
**Heat-treatable 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

STANDARDSISO.COM : Click to view the full PDF of ISO 683-17:2023



STANDARDSISO.COM : Click to view the full PDF of ISO 683-17:2023



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Classification and designation	2
4.1 Classification	2
4.2 Designation	2
5 Information to be supplied by the purchaser	3
5.1 Mandatory information	3
5.2 Options/Supplementary or special requirements	3
6 Manufacturing process	3
6.1 General	3
6.2 Deoxidation, vacuum degassing and hydrogen removal	4
6.3 Heat-treatment and surface condition at delivery	4
6.3.1 Heat-treatment condition	4
6.3.2 Particular surface conditions	4
6.3.3 Traceability of the cast	4
7 Requirements	4
7.1 General	4
7.2 Chemical composition	4
7.3 Hardenability	4
7.4 Hardness	5
7.5 Microstructure	5
7.5.1 Austenitic grain size of case-hardening and induction-hardening bearing steels	5
7.5.2 Spheroidization and distribution of carbides	5
7.5.3 Structure of case-hardening steels in the condition +FP	5
7.6 Non-metallic inclusions	5
7.6.1 Microscopic inclusions	5
7.6.2 Macroscopic inclusions	5
7.7 Internal soundness	5
7.8 Surface quality	5
7.9 Shape dimensions and tolerances	6
8 Inspection	6
8.1 Testing procedures and types of inspection documents	6
8.2 Frequency of testing	6
8.3 Specific inspection and testing	6
8.3.1 Verification of the hardenability and hardness	6
8.3.2 Inspection of the surface quality	6
8.3.3 Dimensional and shape inspection	7
9 Test methods	7
9.1 Chemical analysis	7
9.2 Hardness and hardenability tests	7
9.2.1 Hardness	7
9.2.2 Verification of hardenability	7
9.2.3 Retests	7
10 Marking	7
Annex A (normative) Supplementary or special requirements	19
Annex B (informative) Designations of the steels given in Tables 3, 5 and 6 and of comparable grades covered in various designation systems	22

Bibliography	24
---------------------------	-----------

STANDARDSISO.COM : Click to view the full PDF of ISO 683-17:2023

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.

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 459/SC 5, *Steels for heat treatment, alloy steels, free-cutting steels and stainless steels*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 683-17:2014), which has been technically revised.

The main changes are as follows:

- induction hardening steel 50CrMo4 and stainless steel X30CrMoN15-1 were added;
- requirements for Ca and Ti content have been added for through-hardening bearing steels;
- requirements for O content have been further restricted for through-hardening and induction-hardening bearing steels;
- option for H content for premium bearing steels has been added for through-hardening, case-hardening and induction-hardening bearing steels;
- option for verification of microscopic inclusions in [Table A.1](#) for through-hardening bearing steels has been revised.

A list of all parts in the ISO 683 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-17:2023

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

Part 17: Ball and roller bearing steels

1 Scope

This document 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, and
- high-temperature bearing steels.

This document is applicable to the products and heat-treatment conditions given in [Table 1](#) and the surface conditions given in [Table 2](#).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Steel — 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 inclusions*

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

ISO 4885, *Ferrous materials — 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 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

ISO 4969, *Steel — Etching method for macroscopic examination*

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 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6929, *Steel products — Vocabulary*

ISO 9443, *Surface quality classes for hot-rolled bars and wire rod*

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

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

ISO 23825, *Method for evaluating the nodularity of spheroidal carbides — Steels for cold heading and cold extruding*

ASTM A892, *Standard Guide for Defining and Rating the Microstructure of High Carbon Bearing Steels*

JIS G0555, *Microscopic testing method for the non-metallic inclusions in steel*

SEP 1520, *Microscopic examination of carbide structure in steels by means of diagram series*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 4885, ISO 4948-1, ISO 4948-2, ISO 6929, ISO 9443, ISO 14284 and the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

ball and roller bearing steel

steel for rings and/or rolling bodies 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 document are special steels.

4.2 Designation

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

NOTE Designation of steels covered by this document and of comparable grades covered in various other designation systems are given in [Annex B](#).

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, wire rod, wire, tubes, rings, discs, etc.);
- c) either the reference to 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) a reference to this document, i.e. ISO 683-17:2023;
- 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) designation for an inspection certificate 3.1 (see [8.1.1](#)) 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 document and listed below.

- 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 concerning the hardenability (+H) (see [7.3](#) and [Table 5](#)) and the verification of hardenability and if agreed the information about calculation of the hardenability (see [9.2.2](#)).
- c) Any supplementary requirement that shall be conformed with, the symbol and, where necessary, the details of this supplementary requirement (see [Annex A](#)).

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 $+100/0$ mm 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 × 8 000 L2

steel grade ISO 683-17 - 100Cr6+AC

inspection certificate ISO 10474 - 3.1

6 Manufacturing process

6.1 General

Within the restrictions given by the requirements in [6.2](#) and [6.3](#), the manufacturing process of the steel and of the products is left to the discretion of the manufacturer.

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

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

6.2 Deoxidation, vacuum degassing and hydrogen removal

All steels shall be deoxidized.

Vacuum degassing and hydrogen removal treatment for premium applications is at the discretion of the manufacturer.

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](#), row 2 to row 10, 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 agreed upon at the time of enquiry and order, the products shall be delivered in one of the particular surface conditions given in [Table 2](#), row 3 to row 9.

6.3.3 Traceability of the cast

Each product shall be traceable to the cast, see [Clause 10](#).

7 Requirements

7.1 General

[Table 1](#) gives a survey of 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).

In addition to this document, the general technical delivery requirements of ISO 404 shall apply.

7.2 Chemical composition

The chemical composition determined by cast analysis shall conform 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 [Clause A.2](#)).

7.3 Hardenability

Where the steel is not ordered according 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) shall apply, as appropriate, for the particular heat-treatment condition. In this case, the values of hardenability given in [Table 5](#) shall be for guidance purposes only.

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

7.4 Hardness

The hardness in the usual conditions of delivery is given in [Table 6](#).

7.5 Microstructure

7.5.1 Austenitic grain size of case-hardening and induction-hardening bearing steels

Case-hardening steels and induction-hardening steels shall have a fine grain size of 5 or finer in accordance with ISO 643. For verification of the grain size, see [Clause A.3](#).

7.5.2 Spheroidization and distribution of carbides

7.5.2.1 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 [Clause A.4](#).

7.5.2.2 For distribution of carbides, see [Clause A.5](#).

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

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

7.6 Non-metallic inclusions

7.6.1 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 the content of non-metallic inclusions apply in every case; however, verification requires a special agreement, see [Clause A.6](#).

7.6.2 Macroscopic inclusions

If verification is agreed, then the method and acceptance limits shall be agreed at the time of enquiry and order.

7.7 Internal soundness

Where appropriate, requirements relating to the internal soundness of the products shall be agreed at the time of enquiry and order, see [Clause A.7](#).

7.8 Surface quality

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

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

7.8.3 If hot-rolled, forged, cold-reduced or rough-machined products are ordered for peeling or grinding to avoid

- a) surface decarburization, and

b) surface defects,

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.

7.9 Shape, dimensions and tolerances

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

8 Inspection

8.1 Testing procedures and types of inspection documents

8.1.1 Products conforming with this document 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 The specific inspections and tests described in [8.2](#) and [8.3](#) 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 conforms 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 in accordance with [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 [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.

8.3.2 Inspection of the surface quality

Unless otherwise agreed at the time of enquiry and order (see [Clause A.8](#)), the extent of testing and the test method is left to the discretion of the manufacturer.

8.3.3 Dimensional and shape inspection

Unless otherwise agreed at the time of enquiry and order (see [Clause A.9](#)), the number of products to be inspected for their dimensions and shape shall be left to the discretion of the manufacturer.

9 Test methods

9.1 Chemical analysis

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer. In cases of dispute, the method for product analysis used shall be agreed, taking into account the relevant existing International Standards.

The list of available International Standards on chemical analysis is given in ISO/TR 9769.

9.2 Hardness and hardenability tests

9.2.1 Hardness

For products in treatment conditions +S, +A, +TH, +AC, +AC+C and +FP (see [Table 6](#)), the hardness shall be measured in accordance with ISO 6506-1.

9.2.2 Verification of hardenability

As far as available, the manufacturer has the option to verify the hardenability by calculation. The calculation method is left to the discretion of the manufacturer. If agreed at the time of enquiry and order, the manufacturer shall give sufficient information about the calculation for the customer to confirm the result.

If a calculation formula is not available or in the case of dispute, an end-quench hardenability test shall be carried out in accordance with ISO 642. The temperature for quenching shall conform with [Table 5](#). The hardness values shall be determined in accordance with ISO 6508-1, scale C.

9.2.3 Retests

For retests, ISO 404 shall apply.

10 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that identification of the cast, the steel grade and the origin of the delivery is possible (see [Clause A.10](#)).

Table 1 — Combination of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 6

	1	2	3	4	5	6	7	8	9	10	
			x ^a						Applicable requirements if the steel is ordered with the designation given in Tables 3, 4 and 6		
1	Heat-treatment condition at delivery	Symbol	billets	bars	wire rod	wire	tubes	rings and discs	Table 5		
2	Untreated	None or +U	x	x	x	-	-	-	9.1	9.2	
3	Treated for cold shearability	+S	x	x	x	-	-	-	-	-	
4	Soft annealed/solution annealed	+A/+AT	-	x	x	-	-	-	Column +S	Column +A	
5	Treated to hardness range	+TH	-	x	x	x	-	x	Maximum hardness or hardness range according to Table 6	Column +TH	
6	Annealed to achieve spheroidized carbides	+AC	-	x	x	x	x	x	Column +AC	Column +AC	
7	Annealed to achieve spheroidized carbides and cold-worked	+AC+C	-	x	-	x	x	x	Column +AC+C	Column +FP	
8	Isothermically treated to ferrite-perlite structure and hardness range	+FP	-	x	x	-	x	x	-	-	
9	Stress relieved	+SR	-	-	-	x	x	-	-	-	
10	Others	Other treatment conditions, e.g. the quenched and tempered condition, may be agreed at the time of enquiry and order.							As in columns 9.1 and 9.2 (see footnote b to Table 3)		Hardenability values according to Table 5
x ^a = Applicable for											

Table 2 — Surface condition at delivery

1	2	3	4	5	6	7	8	9
1	Surface condition at delivery	Symbol	x ^b					
2	Unless otherwise agreed	None or +HW	billets	bars	wire rod ^a	wire ^a	tubes	rings and discs
3	As-hot-worked		x	x	x	-	x	x
4	Machined	+MA	-	x	-	-	-	x
5	Peeled/turned	+SH	-	x	x	-	x	-
6	Ground	+G	-	x	-	-	-	-
7	Cold drawn	+C	-	x	-	x	x	-
8	Cold pilgered (rocked)	+CP	-	-	-	-	x	-
9	Cold rolled	+CR	-	-	-	-	-	x
	Others	-	-	x	x	x	x	x
^a Cold drawn rod is by definition wire (see ISO 6929).								
^b x = In general applicable for								

Table 3 — Steel grades and chemical composition (cast analysis)

Steel designation	% [mass fraction] ^{a, b}											Others
Name	C	Si	Mn	P	S	Cr	Mo	Ni	V	W		
Through-hardening bearing steels												
100Cr6	0,93 to 1,05 ^c	0,15 to 0,35 ^d	0,25 to 0,45	0,025	0,015 ^e	1,35 to 1,60	0,10	-	-	-	Al: 0,050 Ca: 0,001 5 ^f Cu: 0,30 O: 0,001 2 ^g Ti: 0,003 0 H: ^k	
100CrMnSi4-4	0,93 to 1,05 _c	0,45 to 0,75	0,90 to 1,20	0,025	0,015 ^e	0,90 to 1,20	0,10	-	-	-		
100CrMnSi6-4	0,93 to 1,05 _c	0,45 to 0,75	1,00 to 1,20	0,025	0,015 ^e	1,40 to 1,65	0,10	-	-	-		
100CrMnSi6-6	0,93 to 1,05 _c	0,45 to 0,75	1,40 to 1,70	0,025	0,015 ^e	1,40 to 1,65	0,10	-	-	-		
100CrMo7	0,93 to 1,05 _c	0,15 to 0,45	0,25 to 0,45	0,025	0,015 ^e	1,65 to 1,95	0,15 to 0,30	-	-	-		
100CrMo7-3	0,93 to 1,05 _c	0,15 to 0,45	0,60 to 0,80	0,025	0,015 ^e	1,65 to 1,95	0,20 to 0,35	-	-	-		
100CrMo7-4	0,93 to 1,05 _c	0,15 to 0,35	0,60 to 0,80	0,025	0,015 ^e	1,65 to 1,95	0,40 to 0,50	-	-	-		
100CrMnMoSi8-4-6	0,93 to 1,05 _c	0,40 to 0,60	0,80 to 1,10	0,025	0,015 ^e	1,80 to 2,05	0,50 to 0,60	-	-	-		
Case-hardening bearing steels												
20Cr3	0,17 to 0,23	0,40	0,60 to 1,00	0,025	0,015 ^e	0,60 to 1,00	-	-	-	-	Al: 0,050 Ca: ^f Cu: 0,30 O: 0,002 0 ^g Ti: ^h H: ^k	
20Cr4	0,17 to 0,23	0,40	0,60 to 0,90	0,025	0,015 ^e	0,90 to 1,20	-	-	-	-		
20MnCr4-2	0,17 to 0,23	0,40	0,65 to 1,10	0,025	0,015 ^e	0,40 to 0,75	-	-	-	-		
17MnCr5	0,14 to 0,19	0,40	1,00 to 1,30	0,025	0,015 ^e	0,80 to 1,10	-	-	-	-		
19MnCr5	0,17 to 0,22	0,40	1,10 to 1,40	0,025	0,015 ^e	1,00 to 1,30	-	-	-	-		
15CrMo4	0,12 to 0,18	0,40	0,60 to 0,90	0,025	0,015 ^e	0,90 to 1,20	0,15 to 0,25	-	-	-		
20CrMo4	0,17 to 0,23	0,40	0,60 to 0,90	0,025	0,015 ^e	0,90 to 1,20	0,15 to 0,25	-	-	-		
20MnCrMo4-2	0,17 to 0,23	0,40	0,65 to 1,10	0,025	0,015 ^e	0,40 to 0,75	0,10 to 0,20	-	-	-		
20MnNiCrMo3-2	0,17 to 0,23	0,40	0,60 to 0,95	0,025	0,015 ^e	0,35 to 0,70	0,15 to 0,25	0,40 to 0,70	-	-		
20NiCrMo7	0,17 to 0,23	0,40	0,40 to 0,70	0,025	0,015 ^e	0,35 to 0,65	0,20 to 0,30	1,60 to 2,00	-	-		
18CrNiMo7-6	0,15 to 0,21	0,40	0,50 to 0,90	0,025	0,015 ^e	1,50 to 1,80	0,25 to 0,35	1,40 to 1,70	-	-		
18NiCrMo14-6	0,15 to 0,20	0,40	0,40 to 0,70	0,025	0,015 ^e	1,30 to 1,60	0,15 to 0,25	3,25 to 3,75	-	-		
16NiCrMo16-5	0,14 to 0,18	0,40	0,25 to 0,55	0,025	0,015 ^e	1,00 to 1,40	0,20 to 0,30	3,80 to 4,3	-	-		

Table 3 (continued)

Steel designation Name	% [mass fraction] ^{a, b}											Others
	C	Si	Mn	P	S	Cr	Mo	Ni	V	W		
Induction-hardening bearing steels												
C56E2	0,52 to 0,60	0,40	0,60 to 0,90	0,025	0,015 ^e	-	-	-	-	-	Al: 0,050	
56Mn4	0,52 to 0,60	0,40	0,90 to 1,20	0,025	0,015 ^e	-	-	-	-	-	Ca: f, Cu: 0,30	
70Mn4	0,65 to 0,75	0,40	0,80 to 1,10	0,025	0,015 ^e	-	-	-	-	-	O: 0,001 5 ^g	
43CrMo4	0,40 to 0,46	0,40	0,60 to 0,90	0,025	0,015 ^e	0,90 to 1,20	0,15 to 0,30	-	-	-	Ti: h	
50CrMo4	0,46 to 0,54	0,40	0,50 to 0,80	0,025	0,015 ^e	0,90 to 1,20	0,15 to 0,30	-	-	-	H: k	
Stainless bearing steels												
X47Cr14	0,43 to 0,50	1,00	1,00	0,040	0,015 ^e	12,5 to 14,5	-	-	-	-	-	
X65Cr14	0,60 to 0,70	1,00	1,00	0,040	0,015 ^e	12,5 to 14,5	0,75	-	-	-	-	
X30CrMoN15-1	0,28 to 0,34	0,30 to 0,80	0,30 to 0,60	0,020	0,010 ^e	14,5 to 16,0	0,95 to 1,10	0,30	-	-	N: 0,35 to 0,44	
X108CrMo17	0,95 to 1,20	1,00	1,00	0,040	0,015 ^e	16,0 to 18,0	0,40 to 0,80	-	-	-	-	
X40CrMoVN16-2	0,37 to 0,45	0,60	0,60	0,025	0,015 ^e	15,0 to 16,5	1,50 to 1,90	0,30	0,20 to 0,40	-	N: 0,16 to 0,25	
X89CrMoV18-1	0,85 to 0,95	1,00	1,00	0,040	0,015 ^e	17,0 to 19,0	0,90 to 1,30	-	0,07 to 0,12	-	-	
High-temperature bearing steels												
33CrMoV12-9	0,29 to 0,36	0,10 to 0,40	0,40 to 0,70	0,025	0,015	2,80 to 3,30	0,70 to 1,20	0,30	0,15 to 0,25	-	Cu: 0,10	
80MoCrV42-16	0,77 to 0,85	0,40	0,15 to 0,35	0,025 ⁱ	0,015 ⁱ	3,9 to 4,3	4,0 to 4,5	-	0,90 to 1,10	0,25	Cu: 0,30	
13MoCrNi42-16-14	0,10 to 0,15	0,10 to 0,25	0,15 to 0,35	0,015	0,010	3,9 to 4,3	4,0 to 4,5	0,20 to 3,60	1,00 to 1,30	0,15	Cu: 0,10 ^j	
X82WMoCrV6-5-4	0,78 to 0,86	0,40	0,40	0,025	0,015	3,9 to 4,3	4,7 to 5,2	-	1,70 to 2,00	6,0 to 6,7	Cu: 0,30	
X75WCrV18-4-1	0,70 to 0,80	0,40	0,40	0,025	0,015	3,9 to 4,3	0,60	-	1,00 to 1,25	17,5 to 19,0	Cu: 0,30	

Table 3 (continued)

Steel designation	% [mass fraction] ^{a, b}										
Name	C	Si	Mn	P	S	Cr	Mo	Ni	V	W	Others
Elements not quoted 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 should be taken to prevent additions from scrap or other materials, used in the manufacture of such elements, which affect the hardenability, mechanical properties and applicability.											
^a	Maximum values unless otherwise indicated.										
^b	In the case of the grades with specified hardenability requirements (see Table 5), except for phosphorus and sulfur, insignificant deviations from the limits for cast analysis are permissible; these deviations shall, however, not exceed ± 0,01 % in the case of carbon and in all other cases the values according to Table 4 .										
^c	Minimum limits lower than 0,93 % C or maximum limits higher than 1,05 % C may be agreed upon at the time of enquiry and order.										
^d	By agreement max. 0,15 % Si for cold forming.										
^e	Where machinability is of primary importance, max. 0,030 % sulfur may be agreed at the time of enquiry and order.										
^f	Intentional additions of calcium or calcium alloys for deoxidation or inclusion shape control are not permitted unless specifically approved by the purchaser.										
^g	The oxygen content can apply to cast analysis or product analysis at the discretion of the manufacturer.										
^h	A maximum titanium content may be agreed upon at the time of enquiry and order.										
ⁱ	Max. 0,015 % phosphorus and max. 0,008 % sulfur may be agreed upon at the time of enquiry and order.										
^j	Max. 0,20 % Cu may be agreed upon at the time of enquiry and order.										
^k	Max. 2 mg/kg (ppm, i. e. parts per million) hydrogen may be agreed upon at the time of enquiry and order for premium bearing steels. The verification applies to the cast or product analysis at the discretion of the manufacturer.										

Table 4 — Permissible deviations between the product analysis and the limiting values given in Table 3 for the cast analysis

Element	Permissible maximum content according to cast analysis % (mass fraction)	Permissible deviation ^a , for all bearing steels % (mass fraction)
C	$C \leq 0,60$	$\pm 0,02$
	$0,60 < C \leq 1,20$	$\pm 0,03$
Si	$Si \leq 0,40$	$\pm 0,03$
	$0,40 < Si \leq 1,00$	$\pm 0,05$
Mn	$Mn \leq 1,00$	$\pm 0,04^b$
	$1,00 < Mn \leq 1,40$	$\pm 0,06$
P	$P \leq 0,040$	$+ 0,005$
S	$S \leq 0,025$	$+ 0,005$
Cr	$Cr \leq 2,00$	$\pm 0,05$
	$2,00 < Cr \leq 10,0$	$\pm 0,10$
	$10,0 < Cr \leq 15,0$	$\pm 0,15$
	$15,0 < Cr \leq 19,0$	$\pm 0,20$
Mo	$Mo \leq 0,30$	$\pm 0,03$
	$0,30 < Mo \leq 0,60$	$\pm 0,05^c$
	$0,60 < Mo \leq 1,75$	$\pm 0,07$
	$1,75 < Mo \leq 5,2$	$\pm 0,10$
Ni	$Ni \leq 1,00$	$\pm 0,03$
	$1,00 < Ni \leq 2,00$	$\pm 0,05$
	$2,00 < Ni \leq 4,3$	$\pm 0,07$
V	$V \leq 0,50$	$\pm 0,03$
	$0,50 < V \leq 1,50$	$\pm 0,05$
	$1,50 < V \leq 2,00$	$\pm 0,10$
W	$W \leq 0,25$	$\pm 0,03$
	$0,25 < W \leq 10,0$	$\pm 0,10$
	$10,0 < W \leq 19,0$	$\pm 0,20$
Al	$Al \leq 0,050$	$+ 0,010$
Cu	$Cu \leq 0,30$	$+ 0,03$

^a $\pm$ means that in one cast the deviation may occur over the upper value or under the lower value of the specified range in Table 3, but not both at the same time.

^b For stainless bearing steels: Mn $+0,03$ %.

^c For high-temperature bearing steels: Mo $+0,03$ %.

Table 5 — Hardness limits for case-hardening and induction-hardening steels (+H-grades) in the end-quench hardenability test

Steel designation	Lim-its of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece															Quenching tempera-ture °C
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	
Name 20Cr3+H	max.	48	46	41	34	31	29	27	25	22	-	-	-	-	-	-	900 ± 5
	min.	40	34	27	22	20	-	-	-	-	-	-	-	-	-	-	
20Cr4+H	max.	49	48	46	42	38	36	34	32	29	27	26	24	23	-	-	900 ± 5
	min.	41	38	31	26	23	21	-	-	-	-	-	-	-	-	-	
20MnCr4-2+H	max.	49	48	46	42	39	37	34	33	32	30	28	26	24	-	-	900 ± 5
	min.	41	38	31	28	24	21	-	-	-	-	-	-	-	-	-	
17MnCr5+H	max.	47	46	44	41	39	37	35	33	31	30	29	28	27	-	-	900 ± 5
	min.	39	36	31	28	24	21	-	-	-	-	-	-	-	-	-	
19MnCr5+H	max.	49	49	48	46	43	42	41	39	37	35	34	33	32	-	-	900 ± 5
	min.	41	39	36	33	30	28	26	25	23	21	-	-	-	-	-	
15CrMo4+H	max.	46	45	41	38	34	31	29	28	26	25	24	24	23	23	22	900 ± 5
	min.	39	36	29	24	21	20	-	-	-	-	-	-	-	-	-	
20CrMo4+H	max.	48	48	47	44	41	39	37	35	33	31	30	30	29	29	28	900 ± 5
	min.	40	39	35	31	28	25	24	23	20	20	-	-	-	-	-	
20MnCrMo4-2+H	max.	48	46	40	34	29	27	25	24	21	-	-	-	-	-	-	900 ± 5
	min.	41	37	27	22	-	-	-	-	-	-	-	-	-	-	-	
20MnNiCrMo3-2+H	max.	49	48	45	42	36	33	31	30	27	25	24	24	23	-	-	900 ± 5
	min.	41	37	31	25	22	20	-	-	-	-	-	-	-	-	-	
20NiCrMo7+H	max.	48	47	45	42	39	36	34	32	29	26	25	24	24	24	24	900 ± 5
	min.	40	38	34	30	27	25	23	22	20	-	-	-	-	-	-	
18CrNiMo7-6+H	max.	48	48	48	48	47	47	46	46	44	43	42	41	41	-	-	860 ± 5
	min.	40	40	39	38	37	36	35	34	32	31	30	29	29	-	-	
18NiCrMo14-6+H	max.	48	47	47	46	46	46	46	46	46	46	45	45	44	44	43	830 ± 5
	min.	40	39	39	38	38	38	38	37	37	36	34	33	32	31	30	
16NiCrMo16-5+H	max.	48	47	47	46	46	46	46	46	46	46	45	45	44	44	43	830 ± 5
	min.	40	39	39	38	38	38	38	37	37	36	34	33	32	31	30	

^a Requirements for hardenability may be agreed upon.

Table 5 (continued)

Steel designation	Lim-its of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece															Quenching temperature °C
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	
C56E2+H ^a	max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
56Mn4+H ^a	max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
70Mn4+H ^a	max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
43CrMo4+H	max.	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45	840 ± 5
	min.	53	53	52	51	49	43	40	37	34	32	31	30	30	29	29	
50CrMo4+H	max.	65	65	64	64	63	63	63	62	61	60	58	57	55	54	54	850 ± 5
	min.	58	58	57	55	54	53	51	48	45	41	39	38	37	36	36	
Requirements for hardenability may be agreed upon.																	

Table 6 — Hardness in the usual conditions of delivery

Steel designation Name	Hardness in the delivery condition					
	+S HBW max.	+A HBW max.	+TH HBW	+AC ^a HBW max.	+AC+Ca HBW max.	+FP HBW
Through-hardening bearing steels						
100Cr6	b	–	–	207	241 ^{c, d, i}	–
100CrMnSi4–4	b	–	–	217	–	–
100CrMnSi6–4	b	–	–	217	251 ^{d, i}	–
100CrMnSi6–6	b	–	–	217	251 ^{d, i}	–
100CrMo7	b	–	–	217	251 ^{d, i}	–
100CrMo7–3	b	–	–	230	–	–
100CrMo7–4	b	–	–	230	260 ⁱ	–
100CrMnMoSi8–4–6	b	–	–	230	–	–
Case-hardening bearing steels						
20Cr3	e	207	156 to 207	170	f	–
20Cr4	e	207	156 to 207	170	f	140 to 187
20MnCr4–2	255	207	163 to 207	170	f	–
17MnCr5	e	207	156 to 207	170	f	140 to 187
19MnCr5	255	217	170 to 217	179	f	152 to 201
15CrMo4	255	207	156 to 207	170	f	137 to 184
20CrMo4	255	207	163 to 207	170	f	146 to 193
20MnCrMo4–2	255	207	156 to 207	170	f	146 to 193
20MnNiCrMo3–2	e	212	163 to 212	170	f	149 to 194
20NiCrMo7	255	229	174 to 229	170	f	154 to 207
18CrNiMo7–6	255	229	179 to 229	179	f	159 to 207
18NiCrMo14–6	255	–	–	241	f	–
16NiCrMo16–5	255	–	–	241	f	–
Induction-hardening bearing steels						
C56E2	255 ^g	229	–	–	–	–
56Mn4	255 ^g	229	–	–	–	–
70Mn4	255 ^g	241	–	–	–	–
43CrMo4	255 ^g	241	–	–	–	–
^a For case-hardening steels, this condition is applied if cold forming operations are intended. For through-hardening, stainless and high-temperature bearing steels, this condition is also used if the steel is processed by machining operations. ^b If this condition is needed, maximum hardness values and requirements concerning the structure shall be agreed upon at the time of enquiry and order. ^c The hardness of wire for needle bearings shall be up to 331 HBW. The maximum Vickers hardness value (HV) shall be agreed upon at the time of enquiry and order. ^d The hardness for cold-finished tubes shall be up to 321 HBW. ^e Under suitable conditions, this grade is shearable in the untreated condition. ^f Depending on the degree of cold working, the values may be up to about 50 HBW above those for condition +AC. Where necessary, exact requirements may be agreed upon at the time of enquiry and order. ^g Depending on the chemical composition of the cast, and on the dimensions condition +A might be necessary. ^h Shearability will, in general, only apply in condition +AC or in condition +A (for grade 13MoCrNi42–16–14 and 50CrMo4 only). ⁱ The hardness for bright steel products with diameter <13 mm shall be <320 HBW.						

Table 6 (continued)

Steel designation Name	Hardness in the delivery condition					
	+S HBW max.	+A HBW max.	+TH HBW	+AC ^a HBW max.	+AC+C ^a HBW max.	+FP HBW
50CrMo4	h	248	–	–	–	–
Stainless bearing steels						
X47Cr14	h	–	–	248	f	–
X65Cr14	h	–	–	255	f	–
X30CrMoN15-1	h	–	–	255	f	–
X108CrMo17	h	–	–	255	f	–
X40CrMoVN16-2	h	–	–	255	f	–
X89CrMoV18-1	h	–	–	255	f	–
High-temperature bearing steels						
33CrMoV12-9	h	–	–	255	f	–
80MoCrV42-16	h	–	–	248	f	–
13MoCrNi42-16-14	h	269	–	–	–	–
X82WMoCrV6-5-4	h	–	–	248	f	–
X75WCrV18-4-1	h	–	–	269	f	–
^a For case-hardening steels, this condition is applied if cold forming operations are intended. For through-hardening, stainless and high-temperature bearing steels, this condition is also used if the steel is processed by machining operations. ^b If this condition is needed, maximum hardness values and requirements concerning the structure shall be agreed upon at the time of enquiry and order. ^c The hardness of wire for needle bearings shall be up to 331 HBW. The maximum Vickers hardness value (HV) shall be agreed upon at the time of enquiry and order. ^d The hardness for cold-finished tubes shall be up to 321 HBW. ^e Under suitable conditions, this grade is shearable in the untreated condition. ^f Depending on the degree of cold working, the values may be up to about 50 HBW above those for condition +AC. Where necessary, exact requirements may be agreed upon at the time of enquiry and order. ^g Depending on the chemical composition of the cast, and on the dimensions condition +A might be necessary. ^h Shearability will, in general, only apply in condition +AC or in condition +A (for grade 13MoCrNi42-16-14 and 50CrMo4 only). ⁱ The hardness for bright steel products with diameter <13 mm shall be <320 HBW.						

Table 7 — Test unit, number or sample products and test pieces and sampling and test methods for the different requirements

No.	Requirements	Test unit ^a	Number of		Sampling ^b	Test method See
			sample prod- ucts	test pieces sample prod- uct		
1a	Chemical composition (cast analysis)	C	c	c	c	c
1b	Chemical composition (product analysis)	C	≥1/cast	≥1	ISO 14284	
2	Hardenability in the end-quench test ^d	C	1/cast	1	ISO 642	ISO 642 ^e
3	Hardness in the condi- tion					
3a	+S	C, T, D ^f	for test units 1 of ≤ 50 t 2 of > 50 t ≤ 100 t 3 > 100 t	1	ISO 6506-1	ISO 6506-1
3b	+A					
3c	+TH					
3d	+AC					
3e	+AC+C					
3f	+FP					
4	Structure					
4a	Austenitic grain size ^d	C	1/cast	1	ISO 643	ISO 643
4b	Spheroidization of carbides	C, T, D ^f	g	g	g	ISO 23825, ASTM A892 or SEP 1520 ^g
4c	Distribution of carbides	C, T, D ^f	g	g	g	ISO 5949
4d	Microscopic non-metal- lic inclusions	C ^j	g	g	Clause A.6	Clause A.6
4e	Macroscopic non-me- tallic inclusions	C ^j	g	g	g	h
5	Surface decarburiza- tion ⁱ	C, T, S, D	g	g	ISO 3887	ISO 3887

^a The tests shall be carried out for each cast, as indicated by "C" – each heat-treatment condition as indicated by "T" – each surface condition as indicated by "S" – and each dimension, as indicated by "D".

^b For all requirements, the general conditions for sampling in accordance with ISO 377 shall apply.

^c The cast analysis shall be given by the manufacturer.

^d Applies only for case-hardening and induction-hardening bearing steels.

^e Quenching temperatures: see [Table 5](#).

^f Products of small differences in thickness (about 1:1,5) can be considered as one test unit.

^g Shall be agreed upon at the time of enquiry and order.

^h Depending on the agreement at the time of enquiry and order, it shall be either the blue fracture test in accordance with ISO 3763 or the etching test in accordance with ISO 4969 or the step-down test or the non-destructive test.

ⁱ Applies only for through-hardening, stainless and high-temperature bearing steels.

^j The test unit may be agreed upon at the time of enquiry and order.

Annex A

(normative)

Supplementary or special requirements

A.1 General

One or more of the following supplementary or special requirements shall be applied but only when specified in the enquiry and order. Details of these requirements shall, where necessary, be agreed upon by the manufacturer and purchaser at the time of enquiry and order.

A.2 Product analysis

One product analysis shall be carried out per cast for the determination of all elements for which values are specified for the cast analysis of the steel type concerned. The conditions for sampling shall be in accordance with ISO 14284.

A.3 Verification of grain size

Fine grain steel shall have an austenite grain size of 5 or finer. If specific testing is ordered, the grain size requirement shall be verified by determining the aluminium content or micrographically. The fine grain structure is normally achieved, when the total aluminium content is a minimum of 0,018 % of case hardening bearing steels and a minimum of 0,007 % of the induction hardening bearing steels. In such cases, the micrographic investigation is not necessary. The aluminium content shall be given in the inspection document.

Otherwise, one test piece per cast shall be inspected for the determination of the austenitic grain size. Sampling and sample preparation shall be as specified in ISO 643. The case hardening bearing steels shall be tested in accordance with the Mc-Quaid-Ehn method and the induction hardening bearing steels in accordance with the Bechet-Beaujard method as described in ISO 643. The grain structure shall be considered satisfactory if 70 % of the area is within the specified size limits.

A.4 Degree of spheroidization

If necessary, the required degree of spheroidization shall be agreed at the time of enquiry and order in accordance with ISO 23825, SEP 1520 or ASTM A892.

A.5 Distribution of carbides

The carbides shall be distributed as agreed upon in accordance with ISO 5949. When making such agreements, the steel grade and the size of the product shall be taken into account.

If the verification of the carbide distribution is required, the details of this shall also be agreed upon.

The size of globular carbides and the share of perlite area are not specified in ISO 5949. For these characteristics, additional requirements may be agreed upon at the time of enquiry and order.