreed at the time of enquiry and order		

[a] If other tests are required, for example for the determination of the modulus of elasticity, this shall be agreed at the time of enquiry and order.

[b] m = the test shall be carried out in each case; o = the test shall be carried out only if agreed at the time of enquiry and order.

[c] If no product analysis is ordered, the chemical composition according to the cast analysis shall be given by the manufacturer for the elements listed in Table 1.

[d] Unless otherwise agreed at the time of enquiry and order, one test piece shall be taken per cast.

[e] Same cast, same nominal thickness, same final heat-treatment condition (i.e. same heat treatment and/or same degree of cold deformation).

[f] See 8.3.1.

[g] Depending on whether tensile strength range or hardness range is specified.

Annex A
(informative)

Additional Information

A.1 Selection of stainless steels for use in precision strip form for spring applications

There are many different demands for the use of corrosion-resistant steels in precision strip form for spring applications. Theoretically, any of the steels specified in ISO/TS 15510 can be used. This standard details the properties of the more common steels used. Both delivery and use conditions for each component depend on the corrosive environment, strip size, mechanical properties required, the shape of the part, amount and method of forming, life of the part, cost constraints and any special physical properties required.

For spring applications, the steel is used in a “hard” or high-strength condition. High strength is obtained in different ways for the different steel structures, and the final spring properties depend upon the specific process route and the steel chosen.

Austenitic and ferritic structure steels are not generally hardened by heat treatment. The higher strengths are obtained by cold rolling. The rate of cold work-hardening depends upon the steel composition. After the same percentage of cold reduction, a less stable austenitic grade, such as X10CrNi18-8 (line 11 in Table 1 of ISO/TS 15510:2003), will have a higher R_m and HV, and retain a higher A value than a more stable austenitic grade such as X5CrNi18-9 (line 6). For more details see Tables 5 and A.2. Ferritic steels cold work-harden to a lesser extent than austenitic grades. Therefore, the properties obtainable in a specific steel at a specific thickness depend upon the degree of cold reduction and the work-hardening characteristic. However, it is possible to increase R_m and E in the formed spring by tempering (see A.2 and A.3, Tables A.3 and A.4 and Figures A.1 to A.3).

Martensitic steels are more “springy” than austenitic or ferritic steels. They are less ductile and possess lower corrosion resistance, the material costs are lower, but the heat treatment may be more expensive. The method of use of these steels is different. The steel manufacturer usually supplies them to the springmaker in either the annealed or lightly cold-rolled condition, and only rarely in the quenched and tempered condition. The lightly cold-rolled condition is easier to blank. It is usually after formation of the spring that these steels are heat-treated by quenching and tempering to obtain the desired balance of strength and ductility (For more details, see A.4, Tables 6, A.3 and A.4 and Figures A.4 to A.6).

The precipitation-hardening grade X7CrNiAl17-7 (line 102) may be used in one of the following two ways.

a) Delivered in the solution-annealed condition. After spring formation, the springs are hardened by a double artificial-ageing treatment (see A.5).

b) Delivered after cold-rolling to a strength level of +C1300 or higher. After spring formation, a single artificial-ageing treatment (see A.5, Table A.4 and Figure A.1) increases E and R_m.

For this steel, the hardening is achieved both by work-hardening in cold-rolling and by the precipitation of another phase from the matrix.

In Table A.1, some of the features of the use of different steel grades are listed.

A.2 Further details on austenitic steels

These steels are hardened principally by work-hardening. As an alternative to specification in terms of R_m, a Vickers hardness range may be specified, as shown in Table 5. In choosing the specification, note should be taken of the remaining ductility in the steels, as shown in Table A.2.

After spring formation, strength may be further increased by a tempering treatment, as shown in Table A.3.

The effect on the modulus of elasticity, E, is given in Table A.4. The effect on R_m is shown in Figures A.1 to A.3. This final tempering treatment also removes the processing stresses introduced during spring formation, and is recommended for this reason, as well as because of the strength increase.

A.3 Further details on ferritic steel X6Cr17 (line 67)

This steel is only hardened by cold-rolling. As an alternative to Table 4, the strength may be specified by HV as shown in Table 5. The modulus of elasticity, E, has a value of approximately 210 MPa, which cannot be increased by heat treatment. Table A.2 shows that this steel has low ductility in the cold-worked condition, so sharp radii cannot be used.

A.4 Further details on martensitic steels

Table 6 shows the Vickers hardness levels available in martensitic steels, and Table A.3 shows the hardening and tempering conditions needed for the higher hardness levels. Although, in some cases, the steels may be delivered in the quenched and tempered condition (process route and surface condition code 2Q), to supply them in the annealed condition is more common, for maximum formability, or in the lightly cold-rolled condition, when ease of stamping is more important than maximum formability. Then, after spring formation, the springs are often quenched and tempered, choosing a lower tempering temperature, such as 250 °C, if a harder, less ductile material is required, or a higher tempering temperature, such as 350 °C, if a softer, more ductile material is required (see also Figures A.4 to A.6). The hardening and temper treatment also raises the modulus of elasticity, E, as shown in Table A.4.

A.5 Further details on precipitation-hardening steel X7CrNiAl17-7 (line 102)

Steel delivered in the solution-annealed condition (+AT) will typically have been annealed at 1 030 °C to 1 050 °C and air-cooled to give R_m of 800 MPa to 1 000 MPa.

After spring formation, double artificial-ageing treatment is carried out by one of the two methods shown in Table A.3.

The condition of supply that produces the hardest final material is to cold roll the steel to a strength of +C1300 or higher. Then, after spring formation, a single artificial-ageing treatment is carried out as shown in Table A.3. This treatment increases R_m and E. The effect on R_m is shown in Figure A.1 and the effect on E is shown in Table A.4.

Where greater formability is required, the possibility of supply in the solution-annealed condition or a less cold-worked condition should be considered, and it is recommended that this be discussed with the steelmaker.

A.6 Further general guidelines on processing

A.6.1 Physical properties

In A.1 to A.5 and Tables A.1 and A.4, the variations in the values of E are described. It should be noted that the values of E decrease with increasing temperature. The variation of magnetic properties with chemical composition and treatment are described in Table A.1.

A.6.2 Cleaning and heat treatment

The springs should be thoroughly cleaned before heat treatment. If the colours produced by heat treatment are not permissible for visual or corrosion-resistance reasons, the heat treatment may be carried out in a protective atmosphere, or a suitable cleaning process may be used which does not impair the spring properties.

A.6.3 Mean surface roughness

The surface condition of strip is characterized by the following approximate values for the mean surface roughness:

— $R_a < 0,3$ µm for tensile levels of +C1150 and higher;

— $R_a < 0,5$ µm for tensile levels of +C700 to +C1000.

Table A.1 — Some features of the use of different steel grades

Steel designation		Features of using these steels
Steel name	**Line number** in ISO/TS 15510:2003	
Austenitic steels (see A.2)		
X5CrNi18-9	6	Most common austenitic stainless steel. Relatively stable austenitic structure results in lower work-hardening rate than X12CrMnNiN17-7-5 or X10CrNi18-8. Maximum temperature of use may be between 120 °C and 250 °C, depending upon the stress. Some degree of magnetic permeability, depending on the condition, but less than X10CrNi18-8 (line 11). Medium corrosion resistance within the austenitic range.
X10CrNi18-8	11	The stainless steel most commonly used for springs and with the highest possible R_m. Relatively unstable austenitic structure. High R_m in solution-annealed condition. Highest rate of work-hardening gives high R_m, whilst still retaining some ductility (A %). Maximum temperature of use may be between 120 °C and 250 °C, depending upon the stress. Some degree of magnetic permeability, depending on condition. Corrosion resistance a little less than for X5CrNi18-9.
X12CrMnNiN17-7-5	13	High R_p and R_m in solution-annealed condition. Work-hardening rate > X5CrNi18-9 but < X10CrNi18-8. Magnetic permeability less than for X5CrNi18-9. Use of this grade is a tradition from USA.
X5CrNiMo17-12-2	30	Used where superior corrosion resistance to X5CrNi18-9 is required. Maximum temperature of use may be 120 °C to 250 °C, depending upon the stress.

Table A.1 (*continued*)

Steel designation		Features of using these steels
Steel name	**Line number** in ISO/TS 15510:2003	
X11CrNiMnN19-8-6	43	Completely non-magnetic in all conditions. High R_m in solution-annealed condition, and capable of being cold rolled to a very high R_m. Maximum temperature of use may be between 120 °C and 250 °C, depending upon the stress. Work-hardening rate $>$ X5CrNi18-9 but $<$ X10CrNi18-8. Corrosion resistance similar to X10CrNi18-8.
Ferritic steel (see A.3)		
X6Cr17	67	Hardenable only by cold-rolling, and only to a moderate level (see Tables 4, 5 and A.2). Moderate corrosion resistance. High magnetic permeability in all conditions.
Martensitic steels (see A.4)		
X20Cr13 X30Cr13 X39Cr13	84 85 86	More “springy” than austenitic or ferritic steels. High strength obtained after spring formation by quench and temper heat treatment. Quench and temper treatment also increases E. Lower ductility and corrosion resistance than other stainless steel structures. Final strength increases with carbon content (see Table 6). High magnetic permeability in all conditions.
Precipitation-hardening steel (see A.5)		
X7CrNiAl17-7	102	High fatigue strength. Hardenable by heat treatment to very high strength level. Higher elevated-temperature strength, but lower corrosion resistance than austenitic steels. Maximum temperature of use may be between 250 °C and 300 °C, depending on the stress. Some degree of magnetic permeability, depending on the condition.

Table A.2 — Information on minimum elongation values (A_{80mm}) for cold-rolled austenitic and ferritic steels at different tensile strength levels

Steel designation		$A_{80mm, min.}$ (longitudinal) for tensile strength level							
Name	**Line number** in ISO/TS 15510:2003	+C700	+C850	+C1000	+C1150	+C1300	+C1500	+C1700	+C1900
Austenitic steels									
X5CrNi18-9	6	25	12	5	3	1	—	—	—
X10CrNi18-8	11	35 [a]	25	20	15	10	5	2	1
X12CrMnNiN17-7-5	13	40 [a]	25	13	5	2	1	—	—
X5CrNiMo17-12-2	30	20	10	4	1	—	—	—	—
X11CrNiMnN19-8-6	43	35 [a]	12	9	8	2	1	—	—
Ferritic steel									
X6Cr17	67	2	1	—	—	—	—	—	—

[a] Steel in the softened condition; not used for springs.

Table A.3 — Guidance data for heat treatment of springs made of strip

Steel designation		Heat treatment [a]					Increase in tensile strength
Name	**Line number** in ISO/TS 15510:2003	**Initial condition**	**Temperature/Duration**	**Cooling**	**Temperature/Duration**	**Cooling**	
Austenitic steels							
X5CrNi18-9	6	cold rolled	Tempering: 250 °C/24 h to 450 °C/30 min	air	—	—	see Figure A.2
X10CrNi18-8	11						see Figure A.1
X12CrMnNiN17-7-5	13						see Figure A.1
X5CrNiMo17-12-2	30						see Figure A.3
X11CrMnNiN19-8-6	43						see Figure A.1
Martensitic steels							
			Hardening: max. 30 min		Tempering: max. 1 h		
X20Cr13	84	annealed	950 °C - 1 050 °C	oil/air	200 °C - 400 °C	—	see Figure A.4
X30Cr13	85		950 °C - 1 050 °C	oil/air	200 °C - 400 °C		see Figure A.5
X39Cr13	86		1000 °C - 1 100 °C	oil/air	200 °C - 400 °C		see Figure A.6
Precipitation-hardening steel							
X7CrNiAl17-7	102	cold rolled	Tempering [b]: 480 °C/2 h to 550 °C/1 h	air	—	—	see Figure A.1
		solution-annealed	1st artificial ageing: 760 °C/40 min to 820 °C/30 min	water/air < 12 °C [c]	2nd artificial ageing: 480 °C/2 h to 550 °C/1 h	air	300 MPa - 550 MPa [d]

NOTE See the classification of the tensile-strength data in Tables 3 and 4 and Figures A.1 to A.3.

[a] The optimum heat-treating conditions may vary. Heat-treating conditions suiting the purpose shall be chosen.

[b] The tempering of X7CrNiAl17-7 in cold-rolled condition +C1300 and higher has some degree of artificial ageing.

[c] The lower maximum temperature depends on the temperature and duration of the intermediate annealing.

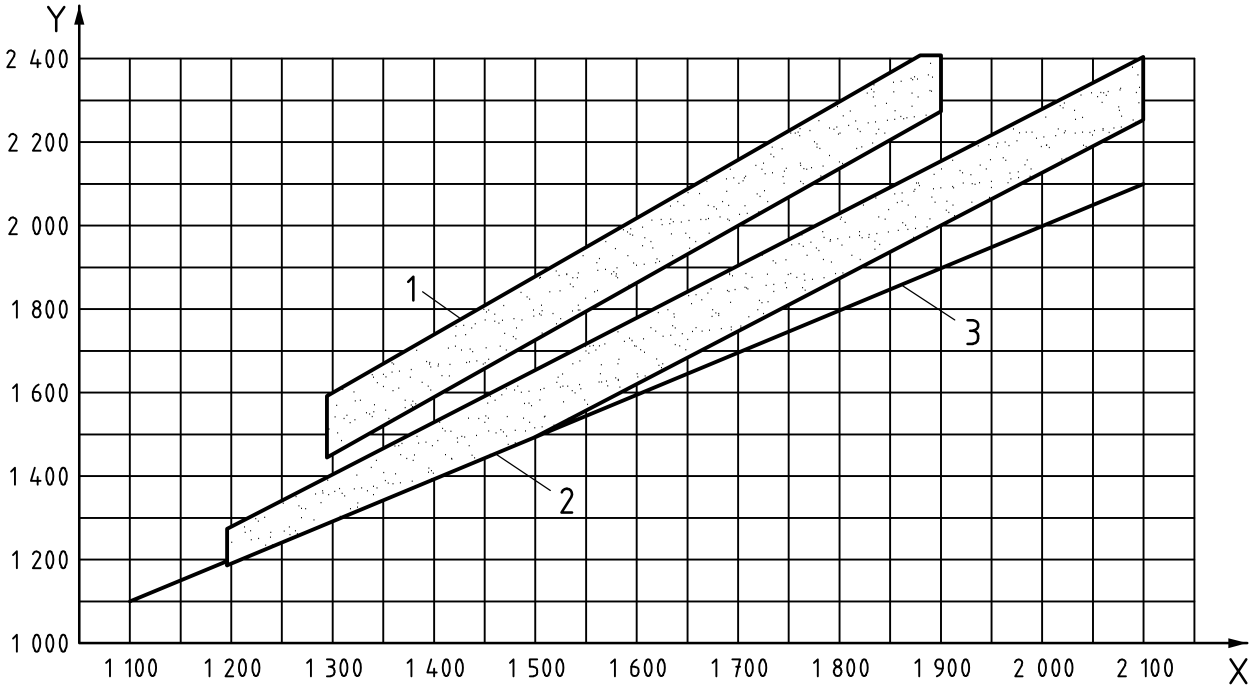
[d] A higher tensile strength of 1 450 MPa can be achieved by heat treatment +P1450: Intermediate annealing at 945 °C to 965 °C/10 min; air cooling; low-temperature treatment at −70 °C/8 h and precipitation-hardening at 500 °C to 520 °C/1h. 1 MPa = 1 N/mm^2.

Table A.4 — Guidance data for the moduli of elasticity

Steel designation		Modulus of elasticity [a] in the	
Name	**Line number** in ISO/TS 15510:2003	**delivery condition +C**	**cold-rolled and heat-treated condition**
		GPa	
Austenitic steels			
X5CrNi18-9	6	185	195
X10CrNi18-8	11	185	195
X12CrMnNiN17-7-5	13	200	210
X5CrNiMo17-12-2	30	180	190
X11CrNiMnN19-8-6	43	190	200
Ferritic steel			
X6Cr17	67	210	—
Martensitic steels			
X20Cr13	84	210	220 [b]
X30Cr13	85	210	220 [b]
X39Cr13	86	210	220 [b]
Precipitation-hardening steel			
X7CrNiAl17-7	102	195	200

[a] The reference data for the modulus of elasticity are applicable to measurements on longitudinal tensile-test pieces for a mean tensile strength of 1 800 MPa; for a mean tensile strength of 1 300 MPa, the values are 6 GPa lower. Intermediate values may be interpolated.

[b] Applies to condition +QT, see Tables 6 and A.3, and Figures A.4 to A.6.



Key

X Tensile strength of strip in initial state (cold-rolled) in MPa *

Y Tensile strength after heat treatment in MPa *

1 X7CrNiAl17-7 tempered [a]

2 X10CrNi18-8 tempered, X12CrMnNiN17-7-5 tempered [b], X11CrNiMnN19-8-6 tempered [b]

3 initial state (cold-rolled)

NOTE 1 The increase in tensile strength depends on the chemical analysis of the relevant steel grade.

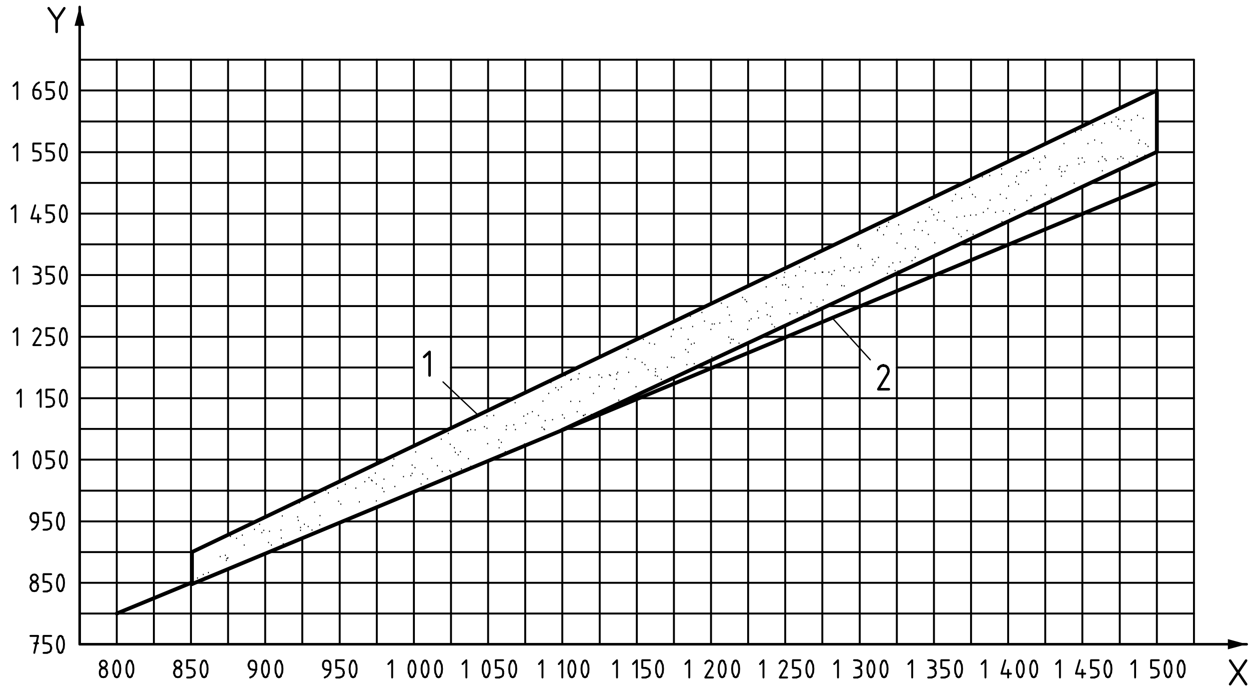
NOTE 2 At lower tensile ranges, the increase in tensile strength is much lower than the increase in 0,2 % proof strength. Therefore, the increase of spring-properties of the heat-treated material or parts is much higher than the tensile values indicate.

[a] The tempering of X7CrNiAl17-7 in cold-rolled conditions +C1300 and higher has some degree of artificial ageing.

[b] For steel X12CrMnNiN17-7-5 and X11CrNiMnN19-8-6, the maximum tensile strength in the initial state is 1 700 MPa *.

* 1 MPa = 1 N/mm^2

Figure A.1 — Guidance data for the increase in tensile strength of cold-rolled strip made of steels X10CrNi18-8 (line 11), X12CrMnNiN17-7-5 (line 13), X11CrNiMnN19-8-6 (line 43) and X7CrNiAl 17-7 (line 102) by heat treatment (see Table A.3)



Key

X Tensile strength of strip in initial state (cold-rolled) in MPa *

Y Tensile strength after heat treatment in MPa *

1 X5CrNiAl18-9 tempered

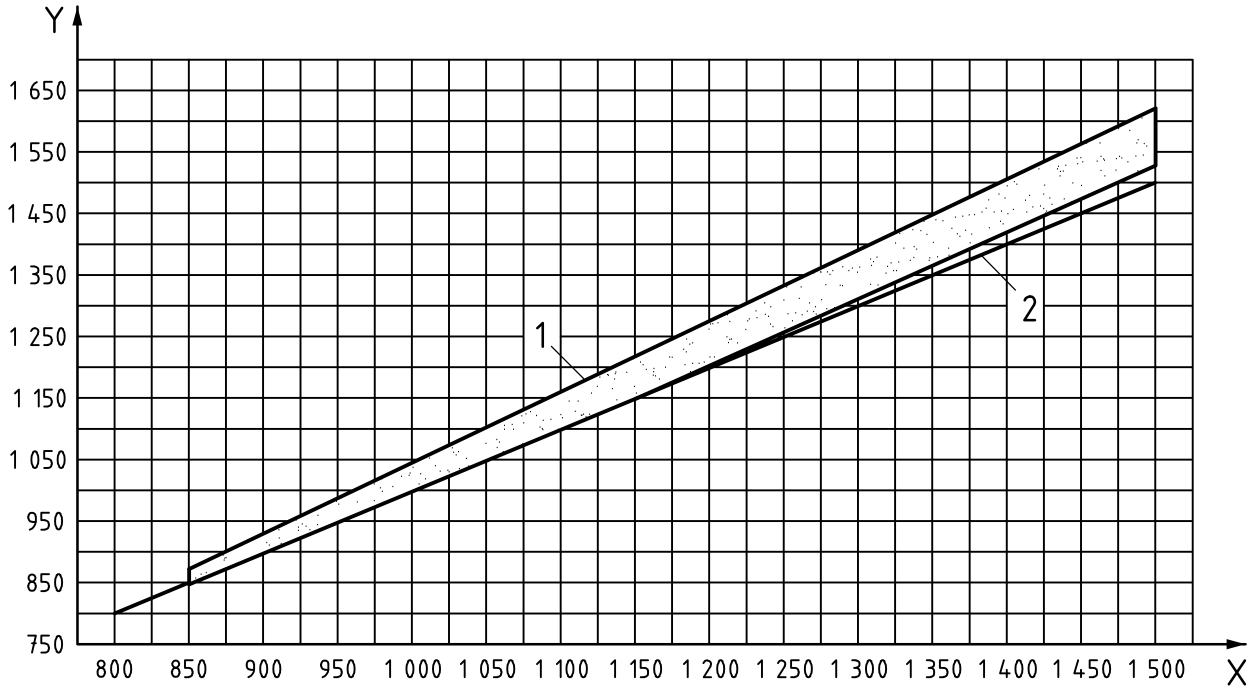
2 initial state (cold-rolled)

NOTE 1 The increase in tensile strength depends on the chemical analysis of the relevant steel grade.

NOTE 2 At lower tensile ranges, the increase in tensile strength is much lower than the increase in 0,2 % proof strength. Therefore, the increase of spring-properties of the heat-treated material or parts is much higher than the tensile values indicate.

* 1 MPa = 1 N/mm^2

Figure A.2 — Guidance data for the increase in tensile strength of cold-rolled strip made of steel X5CrNi18-9 (line 6) by heat treatment (see Table A.3)



Key

X Tensile strength of strip in initial state (cold-rolled) in MPa *

Y Tensile strength after heat treatment in MPa *

1 X5CrNiMo17-12-2 tempered

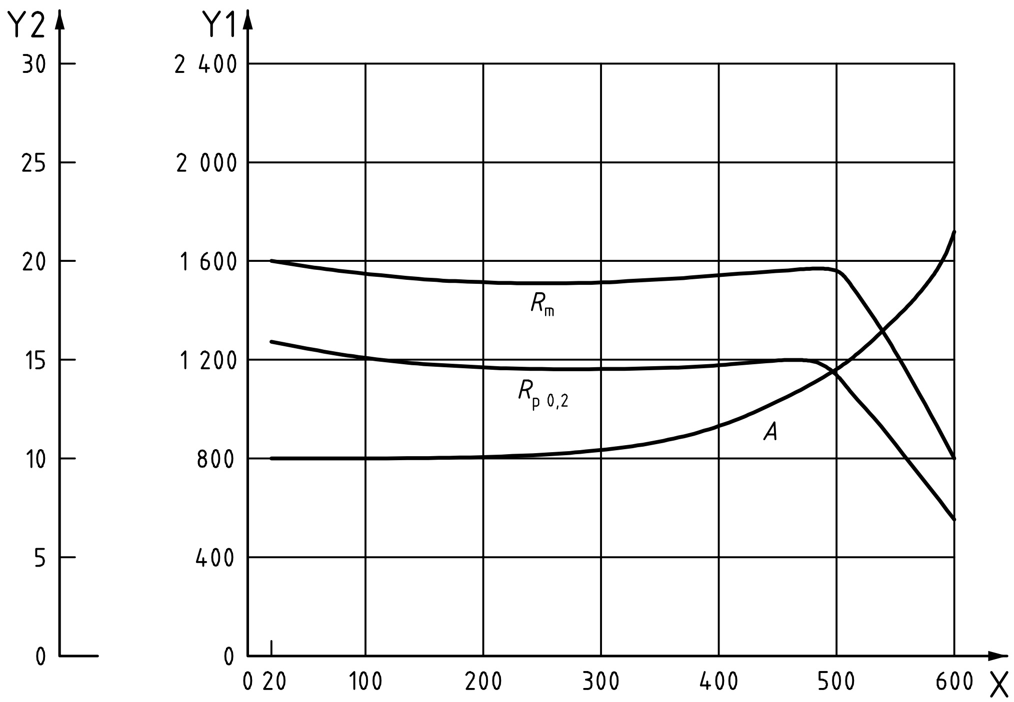
2 initial state (cold-rolled)

NOTE 1 The increase in tensile strength depends on the chemical analysis of the relevant steel grade.

NOTE 2 At lower tensile ranges, the increase in tensile strength is much lower than the increase in 0,2 % proof strength. Therefore, the increase of spring-properties of the heat-treated material or parts is much higher than the tensile values indicate.

* 1 MPa = 1 N/mm^2

Figure A.3 — Guidance data for the increase in tensile strength of cold-rolled strip made of steel X5CrNiMo17-12-2 (line 30) by heat treatment (see Table A.3)



Key

X Tempering temperature [a] in °C

Y1 Strength in MPa [*]

Y2 Elongation in %

R_m Tensile strength

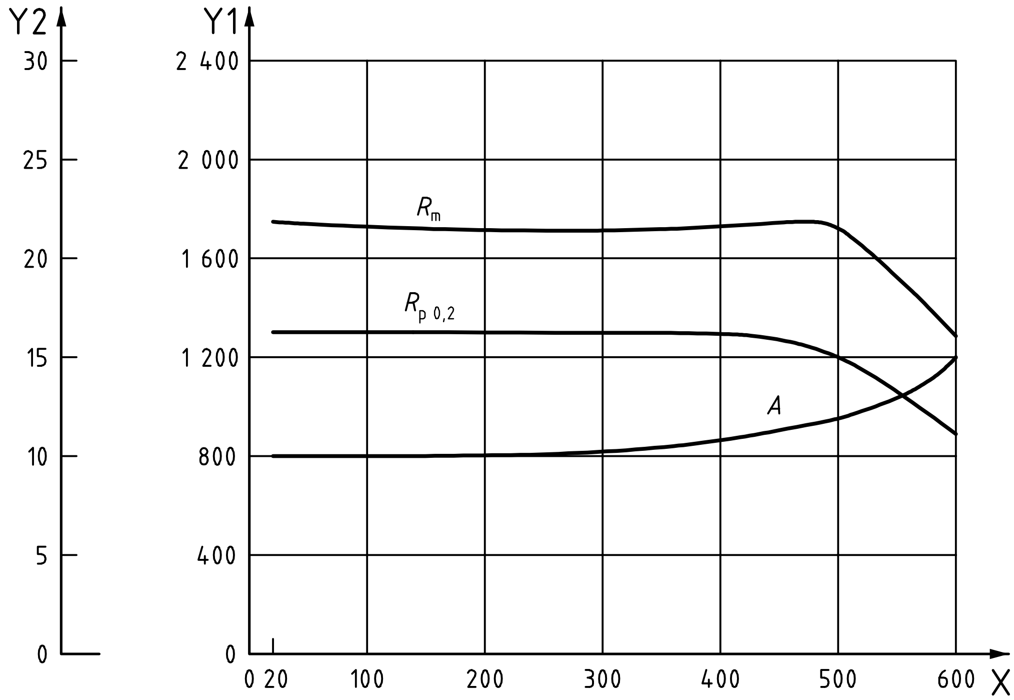
$R_{p0,2}$ Proof strength, non proportional extension (0,2 %)

A Elongation

[a] If the tempering temperature exceeds 400 °C, both the corrosion resistance and the hardness are significantly reduced.

[*] 1 MPa = 1 N/mm^2

Figure A.4 — Guidance data on the mechanical characteristics of steel X20Cr13 (line 84) after quenching and tempering (see Table A.3)



Key

X Tempering temperature [a] in °C

Y1 Strength in MPa*

Y2 Elongation in %

R_m Tensile strength

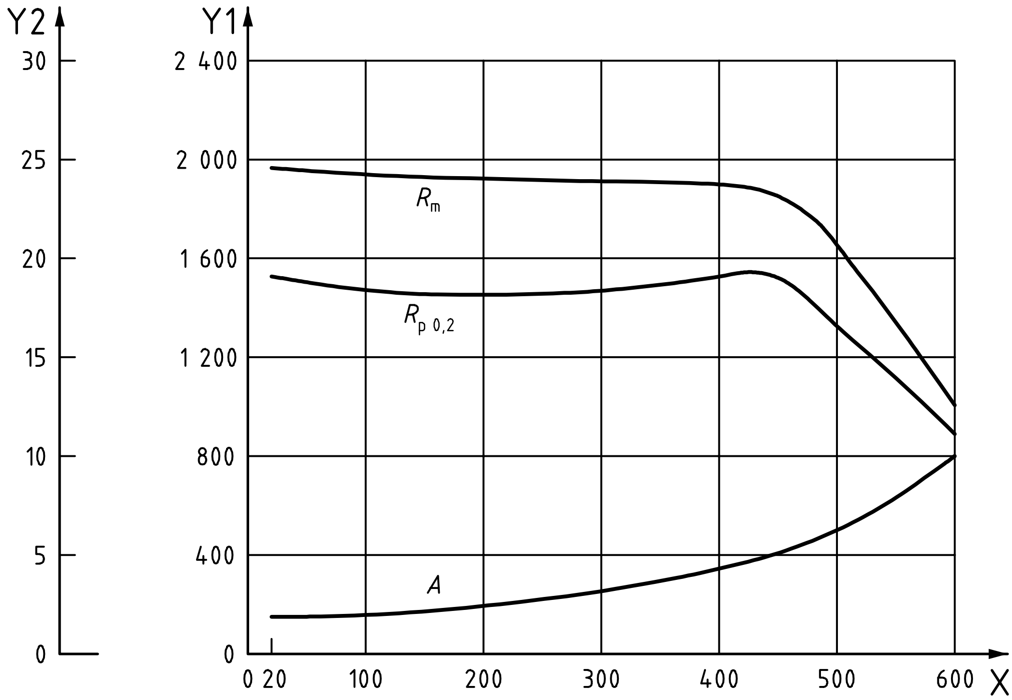
$R_{p0,2}$ Proof strength, non proportional extension (0,2 %)

A Elongation

[a] If the tempering temperature exceeds 400 °C, both the corrosion resistance and the hardness are significantly reduced.

* 1 MPa = 1 N/mm^2

Figure A.5 — Guidance data on the mechanical characteristics of steel X30Cr13 (line 85) after quenching and tempering (see Table A.3)



Key

X Tempering temperature [a] in °C

Y1 Strength in MPa*

Y2 Elongation in %

R_m Tensile strength

$R_{p0,2}$ Proof strength, non proportional extension (0,2 %)

A Elongation

[a] If the tempering temperature exceeds 400 °C, both the corrosion resistance and the hardness are significantly reduced.

* 1 MPa = 1 N/mm²

Figure A.6 — Guidance data on the mechanical characteristics of steel X39Cr13 (line 86) after quenching and tempering (see Table A.3)

Annex B
(informative)

Designations of the steels given in Table 1 and of comparable grades covered in ASTM-, EN- and JIS-Standards

Table B.1 — Designations of the steels given in Table 1 and of comparable grades covered in ASTM-, EN- and JIS-Standards

Steel designations according to					
Table 1		**ASTM/ UNS**	**EN 10151**		**JIS**
Name	**Line number** of ISO/TS 15510:2003		**Name**	**Number**	
Austenitic steels					
X5CrNi18-9	6	S30400	X5CrNi18-10	1.4301	SUS304
X10CrNi18-8	11	S30100	X10CrNi18-8	1.4310	
X12CrMnNiN17-7-5	13	S20100	X12CrMnNiN17-7-5	1.4372	SUS201
X5CrNiMo17-12-2	30	S31600	X5CrNiMo17-12-2	1.4401	SUS316
X11CrNiMnN19-8-6	43		X11CrNiMnN19-8-6	1.4369	
Ferritic steel					
X6Cr17	67	S43000	X6Cr17	1.4016	SUS430
Martensitic steels					
X20Cr13	84	S42000	X20Cr13	1.4021	SUS420J1
X30Cr13	85	S42000	X30Cr13	1.4028	SUS420J2
X39Cr13	86	S42000	X39Cr13	1.4031	
Precipitation-hardening steel					
X7CrNiAl17-7	102	S17700	X7CrNiAl17-7	1.4568	SUS631

ICS 77.140.25

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