

INTERNATIONAL STANDARD

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Second edition
1992-08-15

Heat-treatable steels, alloy steels and free-cutting steels —

Part 15:

Valve steels for internal combustion engines

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*Aciers pour traitement thermique, aciers alliés et aciers pour
décolletage —*

Partie 15: Aciers pour soupapes de moteurs à combustion interne

ISO 683-15:1992

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Reference number
ISO 683-15:1992(E)

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 683-15 was prepared by Technical Committee ISO/TC 17, Steel, Sub-Committee SC 4, *Heat treatable and alloy steels*.

This second edition cancels and replaces the first edition (ISO 683-15:1976), of which it constitutes a technical revision.

ISO 683 consists of the following parts, under the general title *Heat-treatable steels, alloy steels and free-cutting steels*:

- *Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products*
- *Part 9: Wrought free-cutting steels*
- *Part 10: Wrought nitriding steels*
- *Part 11: Wrought case-hardening steels*
- *Part 13: Wrought stainless steels*
- *Part 14: Hot-rolled steels for quenched and tempered springs*
- *Part 15: Valve steels for internal combustion engines*
- *Part 16: Precipitation hardening stainless steels*
- *Part 17: Ball and roller bearing steels*

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— *Part 18: Bright products of unalloyed and low alloy steels*

Annex A of this part of ISO 683 is for information only.

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Heat-treatable steels, alloy steels and free-cutting steels —

Part 15:

Valve steels for internal combustion engines

1 Scope

1.1 This part of ISO 683 applies to the grades of wrought high-alloy materials listed in table 1. These valve materials are used for intake and exhaust valves in reciprocating internal combustion engines.

It is applicable to bars, wire, wire rod and forgings and for the surface finishes listed in note 3 of 6.2.

1.2 This part of ISO 683 does not apply to alloys resistant to wear and corrosion which are used to protect valve seat surfaces.

1.3 In addition to this part of ISO 683, 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 part of ISO 683. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 683 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 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits*.

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 643:1983, *Steels — Micrographic determination of the ferritic or austenitic grain size*.

ISO 783:1989, *Metallic materials — Tensile testing at elevated temperature*.

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

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

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

ISO 6508:1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K)*.

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

ISO 8457-1:1989, *Steel wire rod — Part 1: Dimensions and tolerances*.

ISO 9443:1991, *Heat-treatable and alloy steels — Surface quality classes for hot-rolled round bars and wire rods — Technical delivery conditions*.

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

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

3 Definition

For the purposes of this part of ISO 683, the following definition applies.

3.1 valve materials: Steels and non-ferrous metal alloys which exhibit, to varying degrees, resistance to:

- heat,
- thermal cycling,
- corrosion,
- oxidation,
- fatigue loading,
- impact,
- adhesive and abrasive wear.

Valve materials are therefore used for the manufacture of intake and exhaust valves in reciprocating internal combustion engines.

4 Grade classification and categorization

4.1 The materials listed in this part of ISO 683 are classified according to their chemical composition (see table 1).

4.2 Valve materials are divided into two categories based upon structure, which is itself determined by the general chemical composition:

- martensitic steels which are primarily used for intake valves and the stem portion of exhaust valves;
- austenitic alloys, which are primarily used for exhaust valves.

5 Ordering

The purchaser shall state in his enquiry and order

- a) the quantity to be delivered;
- b) the designation of the product form (e.g. "bar", see 1.1);
- c) the number of the product standard, the dimensions and, where these are not specified in the standard, the surface finish (see 6.2, note 3) and the tolerances (see 6.6);

- d) the designation "valve material";
- e) the number of this part of ISO 683;
- f) the alloy grade (see table 1);
- g) the heat-treatment condition on delivery (see 6.2);
- h) all other necessary details including the intended method of processing (hot extrusion or upsetting with electric resistance heating);
- i) the required type of document (see 7.1).

6 Requirements

6.1 Manufacturing process

6.1.1 Unless otherwise agreed in the order, the type of melting process (see 6.1.2) and the type of process used in making the product are left to the discretion of the manufacturer.

6.1.2 The non-ferrous metal alloys NiCr 15 Fe 7 TiAl, NiFe 25 Cr 20 NbTi and NiCr 20 TiAl are usually produced by remelting processes.

6.2 Heat-treatment condition and surface finish at the time of delivery

The heat-treatment condition and surface finish of the products at the time of delivery shall be agreed when ordering.

NOTES

1 Valve materials intended for subsequent processing by metal forming are normally ordered in one of the heat-treatment conditions indicated in table 3.

2 When they have become finished components, the materials are used, depending on their chemical composition, in the quenched and tempered or the precipitation-hardened condition (see tables A.1 and A.5).

3 Valve materials are mainly supplied in bar form, with one of the following surface finishes:

- peeled and polished;
- peeled and ground;
- ground;
- ground and polished;
- peeled and ground, then polished;
- as rolled.

6.3 Chemical composition

6.3.1 The chemical composition of the materials, as given by the cast analysis, shall conform to the specifications in table 1.

6.3.2 Slight deviations from the specified limits may be permitted by the purchaser, if the characteristics in use are only affected to a negligible extent.

6.3.3 At the time of ordering, it may be agreed that the result of the product analysis, with the permissible deviations given in table 2, shall serve as proof that the limiting values for the cast analysis in table 1 have been complied with.

6.4 Mechanical properties

Table 3 specifies values of the mechanical properties at room temperature for the soft annealed and quenched and tempered conditions of martensitic steels and for the controlled cooled and/or quenched conditions of austenitic materials (see also tables A.1 to A.4).

6.5 Internal and external condition

6.5.1 Any limitations on non-metallic inclusions for valve materials shall be agreed upon at the time of enquiry and order.

NOTE 4 In connection with agreements of the type described in this subclause, it should be borne in mind that, in the case of open melting, the percentage of non-metallic inclusions will be high because of the high alloy contents of the materials complying with this part of ISO 683 and also that an irregular distribution of the non-metallic inclusions is to be expected.

6.5.2 The valve materials shall not have internal bursts, open centreline, or any other kind of internal void apparent on a polished cross-section at 100 × magnification.

6.5.3 The NiCr 20 TiAl alloy shall have a grain size of 4 and/or finer when tested in accordance with ISO 643, but occasional coarser grains shall be tolerated.

6.5.4 In the case of bars which were peeled or ground during finishing (see 6.2, note 3), the depth of surface defects shall not exceed the tolerance class h11 of ISO 286-1.

6.5.5 In all other cases, the requirements governing surface quality shall be agreed upon at the time of enquiry and order.

For round bars and wire rods to be delivered in the hot-rolled surface condition, these requirements should where appropriate be based on ISO 9443.

6.6 Dimensions and tolerances

The dimensions and tolerances of the product 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.

NOTE 5 The following International Standards cover dimensions and/or tolerances for products included in this part of ISO 683:

- for as-rolled bars: ISO 1035-1 and ISO 1035-4,
- for as-rolled wire rod: ISO 8457-1.

7 Testing

7.1 Agreement between tests and documents

7.1.1 For each delivery, the issue of one of the documents listed in 7.6 may be agreed upon at the time of enquiry and order.

7.1.2 If, in accordance with the agreements at the time of enquiry and order, a test report is to be provided, this shall cover the results of the cast analysis for all elements specified for the steel type supplied.

7.1.3 If, in accordance with the agreements at the time of enquiry and order, an inspection certificate or an inspection report is to be provided, the specifications in 7.2 to 7.5 are to be observed.

7.2 Number of tests

7.2.1 Mechanical tests

7.2.1.1 The test unit shall consist of products from the same cast, the same type of manufacturing process and the same heat-treatment batch; all products of the test unit shall have cross-sections of the same form and nominal dimensions.

7.2.1.2 For the purpose of verifying the mechanical properties given in table 3, unless otherwise agreed at the time of ordering, one sample per 10 t shall be taken from the test units as described in 7.2.1.1. As far as possible, the hardness shall be determined, otherwise the tensile test shall be carried out.

7.2.2 Other tests

Where, in addition to the tests in 7.2.1, other tests are to be carried out and certified in an inspection certificate or inspection report, this shall be agreed upon at the time of enquiry and order together with the necessary details on the test unit and the number of tests.

7.3 Selection and preparation of samples and test pieces

7.3.1 Product analysis

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

If the spectrographic analysis method is used, testing may be carried out on the surface of the product. However, in cases of doubt, it will be necessary to carry out several analyses evenly distributed over the cross-section of the product and to average their results.

7.3.2 Tensile and hardness tests

7.3.2.1 The test pieces for the tensile test shall be taken in the longitudinal direction of the products (in accordance with figure 1) and be prepared in accordance with ISO 377-1 and ISO 6892.

7.3.2.2 The hardness test shall be made in the cross-sectional area from which the tensile test pieces are to be taken, in accordance with figure 1. The test pieces for the hardness test shall be prepared in accordance with ISO 6506 or ISO 6508.

7.3.3 Grain size

The instructions given in ISO 643 shall apply to the sampling and preparation of test pieces for determining the austenitic grain size.

7.3.4 Surface testing

In accordance with ISO 9443, in cases of dispute, transverse microsections shall be prepared for the microscopic examination of the surface quality (see also 7.4.5).

7.4 Test methods

7.4.1 Chemical analysis

The chemical composition shall be determined in accordance with the appropriate International Standards listed in ISO/TR 9769 or prepared since the publication of ISO/TR 9769.

7.4.2 Tensile test

The tensile test shall be performed in accordance with ISO 6892.

7.4.3 Hardness test

The Rockwell C hardness test shall be performed in accordance with ISO 6508, the Brinell hardness test shall be performed in accordance with ISO 6506.

7.4.4 Grain size

The austenitic grain size shall be determined in accordance with ISO 643.

Unless otherwise agreed, the choice between the various methods specified in ISO 643 is left to the discretion of the manufacturer.

7.4.5 Surface defects

In cases of dispute, the depth of surface defects shall, in accordance with ISO 9443, be determined by metallography on a transverse microsection. If this is not possible, the defective spot shall be filed until the defect disappears, in order to determine the depth of the defect by suitable means.

7.5 Retests

ISO 404 shall apply for retests.

7.6 Certification of the tests

ISO 10474 is valid, acceptable documents being:

- a test report,
- an inspection certificate, or
- an inspection report.

8 Marking

8.1 Each coil of wire or bundle of bars shall be identified by means of a securely affixed label, featuring

- the manufacturer's mark or name,
- the grade of material,
- the cast number,
- the nominal size.

Marking which identifies the surface finish and/or indicates the coil or bundle weight may be agreed upon.

8.2 The marking on the label shall remain clearly legible even after prolonged outdoor exposure of the coil or bundle.

8.3 In the case of bars with diameters not smaller than 30 mm or with a cross-section of equivalent area, the manufacturer shall also ensure that one bar per bundle is marked as a guide bar. This requires painting its front end white and affixing the manufacturer's mark, the material grade and the

cast number on the front end, either by engraving (die-stamping), or by printing (rubber stamping), or by means of adhesive tape.

In the case of diameters smaller than 30 mm, or cross-sections of equivalent area, a second label

giving information about the manufacturer, the material grade and the cast number shall be provided.

9 Complaints

The conditions for dealing with complaints specified in ISO 404 shall apply.

Dimensions in millimetres

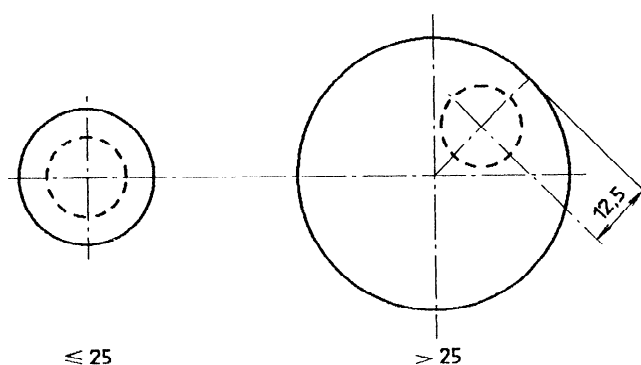


Figure 1 — Location of tensile test pieces

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Table 1 — Types of valve materials and specified chemical composition (applicable to cast analysis)

Material designation	Comparable type in ISO 683-15:1976	Chemical composition [% (m/m)]								
		C	Si	Mn	P max.	S max.	Cr	Mo	Ni	Others
Martensitic steels										
X 50 CrSi 8 2	---	0,45 to 0,55	1,0 to 2,0	max. 0,60	0,030	0,030	7,5 to 9,5	2,0 to 2,5	max. 0,60	0,30 to 0,60 V
X 45 CrSi 9 3	1	0,40 to 0,50	2,7 to 3,3	max. 0,80	0,040	0,030	8,0 to 10,0		max. 0,60	
X 85 CrMoV 18 2	3	0,80 to 0,90	max. 1,0	max. 1,5	0,040	0,030	16,5 to 18,5			
Austenitic materials										
X 55 CrMnNiN 20 8	---	0,50 to 0,60	max. 0,25	7,0 to 10,0	0,050	0,030	19,5 to 21,5		1,5 to 2,75	0,20 to 0,40 N
X 53 CrMnNiN 21 9	8,9	0,48 to 0,58	max. 0,25	8,0 to 10,0	0,050	0,030	20,0 to 22,0		3,25 to 4,5	0,35 to 0,50 N
X 50 CrMnNiNbN 21 9	---	0,45 to 0,55	max. 0,45	8,0 to 10,0	0,050	0,030	20,0 to 22,0		3,5 to 5,5	0,80 to 1,50 W 1,80 to 2,50 Nb + Ta 0,40 to 0,60 N
X 53 CrMnNiNbN 21 9	---	0,48 to 0,58	max. 0,45	8,0 to 10,0	0,050	0,030	20,0 to 22,0		3,25 to 4,5	0,38 to 0,50 N C + N > 0,90 2,00 to 3,00 Nb + Ta
X 33 CrNiMnN 23 8	---	0,28 to 0,38	0,50 to 1,00	1,5 to 3,5	0,050	0,030	22,0 to 24,0	max. 0,50	7,0 to 9,0	max. 0,50 W 0,25 to 0,35 N
NiCr 15 Fe 7 TiAl	---	0,03 to 0,10	max. 0,50	max. 0,50	0,015	0,015	14,0 to 17,0	max. 0,50	Remainder	1,10 to 1,35 Al 5,0 to 9,0 Fe 0,70 to 1,20 Nb + Ta 2,0 to 2,6 Ti
NiFe 25 Cr 20 NbTi	---	max. 0,10	max. 1,0	max. 1,0	0,030	0,015	18,0 to 21,0		Remainder	0,30 to 1,00 Al 23,0 to 28,0 Fe 1,0 to 2,0 Nb + Ta 1,0 to 2,0 Ti max. 0,008 B
NiCr 20 TiAl	11	0,04 to 0,10	max. 1,0	max. 1,0	0,020	0,015	18,0 to 21,0		min. 65	max. 3,0 Fe max. 0,2 Cu max. 2,0 Co max. 0,008 B 1,0 to 1,8 Al 1,8 to 2,7 Ti

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