INTERNATIONAL STANDARD

ISO 683-3

First edition
2014-11-01

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

Part 3: Case-hardening steels

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

Partie 3: Aciers pour cémentation

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Reference number
ISO 683-3:2014(E)

© ISO 2014

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, 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
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **2**

4 Classification and designation ... **3**
4.1 Classification ... 3
4.2 Designation ... 3

5 Information to be supplied by the purchaser ... **3**
5.1 Mandatory Information ... 3
5.2 Options and/or supplementary or special requirements ... 3

6 Manufacturing process ... **4**
6.1 General ... 4
6.2 Deoxidation ... 4
6.3 Heat-treatment condition and surface condition at delivery ... 4
6.4 Traceability of the cast ... 4

7 Requirements ... **5**
7.1 Chemical composition, hardness and hardenability ... 5
7.2 Machinability ... 5
7.3 Cold shearability ... 5
7.4 Grain size ... 5
7.5 Non-metallic inclusions ... 6
7.6 Internal soundness ... 6
7.7 Surface condition ... 6
7.8 Shape, dimensions and tolerances ... 6

8 Inspection ... **7**
8.1 Testing procedures and types of documents ... 7
8.2 Frequency of testing ... 7
8.3 Tests to be carried out for specific inspection ... 7

9 Test methods ... **8**
9.1 Chemical analysis ... 8
9.2 Hardness and hardenability tests ... 8
9.3 Retests ... 8

10 Marking ... **8**

Annex A (normative) **Supplementary or special requirements** ... **30**

Annex B (informative) **Designation of steels given in this part of ISO 683 and of comparable grades covered in various designation systems** ... **32**

Annex C (informative) **Dimensional standards applicable to products complying with this part of ISO 683** ... **34**

Annex D (informative) **Classification of steel grades according to minimum tensile strength as a function of diameter after hardening and tempering at 200 °C** ... **35**

Bibliography ... **36**

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. 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. www.iso.org/patents

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

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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

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

This first edition cancels and replaces the second edition of (ISO 683-11:2012), 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 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*

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

 © ISO 2014 – All rights reserved

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

Part 3: Case-hardening steels

1 Scope

1.1 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,

— hammer or drop forgings (see Note 1)

manufactured from the case-hardening non-alloy or alloy 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 case-hardened (see 3.1) machine parts.

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

NOTE 2 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.

1.2 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 Annex A).

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

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to 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 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 4885, *Ferrous products — Heat treatments — Vocabulary*

© ISO 2014 – All rights reserved

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

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 of ISO 377, ISO 4885, ISO 4948-1, ISO 4948-2, ISO 6929, ISO 14284 and the following apply.

Note 1 to entry For deviations from these terms and definitions, see Note 1 to the Scope and footnote a to Table 2.

3.1
case-hardening steels
structural steels with a relatively low carbon content, which are carburized or carbonitrided on their surface and subsequently hardened

Note 1 to entry: These steels, after hardening, have a high degree of hardness in the surface zone and good resistance to wear, while the core material is characterized principally by extreme toughness.

Note 2 to entry: Further possibilities for heat treatment of case-hardening steels are, for example, nitrocarburizing and nitriding.

3.2
non-alloy steel
non-alloy steel as defined in ISO 4948-1

3.3
alloy steel
special steel as defined in ISO 4948-1

3.4
special steels
special steel as defined in ISO 4948-2

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

 © ISO 2014 – All rights reserved

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades is according to ISO 4948-1 and ISO 4948-2. Steel grades C10E, C10R, C15E, C15R, C16E, C16R and 22Mn6 are non-alloy special steels. All other 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 following information shall be supplied by 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 or square bar, wire rod, wide flats, sheet, plate, strip, forging, etc.);

c) either the designation of the dimensional standard and the dimensions and tolerances selected from this (see 7.8) 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 683-3;

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

f) 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

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 part of ISO 683 (see 5.1):

a) if a heat-treatment condition other than the untreated condition is required, the symbol for this other condition (see Table 1, column 2);

b) if a surface condition other than “hot worked” or a special surface quality is required, the surface condition (see Table 2) and the surface quality (see 7.7.3);

c) any requirement for restricted hardenability scatter bands for alloy steels (+HH, +HL; see 7.1.1, Table 6 and Figure 1);

d) if any supplementary requirement shall be complied with, the symbol and, where necessary, the details of this supplementary requirement (see Annex A);

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

f) verification of hardenability and, if agreed, the information about calculation of the hardenability (see 9.2.2);

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

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

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

EXAMPLE 50 hot-rolled round bars in accordance with 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 683-3, 20MnCr5 (see Table 3) in the heat-treatment condition annealed (+A), surface blast cleaned (+BC) (see Table 2), product analysis/option A.3 with an inspection certificate 3.1 in accordance with ISO 10474.

Round bars ISO 1035 - 40,0S × 8 000L2

ISO 683-3 - 20MnCr5+A+BC, Option A.3

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 A.4.

6.2 Deoxidation

All steels shall be deoxidized.

6.3 Heat-treatment condition and surface condition at delivery

6.3.1 Normal condition at delivery

Unless otherwise agreed at the time of enquiry and order, the products shall be delivered in the untreated condition, i.e. hot-worked condition.

6.3.2 Particular heat-treatment condition

If so agreed at the time of enquiry and order, the products shall be delivered in one of the heat-treatment conditions given in Table 1, lines 3 to 8.

6.3.3 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

The products shall be traceable to the cast, see Clause 10.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

 © ISO 2014 – All rights reserved

7 Requirements

7.1 Chemical composition, hardness and hardenability

7.1.1 General

Table 1 gives a survey on combinations of usual heat-treatment conditions at delivery, product forms and requirements as specified in Tables 3 to 7 (chemical composition, hardenability, maximum hardness and hardness range).

Unless otherwise agreed for alloy steels, the hardenability requirements given in Table 5 apply. If agreed at the time of enquiry and order, alloy steels with restricted hardenability scatter bands given in Table 6 or shown in Figure 1 shall be supplied.

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 A.3).

7.2 Machinability

All steels are machinable in the conditions “soft-annealed”, “treated to hardness range”, “treated to ferrite/pearlite structure” and “normalized.

Where improved machinability is required, the grades with a specified sulfur range should be ordered and/or with a specific treatment to improve machinability (see also Table 3, footnote c).

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 condition “soft-annealed”.

7.3.2 Steel grades 28Cr4, 28CrS4, 20MnCr5, 20MnCrS5, 24CrMo4, 24CrMoS4, 22CrMoS3-5, 20MoCr4, 20MoCrS4, 16NiCr4, 16NiCrS4, 18NiCr5-4, 17CrNi6-6, 15NiCr13, 17NiCrMo6-4 and 18CrNiMo7-6, are, under suitable conditions, also cold shearable when delivered in the condition “treated to improve shearability” with the hardness requirements given in Table 7.

7.3.3 The non-alloy steels and steels 17Cr3, 17CrS3, 20Cr4, 20CrS4, 16MnCr5, 16MnCrS5, 16MnCrB5, 18CrMo4, 18CrMoS4, 20NiCrMo2-2 and 20NiCrMoS2-2 are, under suitable conditions, cold shearable when delivered in the untreated condition.

7.4 Grain size

Unless otherwise agreed at the time of enquiry and order, the steel shall show a fine grain structure with an austenitic grain size of 5 and finer, when tested in accordance with ISO 643. For verification, see A.1.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

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 inquiry and order (see A.2).

7.7 Surface condition

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

7.7.2 Minor surface imperfections which may occur 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 are delivered with surface class A according to ISO 9443 and hot-rolled plates and wide flats shall be 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.

NOTE Bars and wire rod for cold heading and cold extrusion are covered fully by ISO 4954.

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.

7.7.5 Removal of surface discontinuities by welding shall only be permitted with the approval of the customer or his/her representative. If surface discontinuities are repaired, the method and maximum depth of removal shall be agreed at the time of enquiry and order.

7.8 Shape, dimensions and tolerances

The nominal dimensions, tolerances on dimensions and shape of the product shall be agreed at the time of enquiry and order, if possible, with reference to the dimensional standards applicable (see Annex C).

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

 © ISO 2014 – All rights reserved

8 Inspection

8.1 Testing procedures and types of documents

8.1.1 Products complying with this part of ISO 683 shall be ordered and delivered with one of the inspection documents as specified in ISO 10474 or another standard, e.g. regional standards EN 10204 or JIS G 0415. 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, a test report shall be issued.

8.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report 2.2 is to be provided, this shall cover the following information:

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.

8.1.3 If, in accordance with the agreements in the order, an inspection certificate 3.1 or 3.2 is to be provided, the specific inspections and tests described in 8.2 shall be carried out and the results shall be confirmed in the inspection certificate.

In addition, the inspection certificate 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) results of all inspections and tests ordered by supplementary requirements (see Annex A);

d) the symbol, letters or numbers relating the test certificates, the test pieces and products to each other.

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 of Table 9.

8.3 Tests to be carried out for specific inspection

8.3.1 General

For non-alloy steels and for alloy steels without requirements concerning the verification of hardenability, the hardness requirements according to Table 1, columns 8.2 and 9.2, Table 7 are to be verified.

For alloy steels being ordered with the verification of hardenability, unless otherwise agreed, only the hardenability requirements according to Table 5 and Table 6 are to be verified.

8.3.2 Visual and dimensional inspection

A sufficient number of products shall be inspected to ensure the compliance with the specification.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

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 product analysis used shall be agreed taking into account the relevant existing International Standards.

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

9.2 Hardness and hardenability tests

9.2.1 Verification of hardness

For products in the heat-treatment conditions +S (treated to improve shearability), +A (soft-annealed), +TH (treated to hardness range), +FP (treated to ferritic-pearlitic structure) and +N (normalized), the hardness shall be measured in accordance with ISO 6506-1 (see Table 7 and Table 9).

9.2.2 Verification of hardenability

For alloy steels 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 and Table 9. The temperature for quenching shall comply with Table 8. The hardness values shall be determined in accordance with ISO 6508-1, scale C.

9.3 Retests

Retests of case hardening steels and criteria should be as specified in ISO 404.

10 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that the identification of the cast, the steel type and the origin of the delivery is possible (see A.5).

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

 © ISO 2014 – All rights reserved

Table 1 — Combinations of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 7

No.	1	2	3	4	5	6	7	8			9		
1	Heat-treatment condition at delivery	Symbol	x indicates applicable to					Applicable requirements					
								Non-alloy steel grades			Alloy steel grades		
			Semi-finished products	Bars	Wire rod	Flat products	Hammer and drop forgings	8.1	8.2		9.1	9.2	9.3
2	Untreated	None or +U	x	x	x	x	x	Chemical composition according to Tables 3 and 4	-		As in column 8 (see footnote b to Table 3)		Hardenability values according to Table 5 or 6 If option 5.2 f is ordered, the verification of hardenability and, if agreed, the information about calculation of the hardenability (see 8.2.2)
3	Treated to improve shear-ability	+S	x	x	-	-	-		Brinell hardness according to Table 7	Column +S			
4	Soft-annealed	+A	x	x	x	x	x			Column +A			
5	Treated to hardness range	+TH	-	x	x	x	x			Column +TH			
6	Treated to ferrite-pearlite structure	+FP	-	x	-	-	x			Column +FP			
7	Normalized or normalizing forming	+N	-	-	-	x	-			Column +N			
8	Others	Other treatment conditions, for example certain annealing conditions to achieve a certain structure, may be agreed at the time of enquiry and order. The condition "annealed to achieve a spheroidization of the carbides (+AC)", as required for cold heading and cold extrusion, is covered in ISO 4954.											

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 2 — Surface condition at delivery

No.	1	2	3	4	5	6	7	8	9
1	Surface condition at delivery		Symbol	x indicates in general applicable to					Notes
				Semi-finished products (as blooms, billets)	Bars	Wire rod	Flat products	Hammer and drop forgings (see note 3 to 1.1)	
2	Unless otherwise agreed	Hot worked	None or +HW	x[a]	x	x	x	x	-
3	Particular conditions supplied by agreement	Hot worked and pickled	+PI	x	x	x	x	x	–[c]
4		Hot worked and blast cleaned	+BC	x	x	x	x	x	
5		Hot worked and rough machined	+RM[b]	-	x	x	-	x	
6		Others	-	-	x	x	x	x	

[a] The term "hot worked" also includes the continuously cast (+CC) condition in the case of semi-finished products.

[b] Until the term "rough machined" is defined by, for example, machining allowances, the details are to be agreed at the time of enquiry and order.

[c] In addition, certain surface treatments, such as oiled, limed or phosphated, may be agreed upon.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 3 — Steel grades and chemical composition (applicable to cast analysis)[a b c d]

Steel name	Mass fraction [e] %								
	C	Si[f]	Mn	P	S	Cr	Mo	Ni	Cu and B
Non-alloy steels									
C10E	0,07 to 0,13	0,15 to 0,40	0,30 to 0,60	0,025	0,035	0,40	0,10	0,40	Cu: 0,30
C10R					0,020 to 0,040				
C15E	0,12 to 0,18	0,15 to 0,40	0,30 to 0,60	0,025	0,035	0,40	0,10	0,40	Cu: 0,30
C15R					0,020 to 0,040				
C16E	0,12 to 0,18	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,40	0,10	0,40	Cu: 0,30
C16R					0,020 to 0,040				
22Mn6	0,18 to 0,25	0,10 to 0,40	1,30 to 1,65	0,025	0,035	0,40	0,10	0,40	Cu: 0,30
Alloy steels									
17Cr3	0,14 to 0,20	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,70 to 1,00	-	-	Cu: 0,40
17CrS3					0,020 to 0,040				
20Cr4	0,17 to 0,23	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	-	-	Cu: 0,40
20CrS4					0,020 to 0,040				
28Cr4	0,24 to 0,31	0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	-	-	Cu: 0,40
28CrS4					0,020 to 0,040				
16MnCr5	0,14 to 0,19	0,15 to 0,40	1,00 to 1,30	0,025	0,035	0,80 to 1,10	-	-	Cu: 0,40
16MnCrS5					0,020 to 0,040				
16MnCrB5	0,14 to 0,19	0,15 to 0,40	1,00 to 1,30	0,025	0,035	0,80 to 1,10	-	-	Cu: 0,40 B: 0,0008 to 0,0050 [g]
20MnCr5	0,17 to 0,22	0,15 to 0,40	1,10 to 1,40	0,025	0,035	1,00 to 1,30	-	-	Cu: 0,40
20MnCrS5					0,020 to 0,040				
18CrMo4	0,15 to 0,21	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,25	-	Cu: 0,40
18CrMoS4					0,020 to 0,040				
24CrMo4	0,20 to 0,27	0,10 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	-	Cu: 0,40
24CrMoS4					0,020 to 0,040				
22CrMoS3–5	0,19 to 0,24	0,10 to 0,40	0,70 to 1,00	0,025	0,020 to 0,040	0,70 to 1,00	0,40 to 0,50	-	Cu: 0,40

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 3 — *(continued)*

Steel name	Mass fraction [e] %								
	C	Si[f]	Mn	P	S	Cr	Mo	Ni	Cu and B
20MoCr4	0,17 to 0,23	0,10 to 0,40	0,70 to 1,00	0,025	0,035	0,30 to 0,60	0,40 to 0,50	-	Cu: 0,40
20MoCrS4					0,020 to 0,040				
16NiCr4	0,13 to 0,19	0,15 to 0,40	0,70 to 1,00	0,025	0,035	0,60 to 1,00	-	0,80 to 1,10	Cu: 0,40
16NiCrS4					0,020 to 0,040				
18NiCr5–4	0,16 to 0,21	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	-	1,20 to 1,50	Cu: 0,40
17CrNi6–6	0,14 to 0,20	0,15 to 0,40	0,50 to 0,90	0,025	0,035	1,40 to 1,70	-	1,40 to 1,70	Cu: 0,40
15NiCr13	0,12 to 0,18	0,15 to 0,40	0,35 to 0,65	0,025	0,035	0,60 to 0,90	-	3,00 to 3,50	Cu: 0,40
20NiCrMo2–2	0,17 to 0,23	0,15 to 0,40	0,65 to 0,95	0,025	0,035	0,35 to 0,70	0,15 to 0,25	0,40 to 0,70	Cu: 0,40
20NiCrMoS2–2					0,020 to 0,040				
17NiCrMo6–4	0,14 to 0,20	0,15 to 0,40	0,60 to 0,90	0,025	0,035	0,80 to 1,10	0,15 to 0,25	1,20 to 1,60	Cu: 0,40
18CrNiMo7–6	0,15 to 0,21	0,15 to 0,40	0,50 to 0,90	0,025	0,035	1,50 to 1,80	0,25 to 0,35	1,40 to 1,70	Cu: 0,40

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

[b] For steels with hardenability requirements (see Tables 5 and 6), except for phosphorus and sulfur, insignificant deviations from the limits for cast analysis are permissible; these deviations shall, however, not exceed in the case of carbon ±0,01 % and in all other cases, the values according to Table 4.

[c] Steels with improved machinability either by higher sulfur levels up to about 0,10 % S (including controlled sulfide morphology) or lead additions may be supplied on request. In the first case, the upper limit of the manganese content may be increased by 0,15 %.

[d] Additional case-hardening steels, predominantly used for bearings, are covered by ISO 683-17.

[e] Maximum values unless otherwise stated.

[f] A lower silicon content may be agreed at the time of enquiry and order; in this case, the influence on mechanical properties should be taken into account.

[g] Boron is in this case added not for increase of hardenability but to improve the toughness of the case hardened zone.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

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] mass fraction %
C	≤ 0,23	± 0,02
Si	≤ 0,40	± 0,03
Mn	≤ 1,00	± 0,04
	1,00 < Mn ≤ 1,40	± 0,06
P	≤ 0,035	+ 0,005
S	≤ 0,040	± 0,005
Cr	≤ 1,80	± 0,05
Mo	≤ 0,30	± 0,03
	0,30 < Mo ≤ 0,35	± 0,04
Ni	≤ 1,00	± 0,03
	1,00 < Ni ≤ 2,00	± 0,05
	2,00 < Ni ≤ 3,50	± 0,07
Cu	≤ 0,40	+ 0,05
B	≤ 0,005 0	± 0,000 3

[a] ± means that in one cast, the deviation can occur over the upper value or under the lower value of the specified range in Table 3, but not both at the same time.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 5 — Hardness limits for steel grades with specified (normal) hardenability (+H-grades; see 7.1.1)

Steel name	Sym-bol	Limit of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece of												
			1,5	3	5	7	9	11	13	15	20	25	30	35	40
17Cr3 17CrS3	+H	max.	47	44	40	33	29	27	25	24	23	21	-	-	-
		min.	39	35	25	20	-	-	-	-	-	-	-	-	-
20Cr4 20CrS4	+H	max.	49	48	46	42	38	36	34	32	29	27	26	24	23
		min.	41	38	31	26	23	21	-	-	-	-	-	-	-
28Cr4 28CrS4	+H	max.	53	52	51	49	45	42	39	36	33	30	29	28	27
		min.	45	43	39	29	25	22	20	-	-	-	-	-	-
16MnCr5 16MnCrS5 16MnCrB5	+H	max.	47	46	44	41	39	37	35	33	31	30	29	28	27
		min.	39	36	31	28	24	21	-	-	-	-	-	-	-
20MnCr5 20MnCrS5	+H	max.	49	49	48	46	43	42	41	39	37	35	34	33	32
		min.	41	39	36	33	30	28	26	25	23	21	-	-	-
18CrMo4 18CrMoS4	+H	max.	47	46	45	42	39	37	35	34	31	29	28	27	26
		min.	39	37	34	30	27	24	22	21	-	-	-	-	-
24CrMo4 24CrMoS4	+H	max.	52	52	51	50	48	46	43	41	37	35	33	32	31
		min.	44	43	40	37	34	32	29	27	23	21	20	-	-
22CrMoS3–5	+H	max.	50	49	48	47	45	43	41	40	37	35	34	33	32
		min.	42	41	37	33	31	28	26	25	23	22	21	20	-
20MoCr4 20MoCrS4	+H	max.	49	47	44	41	38	35	33	31	28	26	25	24	24
		min.	41	37	31	27	24	22	-	-	-	-	-	-	-
16NiCr4 16NiCrS4	+H	max.	47	46	44	42	40	38	36	34	32	30	29	28	28
		min.	39	36	33	29	27	25	23	22	20	-	-	-	-
18NiCr5–4	+H	max.	49	48	46	44	42	39	37	36	34	32	31	31	30
		min.	41	39	35	32	29	27	25	24	21	20	-	-	-
17CrNi6–6	+H	max.	47	47	46	45	43	42	41	39	37	35	34	34	33
		min.	39	38	36	35	32	30	28	26	24	22	21	20	20
15NiCr13	+H	max.	46	46	46	46	45	44	43	41	38	35	34	34	33
		min.	38	37	36	34	31	29	27	26	24	22	22	21	21
20NiCrMo2–2 20NiCrMoS2–2	+H	max.	49	48	45	42	36	33	31	30	27	25	24	24	23
		min.	41	37	31	25	22	20	-	-	-	-	-	-	-
17NiCrMo6–4	+H	max.	48	48	47	46	45	44	42	41	38	36	35	34	33
		min.	40	39	37	34	30	28	27	26	24	23	22	21	-
18CrNiMo7–6	+H	max.	48	48	48	48	47	47	46	46	44	43	42	41	41
		min.	40	40	39	38	37	36	35	34	32	31	30	29	29

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 6 — Hardness limits for steels with narrowed hardenability scatterbands (+HH- and +HL-grades)

Steel name	Sym-bol	Limit of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece (in millimetres) of												
			1,5	3	5	7	9	11	13	15	20	25	30	35	40
17Cr3 17CrS3	+HH	max.	47	44	40	33	29	27	25	24	23	21	-	-	-
		min.	42	38	30	24	20	-	-	-	-	-	-	-	-
	+HL	max.	44	41	35	29	25	23	21	20	-	-	-	-	-
		min.	39	35	25	20	-	-	-	-	-	-	-	-	-
20Cr4 20CrS4	+HH	max.	49	48	46	42	38	36	34	32	29	27	26	24	23
		min.	44	41	36	31	28	26	24	22	-	-	-	-	-
	+HL	max.	46	45	41	37	33	31	29	27	24	22	21	-	-
		min.	41	38	31	26	23	21	-	-	-	-	-	-	-
28Cr4 28CrS4	+HH	max.	53	52	51	49	45	42	39	38	33	30	29	28	27
		min.	48	46	43	36	32	29	26	23	20	-	-	-	-
	+HL	max.	50	49	47	42	38	35	33	30	27	24	23	22	21
		min.	45	43	39	29	25	22	20	-	-	-	-	-	-
16MnCr5 16MnCrS5 16MnCrB5	+HH	max.	47	46	44	41	39	37	35	33	31	30	29	28	27
		min.	42	39	35	32	29	26	24	22	20	-	-	-	-
	+HL	max.	44	43	40	37	34	32	30	28	26	25	24	23	22
		min.	39	36	31	28	24	21	-	-	-	-	-	-	-
20MnCr5 20MnCrS5	+HH	max.	49	49	48	46	43	42	41	39	37	35	34	33	32
		min.	44	42	40	37	34	33	31	30	28	26	25	24	23
	+HL	max.	46	46	44	42	39	37	36	34	32	30	29	28	27
		min.	41	39	36	33	30	28	26	25	23	21	-	-	-
18CrMo4 18CrMoS4	+HH	max.	47	46	45	42	39	37	35	34	31	29	28	27	26
		min.	42	40	38	34	31	28	26	25	22	20	-	-	-
	+HL	max.	44	43	41	38	35	33	31	30	27	25	24	23	22
		min.	39	37	34	30	27	24	22	21	-	-	-	-	-
24CrMo4 24CrMoS4	+HH	max.	52	52	51	50	48	46	43	41	37	35	33	32	31
		min.	47	46	44	41	39	37	34	32	28	26	24	23	22
	+HL	max.	49	49	47	46	43	41	38	36	32	30	29	28	27
		min.	44	43	40	37	34	32	29	27	23	21	20	–	–
22CrMoS3–5	+HH	max.	50	49	48	47	45	43	41	40	37	35	34	33	32
		min.	45	44	41	38	36	33	31	30	28	26	25	24	23
	+HL	max.	47	46	44	42	40	38	36	35	32	31	30	29	28
		min.	42	41	37	33	31	28	26	25	23	22	21	20	-

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 6 — *(continued)*

Steel name	Sym-bol	Limit of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece (in millimetres) of												
			1,5	3	5	7	9	11	13	15	20	25	30	35	40
20MoCr4 20MoCrS4	+HH	max.	49	47	44	41	38	35	33	31	28	26	25	24	24
		min.	44	40	35	32	29	26	24	22	-	-	-	-	-
	+HL	max.	46	44	40	36	33	31	29	27	24	22	21	20	20
		min.	41	37	31	27	24	22	-	-	-	-	-	-	-
16NiCr4 16NiCrS4	+HH	max.	47	46	44	42	40	38	36	34	32	30	29	28	28
		min.	42	39	37	33	31	29	27	26	24	22	21	20	20
	+HL	max.	44	43	40	38	36	34	32	30	28	26	25	24	24
		min.	39	36	33	29	27	25	23	22	20	-	-	-	-
18NiCr5–4	+HH	max.	49	48	46	44	42	39	37	36	34	32	31	31	30
		min.	44	42	39	36	33	31	29	28	25	24	23	23	22
	+HL	max.	46	45	42	40	38	35	33	32	30	28	27	27	26
		min.	41	39	35	32	29	27	25	24	21	20	-	-	-
17CrNi6–6	+HH	max.	47	47	46	45	43	42	41	39	37	35	34	34	33
		min.	42	41	39	38	36	34	32	30	28	26	25	25	24
	+HL	max.	44	44	43	42	39	38	37	35	33	31	30	29	29
		min.	39	38	36	35	32	30	28	26	24	22	21	20	20
15NiCr13	+HH	max.	46	46	46	46	45	44	43	41	38	35	34	34	33
		min.	41	40	39	38	36	34	32	31	29	26	26	25	25
	+HL	max.	43	43	43	42	40	39	38	36	33	31	30	30	29
		min.	38	37	36	34	31	29	27	26	24	22	22	21	21
20NiCrMo2–2 20NiCrMoS2–2	+HH	max.	49	48	45	42	36	33	31	30	27	25	24	24	23
		min.	44	41	36	31	27	24	22	21	-	-	-	-	-
	+HL	max.	46	44	40	36	31	29	27	26	23	21	20	20	-
		min.	41	37	31	25	22	20	-	-	-	-	-	-	-
17NiCrMo6–4	+HH	max.	48	48	47	46	45	44	42	41	38	36	35	34	33
		min.	43	42	40	38	35	33	32	31	29	27	26	25	24
	+HL	max.	45	45	44	42	40	39	37	36	33	32	31	30	29
		min	40	39	37	34	30	28	27	26	24	23	22	21	-
18CrNiMo7–6	+HH	max.	48	48	48	48	47	47	46	46	44	43	42	41	41
		min.	43	43	42	41	40	40	39	38	36	35	34	33	33
	+HL	max.	45	45	45	45	44	43	42	42	40	39	38	37	37
		min.	40	40	39	38	37	36	35	34	32	31	30	29	29

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 7 — Hardness requirements for products delivered in the conditions "treated to improve shearability" (+S), "soft-annealed" (+A), "treated to hardness range" (+TH), "treated to ferrite-pearlite structure" (+FP) or "normalized" (+N)

Steel name	Brinell hardness in condition:							
	+S	+A	+TH		+FP		+N	
	max.	max.	min.	max.	min.	max.	min.	max.
Non-alloy steels								
C10E C10R	-	131	-	-	-	-	85	140
C15E C15R	-	143	-	-	-	-	95	150
C16E C16R	-	156	-	-	-	-	100	155
22Mn6	-	197	149	197	-		-	-
Alloy steels								
17Cr3 17CrS3	-	174	-	-	-	-	-	-
20Cr4 20CrS4	-	197	149	197	-	-	-	-
28Cr4 28CrS4	255	217	166	217	156	207	-	-
16MnCr5 16MnCrS5 16MnCrB5	-	207	156	207	140	187	138	187
20MnCr5 20MnCrS5	255	217	170	217	152	201	140	201
18CrMo4 18CrMoS4	-	207	156	207	140	187	-	-
24CrMo4 24CrMoS4	255	212	-	-	-	-	-	-
22CrMoS3–5	255	217	170	217	152	201	-	-
20MoCr4 20MoCrS4	255	207	156	207	140	187	-	-
16NiCr4 16NiCrS4	255	217	166	217	156	207	-	-
18NiCr5–4	255	223	170	223	156	207	-	-
17CrNi6–6	255	229	175	229	156	207	-	-
15NiCr13	255	229	179	229	166	217	-	-
20NiCrMo2–2 20NiCrMoS2–2	-	212	161	212	149	194		-
17NiCrMo6–4	255	229	179	229	149	201	-	-
18CrNiMo7–6	255	229	179	229	159	207	-	-

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 8 — Conditions for heat treating test bars and treatment of the steels

Steel name	End quench test austenitizing temperature[a]	Carburizing temperature[b]	Direct and simple hardening temperature[c d]	Double hardening[c]		Tempering temperature[e]
				Core-hardening temperature[d]	Case-hardening temperature[d]	
	°C	°C	°C	°C	°C	°C
Non-alloy steels						
C10E C10R	-	880 to 980	830 to 870	880 to 920	780 to 820	150 to 200
C15E C15R	-	880 to 980	830 to 870	880 to 920	780 to 820	150 to 200
C16E C16R	-	880 to 980	830 to 870	880 to 920	780 to 820	150 to 200
22Mn6	-	880 to 980	830 to 870	880 to 920	780 to 820	150 to 200
Alloy steels						
17Cr3 17CrS3	880 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
20Cr4 20CrS4	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
28Cr4 28CrS4	850 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
16MnCr5 16MnCrS5 16MnCrB5	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
20MnCr5 20MnCrS5	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
18CrMo4 18CrMoS4	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
24CrMo4 24CrMoS4	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
22CrMoS3–5	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
20MoCr4 20MoCrS4	910 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
16NiCr4 16NiCrS4	880 ± 5	880 to 980	820 to 860	850 to 890	780 to 820	150 to 200
18NiCr5–4	880 ± 5	880 to 980	820 to 860	840 to 880	780 to 820	150 to 200
17CrNi6–6	870 ± 5	880 to 980	820 to 860	830 to 870	780 to 820	150 to 200
15NiCr13	850 ± 5	880 to 980	810 to 850	840 to 880	780 to 820	150 to 200

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 8 — *(continued)*

Steel name	End quench test austenitizing temperature[a]	Carburizing temperature[b]	Direct and simple hardening temperature[cd]	Double hardening[c]		Tempering temperature[e]
				Core-hardening temperature[d]	Case-hardening temperature[d]	
	°C	°C	°C	°C	°C	°C
20NiCrMo2–2 20NiCrMoS2–2	900 ± 5	880 to 980	820 to 860	860 to 900	780 to 820	150 to 200
17NiCrMo6–4	900 ± 5	880 to 980	810 to 850	830 to 870	780 to 820	150 to 200
18CrNiMo7–6	860 ± 5	880 to 980	810 to 850	830 to 870	780 to 820	150 to 200

NOTE The temperatures given for carburizing, direct and simple hardening, core-hardening, case-hardening and tempering are for guidance; the actual temperatures chosen should be those that give the required properties.

a Time for austenitizing as a guide: 30 min minimum.

b The carburizing temperature depends on the chemical composition of the steel, the mass of the product and the carburizing medium. If the steels are direct hardened, in general, a temperature of 950 °C is not exceeded. For special procedures, for example under vacuum, higher temperatures (for example 1 020 °C to 1 050 °C) are not unusual.

c The kind of quenching agent depends on, for example the shape of the products, the cooling conditions and the amount of furnace filling.

d If the steels are direct hardened and if there is a danger of distortion, they should be quenched from a temperature between the core-hardening and case-hardening temperatures.

e Time for tempering as a guide: 1 h minimum.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Table 9 — Test conditions for the verification of the requirements given in column 1

No.	1	2		3	4	5	6
	Requirements		Amount of testing			Sampling[b]	Test method
				Number of			
		See table	Test unit[a]	sample products per test unit	tests per sample product		
1	Chemical composition	3 and 4	C	(The cast analysis is given by the manufacturer; for product analysis, see A.3)			
2	Hardenability	5 and 6	C	1	1	In cases of dispute, if possible, the sampling method given in ISO 642:1999, 5.1, a) or b 1) shall be applied. In all other cases, the sampling method, including the method which starts from separately cast and subsequently hot-worked test ingots or from cast and not hot-worked samples is, unless otherwise agreed at the time of enquiry and order, left to the discretion of the manufacturer.	The test shall be carried out in conformity with ISO 642. The quenching temperature shall be as specified in Table 8. The hardness values shall be determined in accordance with method C of ISO 6508-1.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved

Table 9 — *(continued)*

No.	1	2		3	4	5	6
	Requirements		Amount of testing			Sampling[b]	Test method
				Number of			
		See table	Test unit[a]	sample products per test unit	tests per sample product		
3	Hardness in the condition +S or +A, +TH or FP	7	C and D and T	1	1	In cases of dispute, the hardness shall be measured, if possible, at the following point of the surface: — in the case of round bars, at a distance equal to the diameter from one end of the bar, — in the case of bars with a square or rectangular cross-section and in the case of flat products, at a distance equal to the thickness form the end and 0,25 times the thickness from one longitudinal edge on the transverse side of the product. If, for example, for hammer and drop forgings, the above requirements prove unrealistic, agreement shall be agreed at the time of enquiry and order about more appropriate position of the hardness indentations. For sample preparation, see ISO 6506-1.	In accordance with ISO 6506-1.
	Hardness in the condition +N	7	C	1	1	The test shall be performed near the surface.	In accordance with ISO 6506-1.

NOTE Verification of the requirements is only necessary if an inspection certificate is ordered and if the requirement is applicable to Table 1, column 8 or 9.

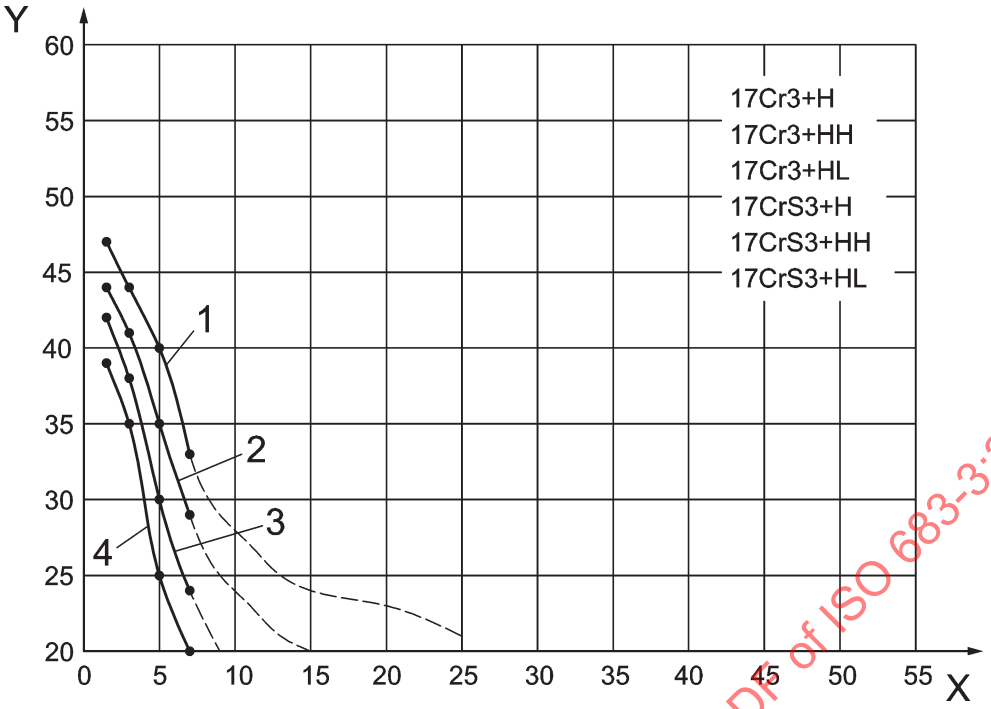
[a] The tests shall be carried out separately for each cast as indicated by “C”, each dimension as indicated by “D”, and each heat- treatment batch as indicated by “T”.

Products with different thickness may be grouped if the thicknesses lie in the same dimensional range for mechanical properties and if the differences in thickness do not affect the properties. In cases of doubt, the thinnest and the thickest product shall be tested.

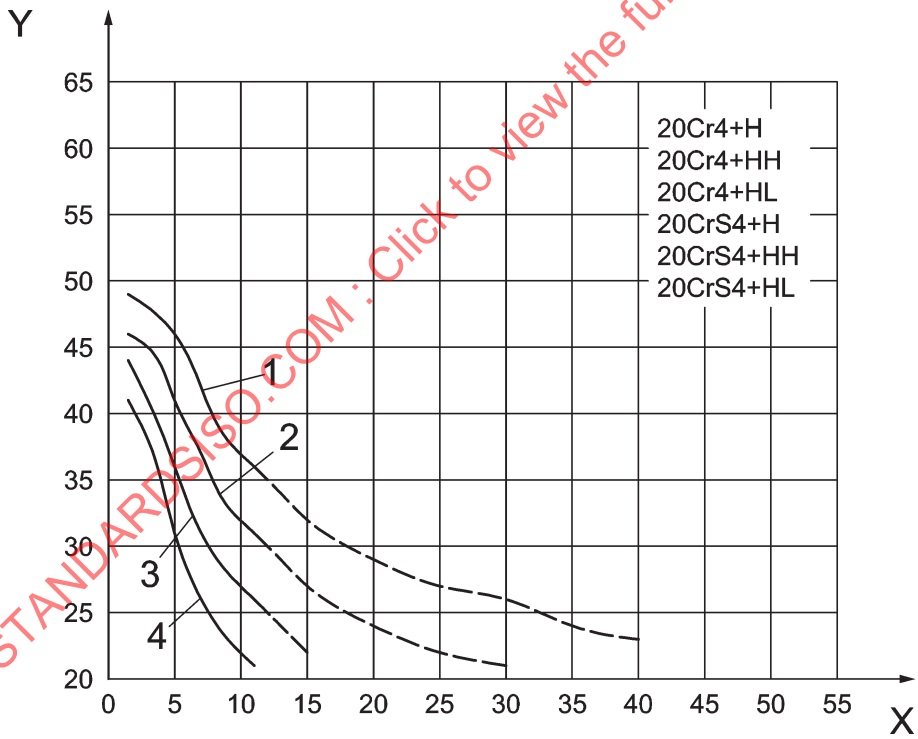
[b] The general conditions for the selection and preparation of samples and test pieces should be in accordance with ISO 377 and ISO 14284.

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved



a)



b)

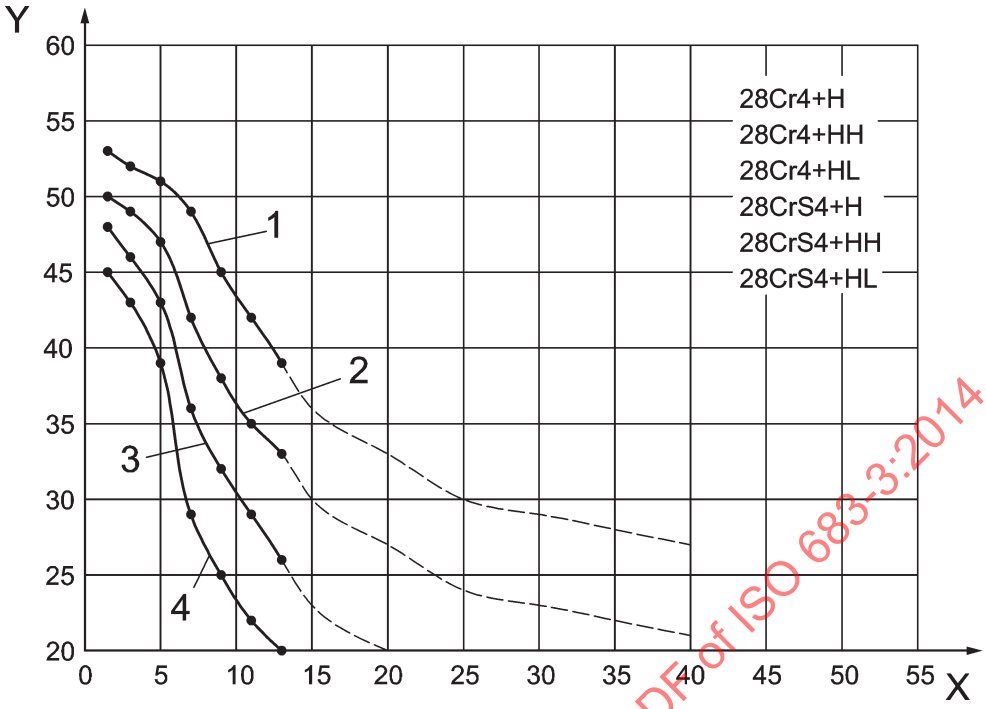
STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Key

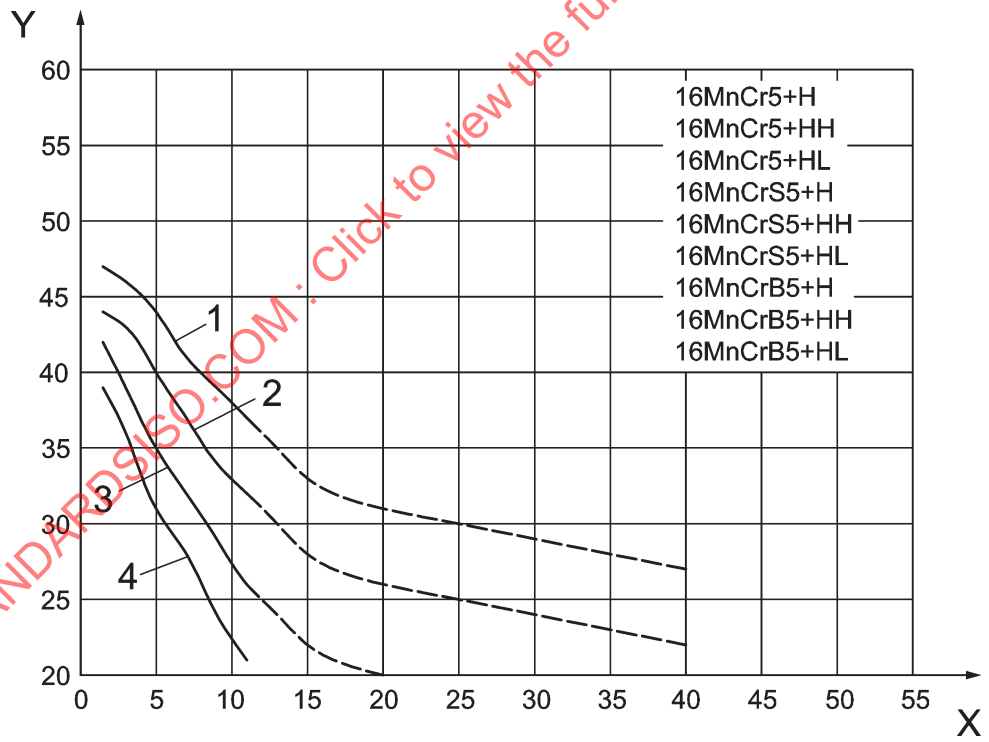
X distance from quenched end of test piece, mm
Y hardness, HRC
1 upper limit
2 upper limit, +HL grades
3 lower limit, +HH grades
4 lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

© ISO 2014 – All rights reserved



c)



d)

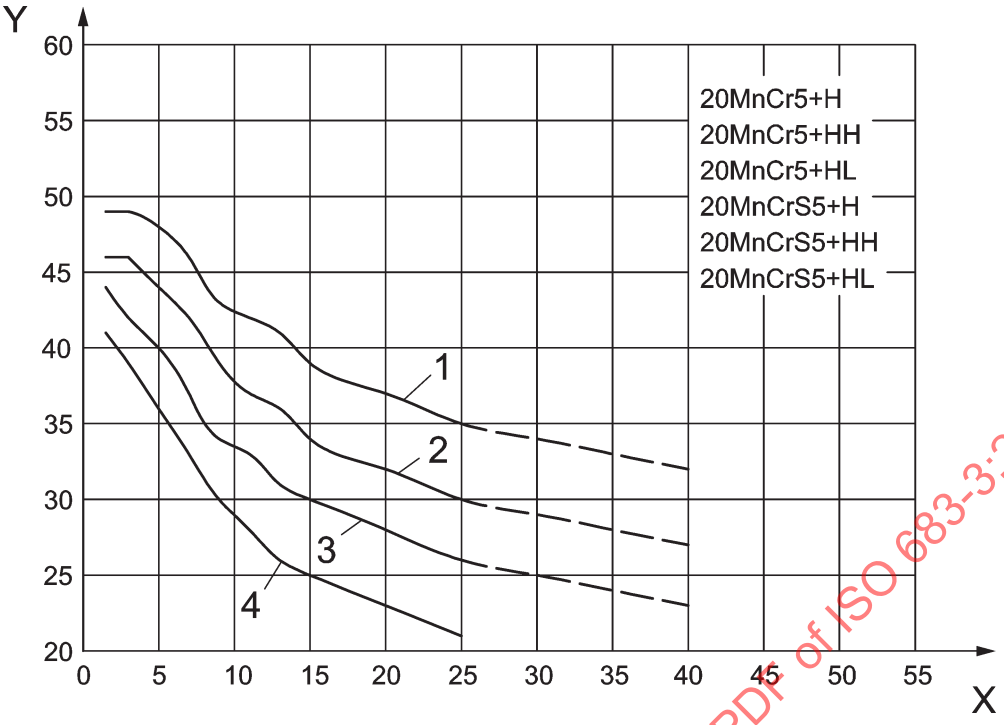
STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Key

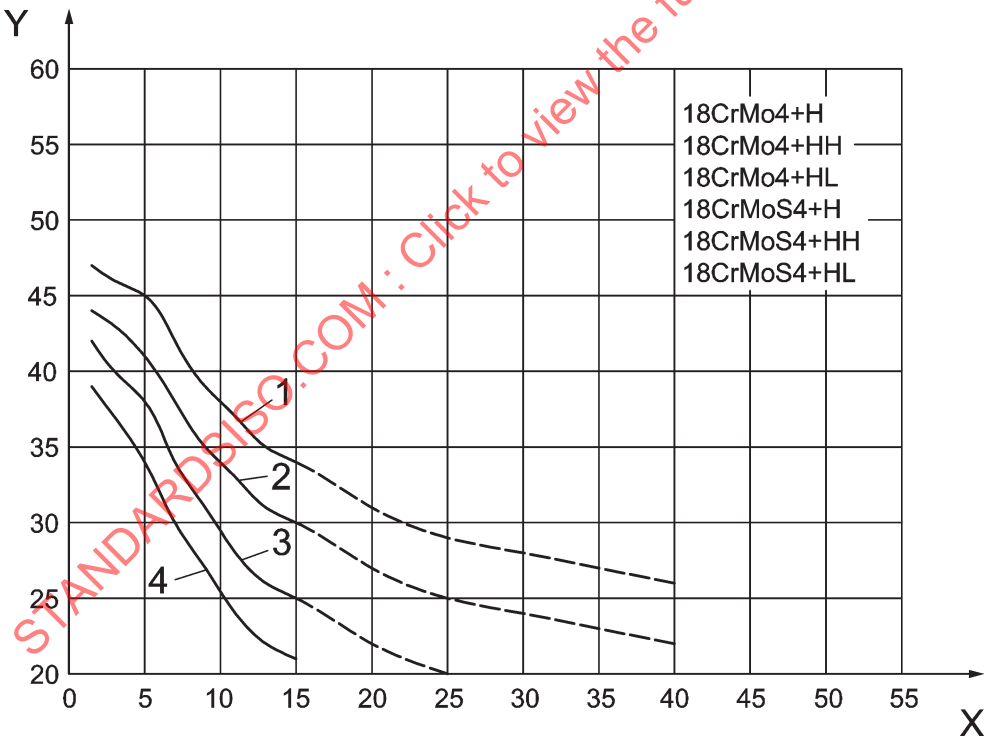
X distance from quenched end of test piece, mm
Y hardness, HRC
1 upper limit
2 upper limit, +HL grades
3 lower limit, +HH grades
4 lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

© ISO 2014 – All rights reserved



e)



f)

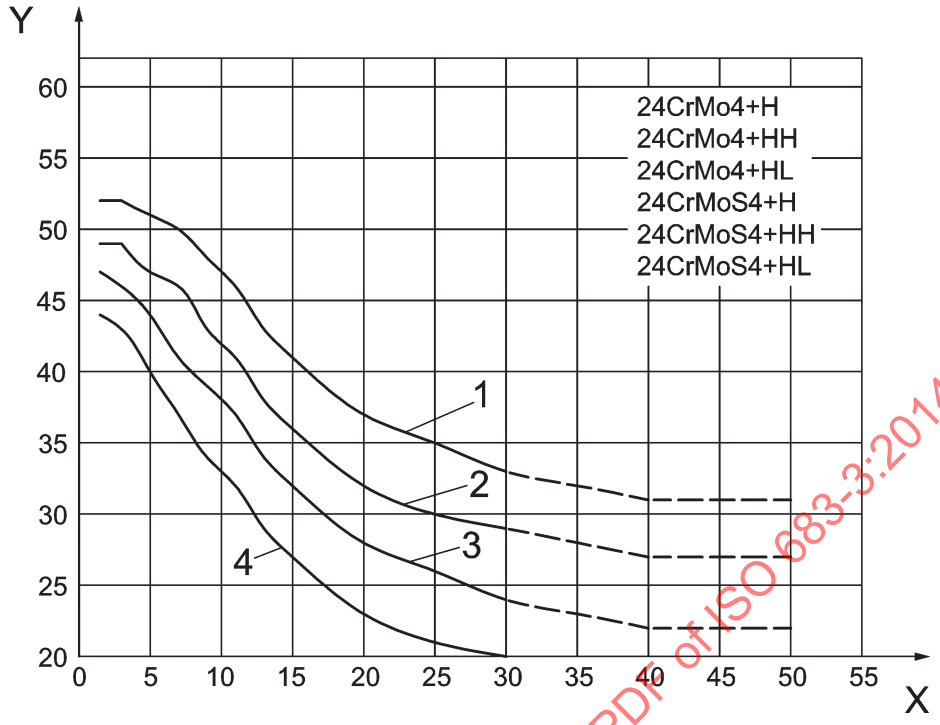
STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Key

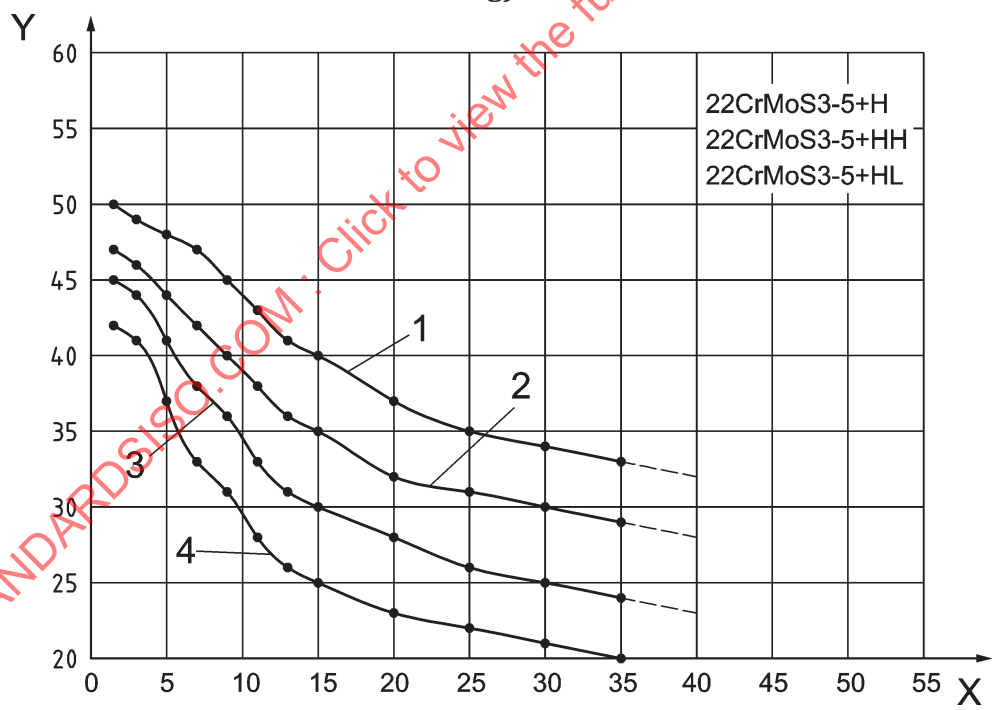
X distance from quenched end of test piece, mm
Y hardness, HRC
1 upper limit
2 upper limit, +HL grades
3 lower limit, +HH grades
4 lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

© ISO 2014 – All rights reserved



g)



h)

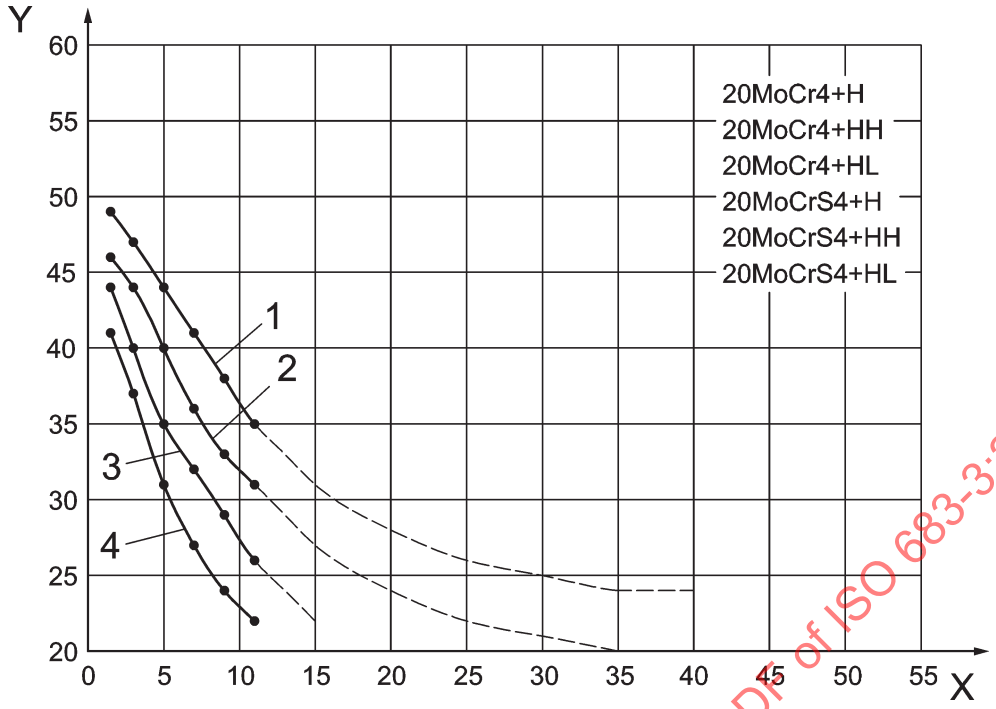
Key

X	distance from quenched end of test piece, mm	2	upper limit, +HL grades
Y	hardness, HRC	3	lower limit, +HH grades
1	upper limit	4	lower limit

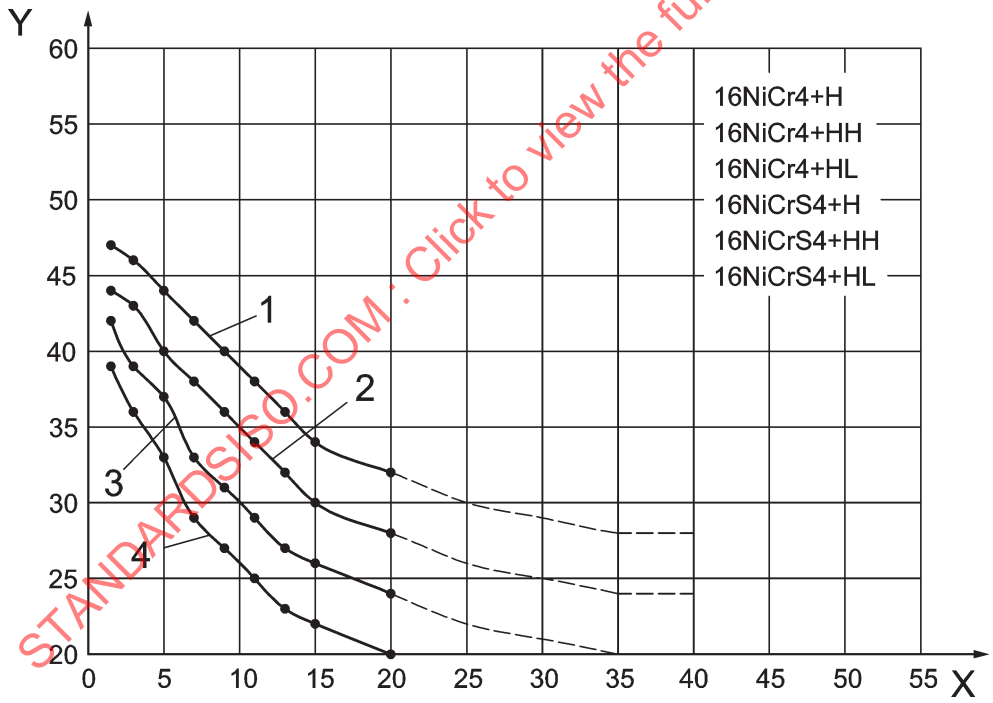
Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved



i)



j)

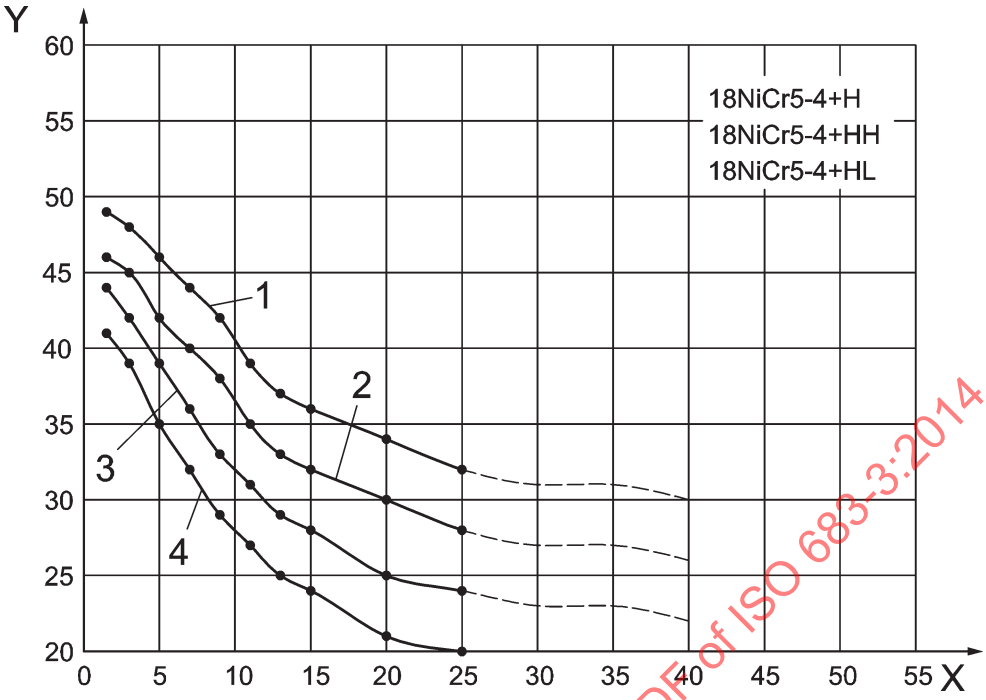
STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Key

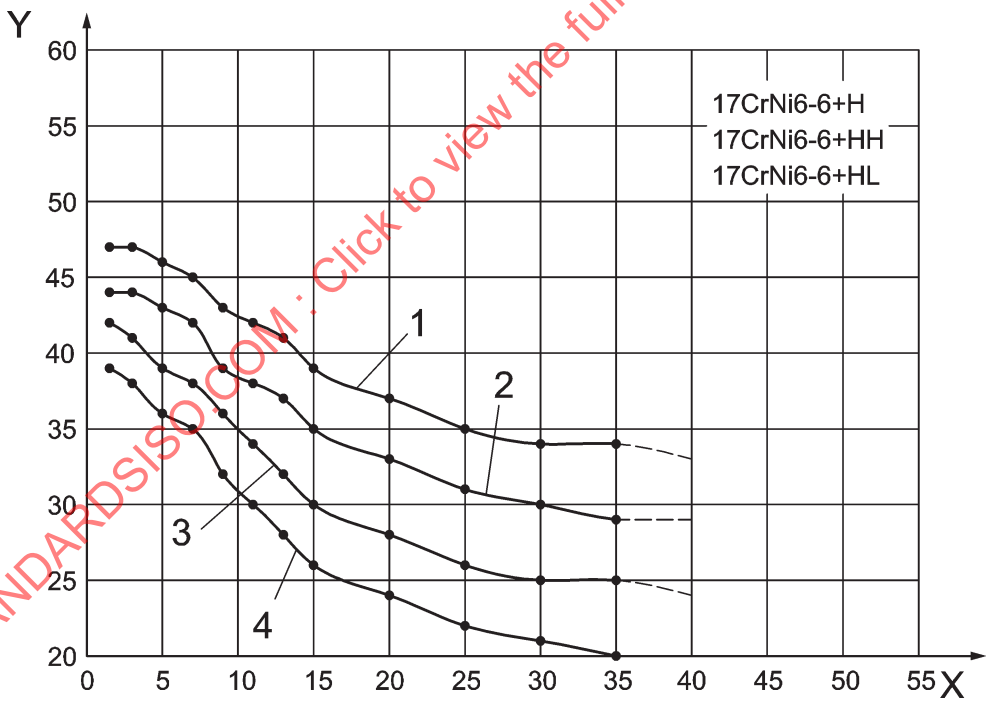
X distance from quenched end of test piece, mm
Y hardness, HRC
1 upper limit
2 upper limit, +HL grades
3 lower limit, +HH grades
4 lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

© ISO 2014 – All rights reserved



k)



l)

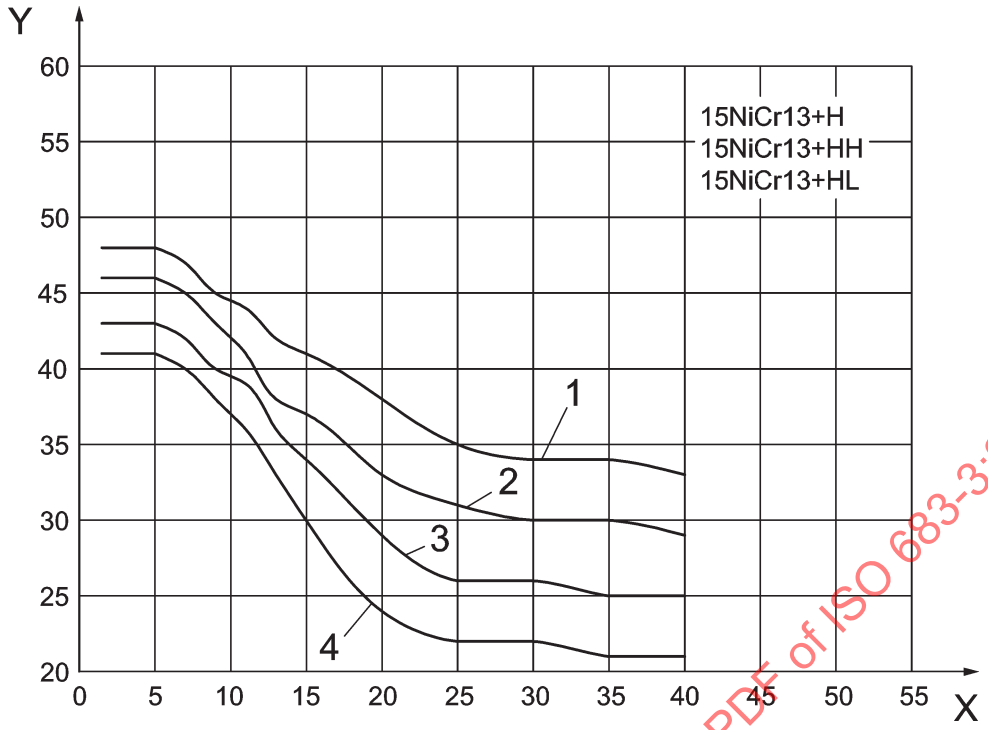
STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

Key

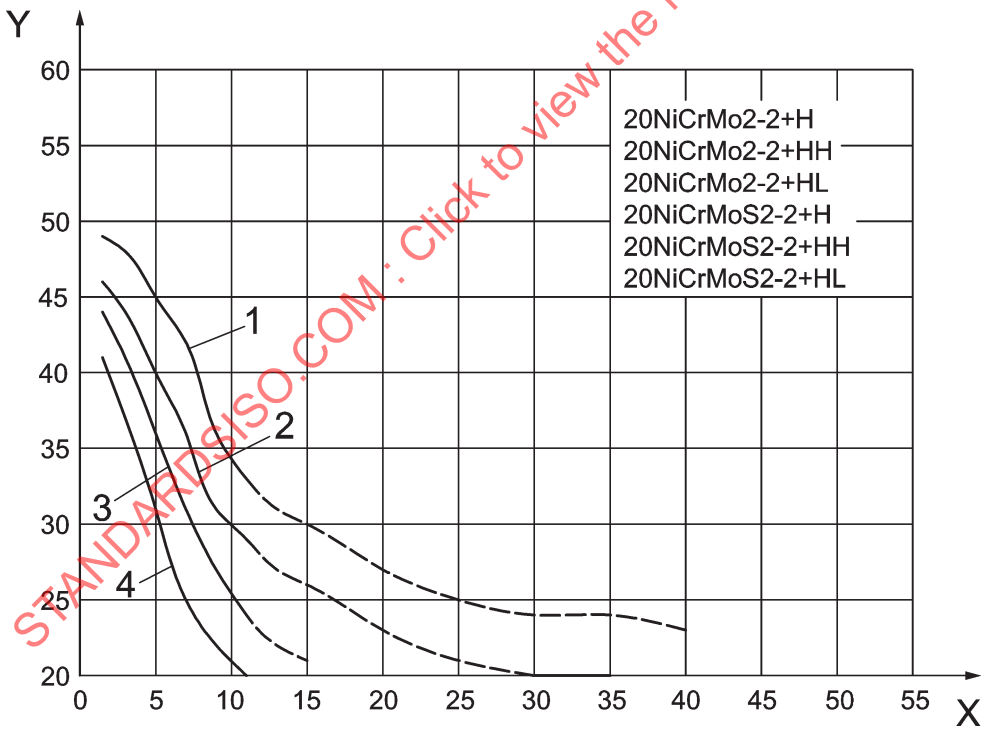
X	distance from quenched end of test piece, mm	2	upper limit, +HL grades
Y	hardness, HRC	3	lower limit, +HH grades
1	upper limit	4	lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

© ISO 2014 – All rights reserved



m)



n)

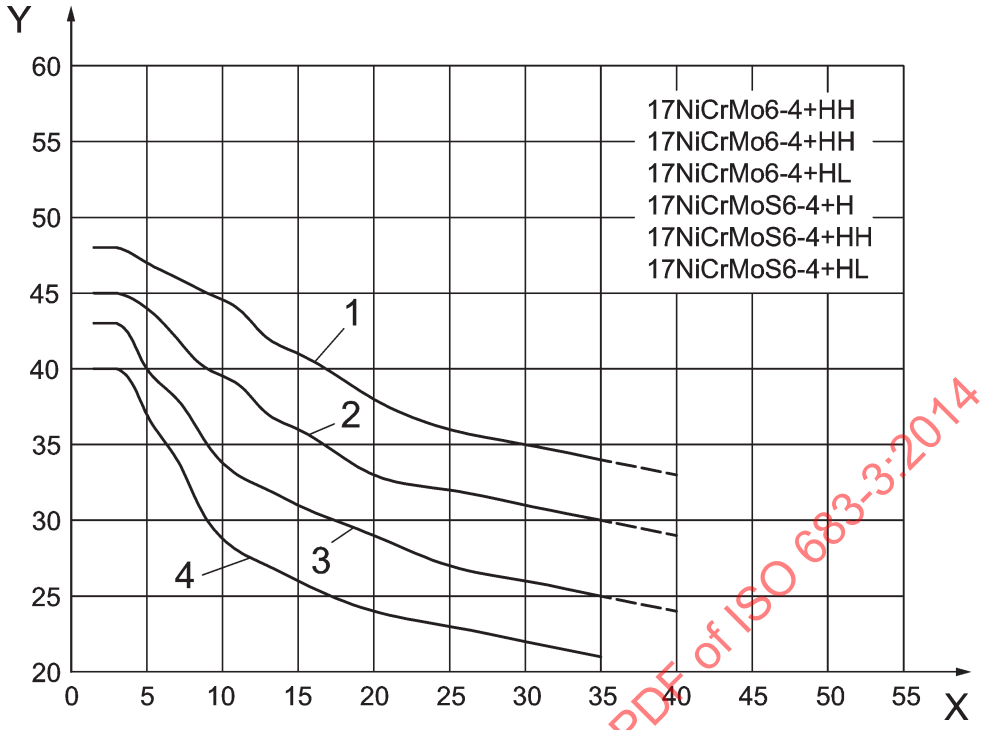
Key

X	distance from quenched end of test piece, mm	2	upper limit, +HL grades
Y	hardness, HRC	3	lower limit, +HH grades
1	upper limit	4	lower limit

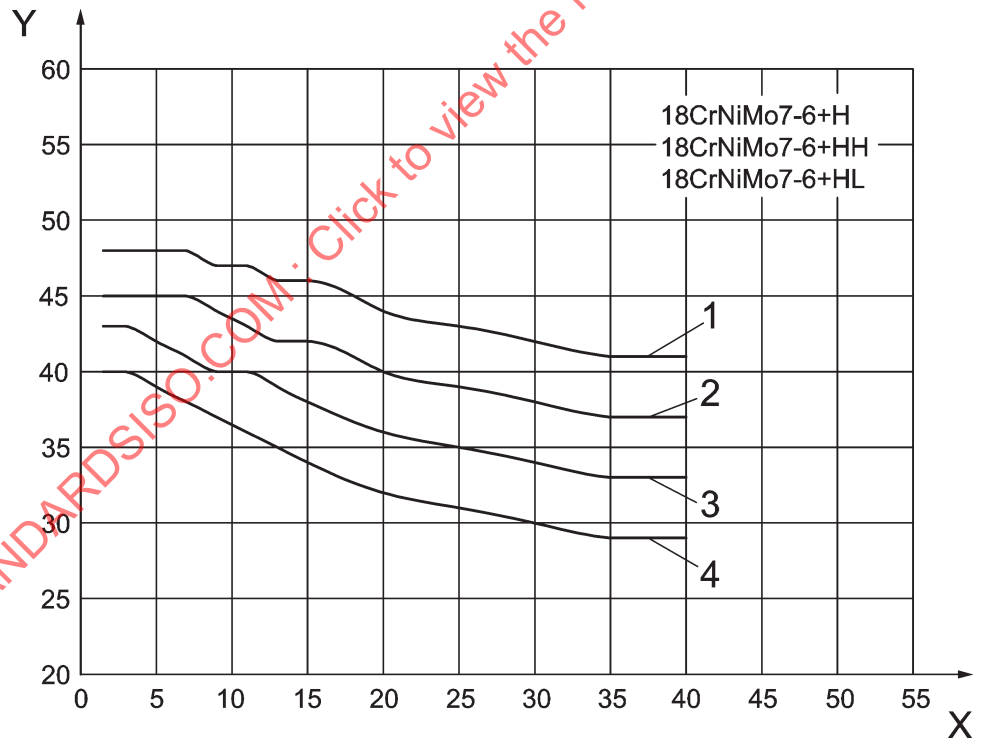
Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test *(continued)*

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved



o)



p)

Key

X distance from quenched end of test piece, mm
Y hardness, HRC
1 upper limit
2 upper limit, +HL grades
3 lower limit, +HH grades
4 lower limit

Figure 1 — Scatter bands for Rockwell C hardness in end quench hardenability test

STANDARDSISO.COM : Click to view the full PDF of ISO 683-3:2014

© ISO 2014 – All rights reserved