

# INTERNATIONAL STANDARD

**ISO**  
**4955**

Second edition  
1994-05-15

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## Heat-resisting steels and alloys

*Aciers et alliages réfractaires*

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ISO 4955:1994

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Reference number  
ISO 4955:1994(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.

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.

International Standard ISO 4955 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 4955:1983), of which it constitutes a technical revision.

Annexes A and B of this International Standard are for information only.

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# Heat-resisting steels and alloys

## 1 Scope

**1.1** This International Standard specifies requirements for the grades of wrought steels and alloys listed in tables 1 and 2 which are usually employed for products for which the resistance to the effects of hot gases and the products of combustion at temperatures in the region above 550 °C is the main requirement.

**1.2** This International Standard is applicable to

- bars;
- flat products;
- wire and rod;
- forgings.

### NOTES

1 Steels which have an increased resistance to deformation when they are subjected for long periods to mechanical stresses are covered by ISO/TR 4956:1984, *Wrought steels for use at elevated temperatures in engines*. Further heat-resisting steels and alloys for valves are covered by ISO 683-15:1992, *Heat-treatable steels, alloy steels and free-cutting steels — Part 15: Valve steels for internal combustion engines*.

2 Not all of the steels included in this International Standard are necessarily available in all product forms.

**1.3** In addition to this International Standard, the general technical delivery requirements of ISO 404 are applicable.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publi-

cation, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 377-1:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 1: Samples and test pieces for mechanical test*.

ISO 377-2:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 2: Samples for the determination of the chemical composition*.

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

ISO/TR 4949:1989, *Steel names based on letter symbols*.

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test*.

ISO 6892:1984, *Metallic materials — Tensile testing*.

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

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

## 3 Ordering

**3.1** The purchaser shall state in his enquiry and order

- a) the type of steel or alloy (see table 1 or 2);
- b) the product form and the dimensions and tolerances of the product (see 4.6);

- c) the treatment condition, including surface condition [see 4.2, 4.5 and footnote 3) to table 5];
- d) the quantity to be delivered;
- e) the required type of document (see 5.1).

**3.2** Certain options in ordering are permitted by this International Standard and the purchaser may also state, in his enquiry and order, the following related requirements:

- a) whether a product analysis is required (see 5.2.1);
- b) whether the mechanical properties are to be verified on reference test pieces (see 4.4).

## 4 Requirements

### 4.1 Manufacture of the steel and of the product

Unless otherwise agreed in the order, the processes used in making the steel and the product are left to the discretion of the manufacturer. When he so requests, the purchaser shall be informed what steelmaking process is being used.

### 4.2 Treatment and surface condition at delivery

**4.2.1** The heat-treatment condition at the time of delivery shall comply with one of the conditions indicated in table 6. The manufacturer shall choose the heat treatment (for guidance, see table B.1) such that the properties are met.

**4.2.2** The type of condition and surface condition of the products shall be one of those indicated in table 5.

### 4.3 Chemical composition

**4.3.1** The chemical composition of the steels and alloys, as given by the cast analysis, shall be in accordance with the specifications in tables 1 and 2.

**4.3.2** The permissible deviations between the values specified in tables 1 and 2 and the product analysis are given in tables 3 and 4.

### 4.4 Mechanical properties

For the usual heat-treatment conditions, the mechanical properties are specified in table 6.

If the products are delivered in the non-heat-treated condition, and if agreed at the time of enquiry and order, the mechanical properties specified in table 6 shall be achievable for suitably treated reference test pieces.

### 4.5 Surface condition

The products shall be ordered in the type of condition and surface condition indicated in table 5. Availability, and the determination of the types of condition most suited to a particular case, should be discussed with the supplier. Except for symbols F10, F11, and F12, minor surface irregularities caused by the manufacturing process are no cause for rejection.

### 4.6 Dimensions and tolerances

**4.6.1** Where possible, the products shall be ordered and delivered in accordance with existing International Standards for dimensions and tolerances (see the list in annex A). The ordered dimensions shall, where applicable, include the minimum machining allowances.

**4.6.2** If none of the International Standards listed in annex A is applicable, then the dimensions and tolerances shall be agreed at the time of enquiry and order on the basis of regional or national standards.

## 5 Testing

### 5.1 Agreement of tests and documents

**5.1.1** For each delivery, the issue of any document according to ISO 10474 may be agreed upon at the time of enquiry and order.

**5.1.2** If, in accordance with such an agreement, a specific inspection is to be carried out, the specifications given in 5.2 to 5.5 shall apply.

### 5.2 Number of tests

#### 5.2.1 Chemical composition

The cast analysis shall be provided by the manufacturer. If a product analysis is required by the purchaser, one sample product shall be taken from each cast.

## 5.2.2 Mechanical properties

The test unit consists of products of the same cast, the same size (see note 3) and the same heat-treatment batch.

All material from the same continuous heat-treatment operation, during the same operating period, is considered to be of the same heat-treatment batch.

For the tensile test at room temperature or for the hardness test, one test piece shall be taken per test unit.

NOTE 3 Products with deviations of 25 % from the largest size may be assembled.

## 5.3 Selection and preparation

### 5.3.1 General

The general conditions given in ISO 377-1 and ISO 377-2 for the selection and preparation of samples and test pieces shall apply.

### 5.3.2 Product analysis

For product analysis, the selection and preparation of samples shall be carried out in conformity with the requirements of ISO 377-2.

### 5.3.3 Tensile test

**5.3.3.1** For the tensile test the requirements of 5.3.3.2 and 5.3.3.3 apply.

If products are delivered in the untreated condition, the sample shall be converted into the usual heat-treatment condition according to tables 6 and B.1.

**5.3.3.2** In the case of bars and wire or rod, the test pieces shall be taken according to figure 1 in the longitudinal direction of the products. In cases of dispute, the tensile test pieces shall have a gauge length of

$$L_0 = 5,65\sqrt{S_0}$$

where  $S_0$  is the original cross-section.

**5.3.3.3** For flat products, the test pieces are to be taken in accordance with figure 2. In cases of dispute, products of thickness  $\geq 3$  mm shall have a gauge length of

$$L_0 = 5,65\sqrt{S_0}$$

For products of thickness  $< 3$  mm, test pieces either of 20 mm width and 80 mm gauge length or of 12,5 mm width and 50 mm gauge length according to ISO 6892 may be used.

### 5.3.4 Hardness test

Details for the selection and preparation of samples and test pieces for hardness tests may be agreed upon at the time of enquiry and order.

## 5.4 Methods of test

### 5.4.1 Chemical analysis

In the case of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method taken from International Standards listed in ISO/TR 9769.

### 5.4.2 Tensile test

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

### 5.4.3 Hardness test

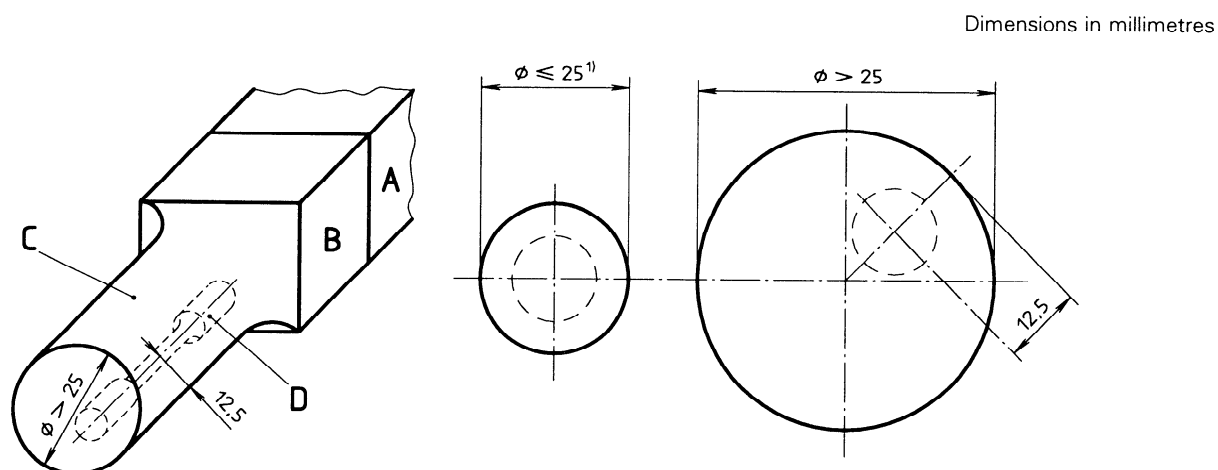
The Brinell hardness test shall be carried out in accordance with ISO 6506.

## 5.5 Retests

Retests shall be carried out in accordance with ISO 404.

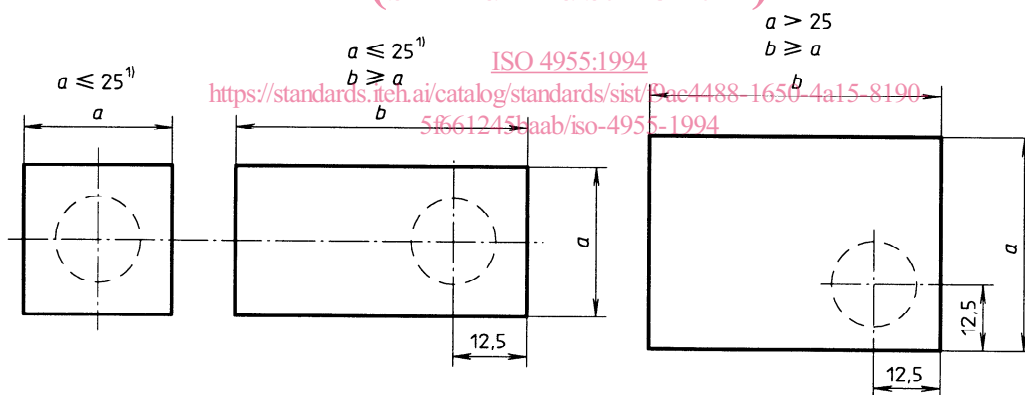
## 6 Marking

The products shall be marked with the manufacturer's symbol, the steel or alloy grade, and, if so agreed when ordering, with the cast number. When specific inspection is carried out, the products are to be provided additionally with an identification number which enables the test pieces to be related to the cast and product from which they stem.

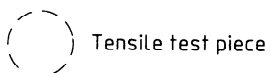


- A = Sample product  
 B = Test sample  
 C = Test bar (the piece after reduction to the size in which it is to be heat treated)  
 D = Test piece

Circular and similar shaped sections  
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Rectangular sections including squares



1) For small products ( $a$  or  $b \leq 25$  mm), the test piece shall, if possible, consist of an unmachined part of the bar.

**Figure 1 — Location of the tensile test pieces in bars and wire or rods**



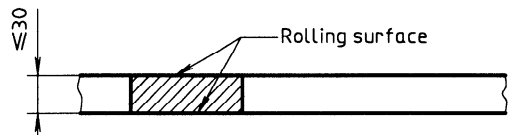
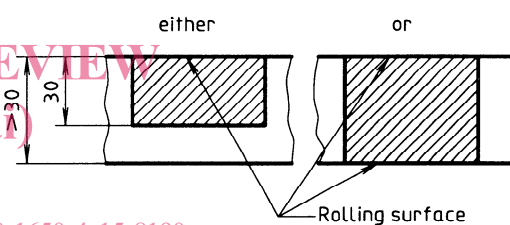
Type of test	Thickness of product	Position of longitudinal test piece axis for a product width, $w$		Distance of test piece from rolling surface
	mm	$w < 300$ mm	$w \geq 300$ mm	mm
Tensile test <sup>1)</sup>	$\leq 30$	longitudinal	transverse	
	$> 30$			
<p>1) The test piece shall be in accordance with ISO 6892. Except in case of dispute, for thicknesses equal to or greater than 20 mm, round test pieces may be used. For thicknesses <math>&gt; 30</math> mm, the round test piece is to be taken in 1/4 of the product thickness.</p>				

Figure 2 — Location of test pieces in sheet, strip or plate

**Table 1 — Types of steel and chemical composition** (applicable to cast analysis)

Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, other than for finishing the heat. All reasonable precautions should be taken to prevent the addition of such elements from scrap or other materials used in the manufacture, but residual elements may be present provided that the mechanical properties and applicability are not adversely affected.

Type of steel Designation <sup>1)</sup>			Chemical composition [% (m/m)]							
No.	Name	according to ISO 4955:1983	C max.	Si	Mn max.	P max.	S max.	Cr	Ni	Others
<b>Ferritic steels</b>										
1	X 6 CrTi 12	H1	0,08	≤ 1,0	1,0	0,040	0,030	10,5 to 12,5	≤ 1,0	Ti: 6 × % C ≤ 1,0
2	X 6 Cr 13	H2	0,08	≤ 1,0	1,0	0,040	0,030	12,0 to 14,0	≤ 1,0	—
3	X 10 CrAlSi 13	H3	0,12	0,70 to 1,4	1,0	0,040	0,030	12,0 to 14,0	≤ 1,0	Al: 0,70 to 1,20
4	X 6 Cr 17	H4	0,08	≤ 1,0	1,0	0,040	0,030	16,0 to 18,0	≤ 1,0	—
5	X 10 CrAlSi 18	H5	0,12	0,70 to 1,4	1,0	0,040	0,030	17,0 to 19,0	≤ 1,0	Al: 0,70 to 1,20
6	X 10 CrAlSi 25	H6	0,12	0,70 to 1,4	1,0	0,040	0,030	23,0 to 26,0	≤ 1,0	Al: 1,20 to 1,70
7	X 15 CrN 26	H7	0,20	≤ 1,0	1,0	0,040	0,030	24,0 to 28,0	≤ 1,0	N: 0,15 to 0,25
<b>Austenitic steels</b>										
10	X 7 CrNi 18-9	H10	0,10 <sup>2)</sup>	≤ 1,0	2,0	0,045	0,030	17,0 to 19,0	8,0 to 11,0	—
11	X 7 CrNiTi 18-10	H11	0,10 <sup>2)</sup>	≤ 1,0	2,0	0,045	0,030	17,0 to 19,0	9,0 to 12,0	Ti: 5 × % C ≤ 0,80
12	X 7 CrNiNb 18-10	H12	0,10 <sup>2)</sup>	≤ 1,0	2,0	0,045	0,030	17,0 to 19,0	9,0 to 12,0	Nb: 10 × % C ≤ 1,2 <sup>3)</sup>
13	X 15 CrNiSi 20-12	H13	0,20	1,5 to 2,5	2,0	0,045	0,030	19,0 to 21,0	11,0 to 13,0	—
14	X 7 CrNiSiN 21-11	—	0,10 <sup>4)</sup>	1,4 to 2,0	0,80	0,040	0,030	20,0 to 22,0	10,0 to 12,0	N: 0,14 to 0,20; Ce: 0,03 to 0,08
15	X 6 CrNi 23-14	H14	0,08	≤ 1,0	2,0	0,045	0,030	22,0 to 24,0	12,0 to 15,0	—
16	X 6 CrNi 25-21	H15	0,08	≤ 1,5	2,0	0,045	0,030	24,0 to 26,0	19,0 to 22,0	—
17	X 15 CrNiSi 25-21	H16	0,20	1,5 to 2,5	2,0	0,045	0,030	24,0 to 26,0	19,0 to 22,0	—
18	X 12 NiCrSi 35-16	H17	0,15	1,0 to 2,0	2,0	0,045	0,030	15,0 to 17,0	33,0 to 37,0	—
19	X 6 NiCrSi 36-19	—	0,08	0,75 to 1,5	2,0	0,030	0,030	17,0 to 20,0	34,0 to 37,0	Cu: ≤ 1,0; Pb: ≤ 0,005; Sn: ≤ 0,025
20	X 8 NiCrAlTi 32-21	H18	0,10 <sup>4)</sup>	≤ 1,0	1,5	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: ≤ 0,7

1) The designations given in the first column are consecutive numbers. The designations given in the second column are in accordance with ISO/TR 4949. The designations given in the third column represent the antiquated numbers of ISO 4955:1983.

2) A minimum of 0,04 % C shall also apply.

3) Tantalum determined as niobium.

4) A minimum of 0,05 % C shall also apply.

**Table 2 — Types of alloys and chemical composition** (applicable to cast analysis)

Type of alloy <sup>1)</sup> Designation <sup>2)</sup>			Chemical composition [% (m/m)]													
No.	Name	according to ISO 4955:1983	C	Si max.	Mn max.	P max.	S max.	Al max.	Co max.	Cr	Cu max.	Fe	Mo	Nb +Ta	Ni	Ti
NW6600	NiCr15Fe8	H20	≤ 0,15	0,5	1,0	—	0,015	—	3)	14,0 to 17,0	0,5	6,0 to 10,0	—	—	≥ 72,0	—
NW6621	NiCr20Ti	H21	0,08 to 0,15	1,0	1,0	—	0,020	—	5,0	18,0 to 21,0	0,5	≤ 5,0	—	—	Re- mainder	0,20 to 0,60
NW6625	NiCr22Mo9Nb	H22	≤ 0,10	0,50	0,50	0,015	0,015	0,40	1,0	20,0 to 23,0	—	≤ 5,0	8,0 to 10,0	3,15 to 4,15	≥ 58,0	≤ 0,40

1) In addition to the grades listed in this table, other nickel alloys, e.g. NW6002, NW6601 and NW6617 (see ISO 9722, ISO 9723, etc.), are also used for the same purpose, but because of insufficient data they are not listed here.

2) The designations given in the first two columns are the same as in ISO 9722, and for alloy designation either the number or the name may be used. The designations given in the third column represent the antiquated numbers of ISO 4955:1983.

3) A maximum of 1,5 % Co is allowed and counted as nickel. Reporting of cobalt is not required.