INTERNATIONAL STANDARD

ISO 683-2

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

Part 2: Alloy steels for quenching and tempering

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

Partie 2: Aciers alliés pour trempe et revenu

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

This second edition cancels and replaces the first edition (ISO 683-2:2012), of which it constitutes a minor revision.

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

— *Part 1: Non-alloy steels for quenching and tempering*

— *Part 2: Alloy steels for quenching and tempering*

— *Part 3: Case-hardening steels*

— *Part 4: Free-cutting steels*

— *Part 5: Nitriding steels*

— *Part 14: Hot-rolled steels for quenched and tempered springs*

— *Part 15: Valve steels for internal combustion engines*

— *Part 17: Ball and roller bearing steels*

— *Part 18: Bright steel products*

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

Part 2:
Alloy steels for quenching and tempering

1 Scope

This part of ISO 683 specifies the technical delivery requirements for

— semi-finished products, hot formed, e.g. blooms, billets, slabs (see Note 1),

— bars (see Note 1),

— wire rod,

— finished flat products, and

— hammer or drop forgings (see Note 1)

manufactured from the direct hardening alloy steels and the alloy flame- and induction-hardening steels listed in Table 3 and supplied in one of the heat-treatment conditions given for the different types of products in Table 1 and in one of the surface conditions given in Table 2.

The steels are, in general, intended for the manufacture of quenched and tempered or austempered (see 3.2 and Note 2) and flame- or induction-hardened machine parts (see Tables 8 and 9).

The requirements for mechanical properties given in this part of ISO 683 are restricted to the sizes given in the relevant Table 8.

NOTE 1 Hammer-forged semi-finished products (blooms, billets, slabs, etc.), seamless rolled rings and hammer-forged bars are in the following covered under semi-finished products or bars and not under the term "hammer and drop forgings".

NOTE 2 For the purposes of simplification, the term "quenched and tempered" is, unless otherwise indicated, used in the following also for the austempered condition.

NOTE 3 For International Standards relating to steels complying with the requirements for the chemical composition in Table 3, however, supplied in other product forms or treatment conditions than given above or intended for special applications, and for other related International Standards, see the Bibliography.

NOTE 4 This part of ISO 683 does not apply to bright products and bars and wire rod for cold heading. For such products, see ISO 683-18 and ISO 4954.

In special cases, variations in these technical delivery requirements or additions to them can form the subject of an agreement at the time of enquiry and order (see 5.2 and Annex B).

In addition to this part of ISO 683, the general technical delivery requirements of ISO 404 are applicable.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

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

ISO 404:2013, *Steel and steel products — General technical delivery requirements*

ISO 642, *Steel — Hardenability test by end quenching (Jominy test)*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 3887, *Steels — Determination of depth of decarburization*

ISO 4885:—[1)], *Ferrous products — Heat treatments — Vocabulary*

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

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

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

ISO 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6929, *Steel products — Vocabulary*

ISO 7788, *Steel — Surface finish of hot-rolled plates and wide flats — Delivery requirements*

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

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

3 Terms and definitions

For the purposes of this document, the definitions in ISO 377, ISO 4885, ISO 4948-1, ISO 4948-2, ISO 6929, ISO 14284, and the following apply.

NOTE For deviations from these terms and definitions, see Notes 1 and 2 of Clause 1.

3.1
ruling section
section for which the specified mechanical properties shall apply

Note 1 to entry: Independent of the actual shape and dimensions of the cross-section of the product, the size of its ruling section is always given by a diameter. This corresponds to the diameter of an "equivalent round bar". That is a round bar which will show the same cooling rate as the actual ruling section of the product concerned at its position for taking the test pieces, when being cooled from austenitizing temperature.

1) Under preparation. Stage at the time of publication: ISO/DIS 4885:2016.

3.2
austempering
isothermal heat treatment for producing bainitic or ausferritic structure of a work piece

Note 1 to entry: The final cooling to ambient temperature is not at a specific rate.

[SOURCE: ISO 4885:—[2)], 3.11]

3.3
alloy steel
as defined in ISO 4948-1:1982, 3.1.3

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades is according to ISO 4948-1 and ISO 4948-2. All steel grades covered by this part of ISO 683 are alloy special steels.

4.2 Designation

For the steel grades covered by this part of ISO 683, the steel names as given in the relevant tables are allocated in accordance with ISO/TS 4949.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The manufacturer shall obtain the following information from the purchaser at the time of enquiry and order:

a) quantity to be delivered;

b) designation of the product form (slab, bloom, billet, round bar, wire rod, wide flat, sheet, plate, strip, forging, etc.);

c) either the designation of the dimensional standard and the dimensions and tolerances selected from this (see 7.9) or, for example in the case of drop forgings, the designation of the drawing or any other document covering the dimensions and tolerances required for the product;

d) reference to this part of ISO 683, i.e. ISO 683-2;

e) the designation of the steel grade given in Table 3;

f) the symbol for the required heat-treatment condition (see Table 1, column 2);

g) standard designation for a test report 2.2 or, if required any other type of inspection document in accordance with ISO 10474 or according to another regional standard, e.g. EN 10204 or JIS G 0415.

5.2 Options and/or supplementary or special requirements

Several options are specified in this part of ISO 683 and listed below. If the purchaser does not indicate any of these options, the products will be supplied in accordance with the basic specifications of this part of ISO 683 (see 5.1):

a) if another surface condition than “hot worked” or a special surface quality is required, the surface condition (see Table 2) and the surface quality (see 7.7);

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b) any requirement for the hardenability (+H, +HH, +HL) for special steels (see 7.1.4 and Tables 5 to 7);

c) any supplementary requirement that shall be complied with, the symbol and, where necessary, the details of this supplementary requirement (see Annex B);

d) any requirement for the verification of non-metallic inclusion content (see 7.5);

e) verification of hardenability and, if agreed, the information about calculation of the hardenability (see 9.3.2);

f) any requirement regarding the permissible depth of decarburization (see 7.8);

g) suitability of bars and rod for bright drawing (see 7.7.4);

h) any requirement relating to the removal of surface defects (see 7.7.5).

5.3 Ordering example

EXAMPLE Fifty hot-rolled round bars according to ISO 1035-1 with a nominal diameter of 40 mm and a nominal length of 8 000 mm with diameter tolerance according to class S and with length tolerance according to class L2 of ISO 1035-4 made of steel grade ISO 683-2, 42CrMo4 (see Table 3) in the heat-treatment condition +S (see Table 1), surface blast cleaned (+BC) (see Table 2), product analysis/option B.4 with an inspection certificate 3.1 according to ISO 10474:

50 round bars ISO 1035 – 40,0S × 8 000L2

ISO 683-2 – 42CrMo4+S +BC option B.4

ISO 10474 – 3.1

6 Manufacturing process

6.1 General

The manufacturing process of the steel and of the products is, with the restrictions given by the requirements in 6.2 to 6.4, left to the discretion of the manufacturer.

For minimum reduction ratio or minimum thickness deformation ratio of rolled and forged products, see B.5.

6.2 Deoxidation

All steels shall be deoxidized.

6.3 Heat-treatment condition and surface condition at delivery

6.3.1 Heat-treatment condition

The products shall be delivered in one of the heat-treatment conditions given in Table 1, lines 2 to 6 as agreed during time of enquiry and order.

6.3.2 Particular surface conditions

If so agreed at the time of enquiry and order, the products shall be delivered in one of the particular surface conditions given in Table 2, lines 3 to 6.

6.4 Traceability of the cast

Each product shall be traceable to the cast (see Clause 10).

7 Requirements

7.1 Chemical composition, mechanical properties and hardenability

7.1.1 General

Table 1 shows the combinations of usual heat-treatment conditions at delivery, product forms and requirements, as specified in Tables 3 to 9.

Except where steels are ordered in the quenched and tempered condition, this part of ISO 683 makes for the alloyed steels provisions to be supplied with or without hardenability requirements (see Table 1, columns 8 and 9).

7.1.2 Chemical composition

The chemical composition determined by cast analysis shall comply with the values in Table 3.

Permissible deviations between the limiting values for cast analysis and the values for product analysis are given in Table 4.

The product analysis shall be carried out when specified at the time of the enquiry and order (see B.4).

7.1.3 Mechanical properties

Where the steel is ordered without hardenability requirements, the requirements for mechanical properties specified in Tables 7 or 8 apply as appropriate for the particular heat treatment condition.

In this case, the hardenability values given in Table 5 are for guidance purposes only.

The mechanical property values given in Table 8 apply to test pieces in the quenched and tempered condition, which have been taken and prepared in accordance with Figure 2 or Figures 3 and 4 (see also footnote a to Table 1).

7.1.4 Hardenability

Where the steel is ordered using the designations given in Table 5 or 6 to normal (see Table 5) or to narrowed (see Table 6) hardenability requirements, the values of hardenability given in Table 5 or 6, respectively apply in addition to the requirements cited in Table 1, columns 9.1 and 9.2. (see footnote b to Table 3).

7.1.5 Surface hardness

For the surface hardness of alloy steels after flame or induction hardening, the specifications in Table 9 apply.

7.2 Machinability

All steels are machinable in the condition “soft annealed”. Where improved machinability is required, grades with a specified sulfur range and/or with a specific treatment should be ordered to improve machinability (see also Table 1, line 6).

7.3 Cold shearability

7.3.1 Under suitable shearing conditions (avoiding local stress peaks, preheating, application of blades with a profile adapted to that of the product, etc.) all steels are cold shearable in the soft annealed (+A) condition.

7.3.2 Steel grades 34Cr4, 37Cr4, 41Cr4, 25CrMo4, 34CrMo4, 42CrMo4 and 41CrNiMo2 with maximum and specified range S-content, boron-alloy steel grades 33MnCrB5-2 and 39MnCrB6-2 and the corresponding +H, +HH and +HL grades (see Tables 3 and 5 to 7) are, under suitable conditions, also cold shearable when being delivered in the condition "treated to improve shearability (+S)" with the hardness requirements given in Table 7.

7.3.3 Under suitable conditions, steel grades 20MnB5, 30MnB5, 39MnB5 and 27MnCrB5-2, and the corresponding grades with requirements on hardenability (see Table 5), are cold shearable in the untreated condition.

7.4 Grain size

All steels shall have a fine grain structure with an austenite grain size of 5 or finer when tested in accordance with ISO 643. For verification, see B.2.

7.5 Non-metallic inclusions

7.5.1 Microscopic inclusions

The special steels shall have a certain degree of cleanness; however, verification of the non-metallic inclusion content requires a special agreement. If there is such an agreement at the time of enquiry and order, the microscopic non-metallic inclusion content shall be determined to an agreed procedure and within agreed limits in accordance with ISO 4967 or another standard, e.g. regional standards EN 10247 or JIS G 0555.

For grades with specified minimum sulfur content, the agreement should not include sulfides.

7.5.2 Macroscopic inclusions

This requirement is applicable to the verification of the macroscopic inclusions in special steels. If verification is agreed, the method and acceptance limits shall be agreed at the time of enquiry and order.

7.6 Internal soundness

Where appropriate, requirements relating to the internal soundness of the products shall be agreed at the time of enquiry and order (see B.3).

7.7 Surface quality

7.7.1 All products shall have a smooth surface finish appropriate to the manufacturing process applied.

7.7.2 Minor surface imperfections, which may occur also under normal manufacturing conditions, such as prints originating from rolled-in scale, are not to be regarded as defects.

7.7.3 Bars and wire rod shall be delivered with surface class 1za2 according to ISO 9443 and hot-rolled plates and wide flats are delivered with a surface according ISO 7788 unless otherwise agreed at the time of enquiry and order.

Where no International Standard on the surface quality of steel products exists, detailed requirements referring to this characteristic shall, where appropriate, be agreed at the time of enquiry and order.

It is more difficult to detect and eliminate surface discontinuities from coiled products than from cut lengths. This should be taken into account when agreements on surface quality are made.

7.7.4 If suitability of bars and rod for bright drawing is required, this shall be agreed at the time of enquiry and order.

