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

Part 17: Ball and roller bearing steels

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

Partie 17: Aciers pour roulements

[Revision of second edition (ISO 683-17:1999)]

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ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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

This third edition cancels and replaces the second edition (ISO 683-17:1999) which has been technically revised.

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 9: Wrought free-cutting steels*
- *Part 10: Wrought nitriding steels*
- *Part 11: Case-hardening 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 products of non-alloy and alloy steels*

Heat-treatable steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels

1 Scope

1.1 This part of ISO 683 specifies the technical delivery requirements for five groups of wrought ball and roller bearing steels as listed in Table 3, namely:

- through-hardening bearing steels (steels with about 1 % C and 1 % to 2 % Cr),
- case-hardening bearing steels,
- induction-hardening bearing steels (unalloyed and alloyed),
- stainless bearing steels,
- high temperature bearing steels.

1.2 This part of ISO 683 applies to the products and heat-treatment conditions given in Table 1 and the surface conditions given in Table 2.

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 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, *Steel and steel products – Location and preparation of samples and test pieces for mechanical testing*

ISO 404, *Steel and steel products - General technical delivery requirements*

ISO 642, *Steels - Hardenability test by end quenching (Jominy test)*

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

ISO 3763, *Wrought steels - Macroscopic methods for assessing the content of non-metallic inclusion.*

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

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 4969, *Steel - Macroscopic examination by etching with strong mineral acids*

ISO 5949, *Tool steels and bearing steels - Micrographic method for assessing the distribution of carbides using reference photomicrographs*

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

ISO 6929, *Steel products - Definitions and classification*

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

ISO/TR 9769, *Steel and iron - Review of available methods of analysis*

ISO 10474:1991, *Steel and steel products - Inspection documents (Corrected and reprinted in 1992-12)*

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 terms and definitions given in ISO 6929 and the following apply.

3.1 ball and roller bearing steels
steels for rolling elements which use balls and rollers to maintain the separation between the moving parts of the bearing

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades is allocated in accordance with ISO 4948-1 and ISO 4948-2. All steel grades covered by this standard are special steels.

4.2 Designation

For the steel grades covered by this document, 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) The quantity to be delivered;
- b) The designation of the products form (billets, bars, rod, wire, tubes, rings, discs etc.);

- c) Either the designation of the dimensional standard and the dimensions and tolerances selected from it (see 7.6) or the designation of any other document covering the dimensions and tolerances required for the product;
- d) Reference to this standard ISO 683-17;
- e) the designation of the steel grade (see Table 3);
- f) the symbol for the heat-treatment condition on delivery (see 6.3.1 and Table 1);
- g) standard designation for an inspection certificate 3.1 or, if required an inspection certificate 3.2 in accordance with ISO 10474.

5.2 Options/Supplementary or special requirements

A number of options are specified in this International Standard and listed below. If the purchaser does not indicate the wish to implement any of these options, the products will be supplied in accordance with the basic specifications of this standard (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 7.5);
- b) Any requirement to the hardenability (+H, +HH, +HL) (see 7.1.3 and Table 5);
- c) Any supplementary requirement that shall be complied with, the symbol and, where necessary, the details of this supplementary requirement (see Annex A);
- d) Verification of hardenability and if agreed the information about calculation of the hardenability (see 9.2.2), if specific inspection is ordered verification is done in every case (see 8.3.1).

EXAMPLE 50 Hot-rolled round bars according to ISO 1035-1 with nominal diameter of 50,0 mm, nominal length of 8 000 mm and with tolerance class S on diameter of $\pm 0,40$ mm and tolerance class L2 on length of +100/0 in accordance with ISO 1035-4 and with hot worked surface made of steel grade ISO 683-17 100Cr6 (see Table 3) in annealed condition to achieve spheroidized carbides (+AC), with an inspection certificate 3.1 in accordance with ISO 10474:

**50 round bars ISO 1035-1/-4 – 50,0 S x 8 000 L2
steel grade ISO 683-17 – 100Cr6+AC
inspection certificate 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 and 6.3, left to the discretion of the manufacturer.

If requested the purchaser shall be informed on the steel making process used.

Remelting of the steel may be agreed upon at the time of enquiry and order.

6.2 Deoxidation

All steels shall be deoxidized.

6.3 Heat treatment 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 11 as agreed at the time of enquiry and order. If there is no agreement the products shall be delivered in the untreated condition.

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 10.

6.3.3 Traceability of the cast

Each product shall be traceable to the cast, see 10.

7 Requirements

7.1 Chemical composition and hardenability

7.1.1 General

Table 1 gives a survey on combinations of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 6 (chemical composition, hardenability, maximum hardness, hardness range).

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 9.1 and A.1).

7.1.3 Hardenability

Where the steel is not ordered to hardenability requirements - i.e. where the steel type designations of Table 3 and not the designations given in Table 5 are applied - the requirements for hardness specified in table 6 (see also Table 1, column 9) apply as appropriate for the particular heat-treatment condition. In this case the values of hardenability given in Table 5 are for guidance purposes only.

Where the steel is, by using the designations given in Table 5, ordered to hardenability requirements, the values of hardenability given in Table 5 apply in addition to the requirements cited in Table 1, column 9 (see footnote b to Table 3).

7.1.4 Hardness

The hardness in the usual conditions of delivery is given in Table 6.

7.2 Microstructure

7.2.1 Austenitic grain size of case hardening and induction hardening bearing steels

Case hardening steels and induction hardening steels shall be fine grained. This requirement shall be regarded as complied with if

- a) in the case of case hardening steels after holding the steel for 4 h at (925 ± 10) °C, at least 70 % of the microstructure revealed according to one of the procedures given in ISO 643 consists of grains of size 5 or finer
- b) in the case of induction hardening steels after holding for 1,5 h at (850 ± 10) °C the microstructure revealed according to one of the procedures given in ISO 643 consists of grains of size 5 or finer.

For verification of the grain size, see Annex A.2.

7.2.2 Spheroidization and distribution of carbides

7.2.2.1 For deliveries in treatment conditions +AC and +AC+C, the carbides of the through hardening steels shall be spheroidized and the carbides of the stainless and high temperature bearing steels shall be predominantly spheroidized. Case hardening steels may show remnants of incompletely spheroidized carbides. For the degree of spheroidization see Annex A.3.

7.2.2.2 For distribution of carbides, see Annex A.4.

7.2.3 Structure of case-hardening steels in the condition +FP

The structure shall consist of ferrite-pearlite. Bainite contents up to 10 % are, however, permissible.

7.3 Non-metallic inclusions

7.3.1 Microscopic inclusions

The characterization of non-metallic inclusions is critically important to the fatigue life of bearings. Therefore all bearing steels shall have a certain degree of cleanliness. The requirements for non-metallic inclusions content apply in every case; however, verification requires a special agreement, see Annex A.5.

7.3.2 Macroscopic inclusions

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

7.4 Internal soundness

Where appropriate, requirements relating to the internal soundness of the products shall be agreed at the time of enquiry and order, see Annex A.6.

7.5 Surface quality

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

7.5.2 Ground or turned or machined products shall be free from surface discontinuities detrimental to practical use and surface decarburization.

7.5.3 Hot-rolled, forged, cold-reduced, peeled or rough-machined products shall be ordered with sufficient material machining allowances to be removed from all surfaces by machining or grinding to allow for:

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

The machining allowances shall be agreed upon at the time of enquiry and order.

Alternatively, for round bars and rod the permissible depth of surface discontinuities may be specified in accordance with ISO 9443.

7.6 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 (see Annex C) or, otherwise, on suitable national standards.

8 Inspection

8.1 Testing procedures and types of inspection documents

8.1.1 Products complying with this International Standard shall be ordered and delivered with inspection certificate 3.1 or 3.2 as specified in ISO 10474. The type of document shall be agreed upon at the time of enquiry and order. If the order does not contain any specification of this type, an inspection certificate 3.1 shall be issued.

8.1.2 If in accordance with the agreements in the order an inspection certificate 3.1 or 3.2 to ISO 10474 is to be provided, the specific inspections and tests described in 8.3 and 9 shall be carried out and the results shall be confirmed in the inspection certificate.

In addition the inspection certificate report shall cover:

- a) Confirmation that the material complies with the requirements of the order;
- b) Results of the cast analysis for all elements specified in Table 3 for the steel grade concerned;
- c) the results of all inspections and tests ordered by supplementary requirements (see Annex A);
- d) the symbol letters or numbers connecting the inspection document with the relevant test unit.

8.2 Frequency of testing

The amount of testing, the sampling conditions and the test methods to be applied for the verification of the requirements shall be in accordance with the prescriptions in Table 7.

8.3 Specific inspection and testing

8.3.1 Verification of the hardenability and hardness

The hardness requirements given for the relevant heat-treatment condition in Table 6 (see also Table 1, column 9, sub-column 9.2) shall be verified.

For steels ordered with the symbol +H in the designation (see Table 5), in addition, the hardenability requirements according to Table 5 shall be verified.