

INTERNATIONAL STANDARD

ISO 4957

Second edition
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Tool steels

Aciers à outils

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

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Contents

1	Scope	1
2	Normative references	1
3	Terms and definitions	2
4	Requirements	3
5	Inspection, testing and conformance of products	4
6	Marking	5
7	Ordering and designation	5
	Annex A (informative) Hardness-tempering temperature-curves	18
	Annex B (normative) Supplementary or special requirements	28
	Annex C (informative) Designations of comparable steels.....	30
	Bibliography	32

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4957 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 4957:1980) which has been technically revised.

Annex B forms a normative part of this International Standard, annexes A and C are for information only.

ISO 4957:1999
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Tool steels

1 Scope

1.1 This International Standard covers the following grades of wrought tool steels:

- a) non-alloy cold-work tool steels;
- b) alloy cold-work tool steels;
- c) alloy hot-work tool steels;
- d) high-speed tool steels.

If not stated otherwise, this International Standard applies to all types of hot-rolled, forged, cold-drawn or cold-rolled products which are supplied in one of the surface and heat-treatment conditions given in 4.1.2 and Table 1.

Products according to this International Standard may be produced by powder metallurgy.

NOTE 1 The Tables 2, 4, 6 and 8 cover only those steels which have gained certain international importance, which does not mean however, that they are available in all industrial countries. In addition, a number of other steels for tools are specified in regional, national or company standards.

NOTE 2 Where the heat resistance of the tools is of particular importance, as for example in the case of tools for hot forming glass, the material selection should be based on ISO 4955 or ISO 9722.

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*.

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

ISO 1035-1:1980, *Hot-rolled steel bars — Part 1: Dimensions of round bars*.

ISO 1035-3:1980, *Hot-rolled steel bars — Part 3: Dimensions of flat bars*.

ISO 1035-4:1982, *Hot-rolled steel bars — Part 4: Tolerances*.

ISO 4957:1999(E)

ISO 4948-1:1982, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition.*

ISO 6506:1981¹⁾, *Metallic materials — Hardness test — Brinell test.*

ISO 6508:1986²⁾, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K).*

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

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.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 4948-1 and ISO 6829 as well as the following apply.

3.1
product forms
[ISO 6929]

3.2
unalloyed and alloyed steel
[ISO 4948-1]

3.3
tool steels

special steels suitable for working or processing of materials, for handling and measuring workpieces and, for this purpose, exhibiting high hardness and wear resistance and/or toughness

3.3.1
cold-work tool steels

non-alloy or alloy tool steels for applications in which the surface temperature is generally below 200 °C

3.3.2
hot-work tool steels

alloy tool steels for applications in which the surface temperature is generally over 200 °C

3.3.3
high-speed tool steels

steels used mainly for machining and for forming processes and which, because of their chemical composition, have the highest high-temperature hardness and temper resistance up to about 600 °C

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1) To be replaced by ISO 6506-1, ISO 6506-2 and ISO 6506-3.

2) To be replaced by ISO 6508-1, ISO 6508-2 and ISO 6508-3.

4 Requirements

4.1 Manufacturing process

4.1.1 General

The manufacturing process of the steel and the products is left to the discretion of the manufacturer, with the restrictions given in 4.1.2.

When he so requests, the purchaser shall be informed what steel making process is being used.

4.1.2 Heat-treatment condition and surface condition on delivery

The heat-treatment and surface conditions of the products shall comply with the agreements when ordering.

4.1.2.1 Heat-treatment condition

The heat-treatment conditions are given in Table 1.

Unless otherwise specified in the order, the tool steels (except C45U, Table 2, 35CrMo7, X38CrMo16 and 40CrMnNiMo8-6-4, Table 4, 55NiCrMoV7, Table 6) are delivered in the annealed condition.

4.1.2.2 Surface condition

Usual surface conditions are:

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- a) the hot-rolled or forged condition (= as hot worked);
 - b) the machined (ground, polished, turned, peeled or milled) condition;
 - c) the cold-reduced condition.

4.2 Chemical composition and mechanical properties

4.2.1 Table 1 gives a survey of combinations of usual heat-treatment conditions at delivery and requirements according to Tables 2 to 9 (chemical composition, hardness).

4.2.2 For hardness-tempering temperature-curves of the steels see annex A.

4.2.3 For hardness penetration depth of non-alloy cold-work tool steels, see Table 2, footnote d.

4.3 Surface quality

4.3.1 All products shall have a workmanlike finish and shall be clean and free from surface imperfections likely to have an adverse effect on their processing or designated application.

4.3.2 Ground, polished or finished-machined products shall be free from surface imperfections and surface decarburization.

4.3.3 Hot-rolled, forged, cold-drawn or rough-machined products shall be ordered with sufficient material to be removed from all surfaces by machining or grinding to allow for

- a) surface decarburization and
- b) surface imperfections.

As long as no International Standard for the machining allowances of tool steels is available, the allowances shall be agreed at the time of enquiry and order.

4.4 Shape, dimensions and tolerances

The shape, dimensions and tolerances of the products shall comply with the requirements agreed upon at the time of enquiry and order. The agreements shall, as far as possible, be based on corresponding International Standards or otherwise, on suitable national standards.

For rolled flat and round bars, the following International Standards cover dimensions and/or tolerances for products included in this International Standard: ISO 1035-1, ISO 1035-3 and ISO 1035-4.

NOTE By agreement, the tolerances can be all plus or other disposition than equal plus/minus.

5 Inspection, testing and conformance of products

5.1 Inspection and testing procedures and types of inspection documents

5.1.1 For each delivery, the issue of any inspection document in accordance with ISO 10474 may be agreed upon at the time of enquiry and order.

5.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report is to be provided, this shall cover:

- a) the statement that the material complies with the requirements of the order;
- b) the results of the cast analysis for all elements specified for the type of steel supplied.

5.1.3 If, in accordance with the agreements in the order, an inspection certificate 3.1.A, 3.1.B or 3.1.C or an inspection report 3.2 (see ISO 10474) is to be provided, the specific inspections and tests described in 5.2 shall be carried out and their results shall be certified in the document.

In addition the document shall cover

- a) the results of the cast analysis provided by the manufacturer for all elements specified for the steel type concerned;
- b) the results of all inspections and tests ordered by supplementary requirements (see annex B);
- c) the symbol letters of numbers connecting the inspection documents, the test pieces and products to each other.

5.2 Specific inspection and testing

5.2.1 Number of sample products

5.2.1.1 Chemical composition

The cast analysis is given by the manufacturer. For product analysis see B.2 in annex B.

5.2.1.2 Mechanical properties

One sample product per test unit shall be tested.

5.2.1.2.1 For material delivered in the annealed or annealed and cold rolled or annealed and cold drawn condition, the test unit shall consist of products from the same cast and the same heat-treatment batch.

In the case of material heat treated in a continuous furnace, a heat-treatment batch is regarded as that quantity of products (of the same cast and dimensions) which without any interruptions, was under constant treatment conditions (same furnace temperature, atmosphere and transportation speed) through the furnace.

5.2.1.2.2 For material delivered in the quenched and tempered condition, the test unit shall consist of products from the same cast, heat-treatment and thickness.

However, if the manufacturer verifies that the thickness has no significant effect on the hardness in the quenched and tempered condition, then different thicknesses may be covered in a test unit.

5.2.1.3 Inspection of the surface quality

Unless otherwise agreed when ordering (see B.5), the number of products to be inspected for surface quality is left to the discretion of the inspector.

5.2.1.4 Dimensional inspection

Unless otherwise agreed when ordering (see B.6) the number of products to be inspected for their shape and dimensions is left to the discretion of the inspector.

5.2.2 Sampling

5.2.2.1 The general conditions for selection and preparation of samples and test pieces shall be in accordance with ISO 377 and ISO 14284.

5.2.2.2 For the Brinell hardness test the surface of the sample product or of a test piece taken from the sample product in the delivery condition shall be prepared in accordance with the requirements of ISO 6506.

5.2.3 Test methods

5.2.3.1 The Brinell hardness test shall be made in accordance with ISO 6506.

5.2.3.2 Unless otherwise agreed (see B.5), the surface quality shall be inspected visually.

5.2.4 Retests

For retests, ISO 404 shall apply.

6 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that the identification of the cast, the steel type and the origin of the delivery is possible (see B.8).

7 Ordering and designation

The designation of the product in an order shall cover the following:

- a) The quantity to be delivered.
- b) The designation of the product form (e.g. bar) followed by
 - 1) either the designation of the dimensional standard and the dimensions and tolerances selected from it (see 4.4) or
 - 2) the designation of any other document covering the dimensions and tolerances required for the product.

ISO 4957:1999(E)

- c) If a surface condition other than "hot worked" or a special surface quality is required
- 1) the surface condition (see 4.1.2.2);
 - 2) the surface quality (see 4.3).
- d) A description of the steel comprising
- 1) the reference to this International Standard;
 - 2) the designation of the steel type (see Tables 2, 4, 6 and 8);
 - 3) the symbol for the heat-treatment condition on delivery (see Table 1) and, if the products are to be delivered in the quenched and tempered condition, the hardness values required;
 - 4) the standard designation for the required type of inspection document (see ISO 10474);
 - 5) the symbol and, where necessary, the details of this supplementary requirement (see annex B), if any supplementary requirement shall be complied with.

EXAMPLE

The following are to be ordered.

- a) 2 t Hot-rolled round bars

- 1) in accordance with ISO 1035-1;
- 2) with a nominal diameter of 30,0 mm;
- 3) with a nominal length of 4 000 mm;
- 4) with a tolerance on diameter of $\pm 0,30$ mm (class S of ISO 1035-4:1982);
- 5) with a tolerance on length of $^{+100}_0$ mm (class L2 of ISO 1035-4:1982);
- 6) all other tolerances as given in ISO 1035-4, for normal cases.

- b) Surface

- 1) as hot worked.

- c) Steel

- 1) in accordance with this International Standard, type X153CrMoV12 (see Table 4);
- 2) heat-treatment condition: annealed (soft annealed) (symbol +A, see Table 1);
- 3) with an inspection certificate 3.1.B (see ISO 10474).

- d) Designation

2 t rounds ISO 1035-1-30,0 S x 4 000 L2

Steel ISO 4957-X153CrMoV12+A-3.1.B

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ISO 4957:1999
<https://standards.iteh.ai/catalog/standards/sist/2097a767-1900-46c8-85ce-67a479e6e9fe/iso-4957-1999>

Table 1 — Combinations of heat-treatment conditions at delivery and requirements in accordance with Tables 2 to 9

		4																
		Applicable requirements for																
1	2	3	4.1				4.2				4.3				4.4			
	Heat-treatment condition at delivery	Symbol ^a	non-alloy cold-work tool steels				alloy cold-work tool steels				hot-work tool steels				high-speed tool steels			
2	Untreated	+U	— ^c		+A ^c		— ^c		+A ^c		— ^c		+A ^c		— ^c		+A ^c	
3	Annealed (soft annealed) ^b	+A ^b	Hardness acc. to Table 2		Chemical composition acc. to Tables 2 and 3		Hardness acc. to Table 4		Chemical composition acc. to Tables 4 and 5		Hardness acc. to Table 6		Chemical composition acc. to Tables 6 and 7		Hardness acc. to Table 8		Chemical composition acc. to Tables 8 and 9	
4	Annealed and cold drawn	+A+C	+A and footnote b to Table 2 ^c				+A and footnote c to Table 4 ^c				+A and footnote c to Table 6 ^c				+A and footnote c to Table 8 ^c			
	Annealed and cold-rolled ^d	+A+CR ^d																
5	Quenched and tempered ^e	+QT ^e	—				f				f				—			

^a In cases where no heat-treatment condition is specified at the time of ordering, the product will be delivered in the usual heat-treatment condition given in 4.1.2.1.

^b Most common heat-treatment condition at delivery.

^c In addition, the requirements for minimum hardness in the hardening test apply. For verification see B.3.

^d Only for steels of Table 8.

^e Mainly for individually manufactured blocks for moulds and dies.

^f The hardness requirements are to be agreed at the time of enquiry and order.

Table 2 — Chemical composition (cast analysis), annealed hardness, temperature for hardening and hardness in the hardened and tempered condition for non-alloy cold-work tool steels

Steel name	Chemical composition, (% m/m) ^a						Hardness (annealed) ^b +A HB max.	Hardening test			
	C	Si	Mn	P	S	Hardening temperature °C (± 10 °C)		Quenching medium	Tempering temperature °C (± 10 °C)	Hardness HRC min.	
C45U	0,42 to 0,50	0,15 to 0,40	0,60 to 0,80	0,030	0,030	0,030	207 ^c	W	180	54	
C70U ^d	0,65 to 0,75	0,10 to 0,30	0,10 to 0,40	0,030	0,030	0,030	183	W	180	57	
C80U ^d	0,75 to 0,85	0,10 to 0,30	0,10 to 0,40	0,030	0,030	0,030	192	W	180	58	
C90U ^d	0,85 to 0,95	0,10 to 0,30	0,10 to 0,40	0,030	0,030	0,030	207	W	180	60	
C105U ^d	1,00 to 1,10	0,10 to 0,30	0,10 to 0,40	0,030	0,030	0,030	212	W	180	61	
C120U ^d	1,15 to 1,25	0,10 to 0,30	0,10 to 0,40	0,030	0,030	0,030	217	W	180	62	

^a Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

^b Hardness in the cold drawn condition (+A+C) may be 20 HB higher than in the annealed (+A) condition.

^c This grade is used in the non-heat treated condition.

^d Steel grades C70U to C120U are due to their chemical composition shallow hardening steels. For diameters of 30 mm, the hardness penetration depth will be approximately 3 mm. Through-hardening may only be achieved in diameters up to 10 mm.