
Stainless steels for springs —
Part 2:
Narrow strip

Aciers inoxydables pour ressorts —

Partie 2: Feuillard

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ISO 6931-2:2005

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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*

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— *Part 2: Narrow strip*

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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 6931-2:2005(E)

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.

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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

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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

[ISO 6931-2:2005](https://standards.iteh.ai/catalog/standards/sist/232c76e0-509a-4a08-a2dd-360b8564459d/iso-6931-2-2005)

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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; [ISO 6931-2:2005](https://standards.iteh.ai/catalog/standards/sist/232c76e0-509a-4a08-a2dd-36068364459d/iso-6931-2-2005)
- b) the results of the mandatory tests marked in the second column of Table 8 by an "m" ; <https://standards.iteh.ai/catalog/standards/sist/232c76e0-509a-4a08-a2dd-36068364459d/iso-6931-2-2005>
- 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.

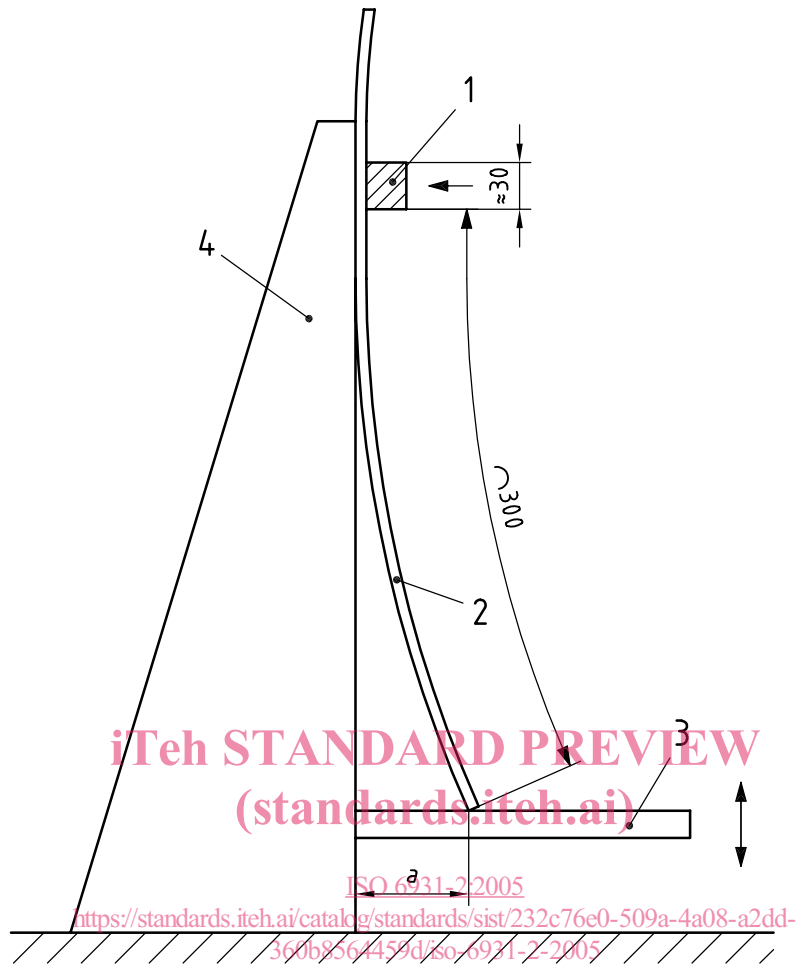
8.3.3.2.3 By analogy with the process of spring manufacture, to check the bending ability, a test strip, if possible 20 mm in width, is bent through 90° under a press around a mandrel with a radius matched to the thickness of the test piece (see Table 7). Bending is carried out perpendicular to the longitudinal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



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