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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

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

Part 1 :
Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products

Aciers pour traitement thermique, aciers alliés et aciers pour décolletage —
Partie 1 : Aciers corroyés non alliés et faiblement alliés à durcissement par trempe directe se présentant sous la forme de différents produits noirs

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 683-1 was prepared by Technical Committee ISO/TC 17, *Steel.*

It cancels and replaces ISO Recommendations R 683-1:1968, R 683-2:1968 and R 683-3 to 8:1970, of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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

Part 1 :
Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products

1 Scope and field of application

1.1 This part of ISO 683 gives the technical delivery requirements for

— semi-finished products, for example blooms, billets, slabs (see note 4)

— bars (see note 4)

— wire rod

— hot-rolled plates (see note 3)

— hammer or drop forgings (see note 4)

manufactured from the direct hardening unalloyed or low alloyed steels listed in table 3 and supplied in one of the heat-treatment conditions given for the different types of products in table 1, line 2 to 7 and in one of the surface conditions given in table 2.

The steels are in general intended for the fabrication of quenched and tempered or austempered (see 3.3 and note 2) machine parts, but are partly (see table 10) also applied in the normalized condition.

The requirements for mechanical properties given in this part of ISO 683 are restricted to the sizes given in table 9 and 10.

NOTES

1 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 other related International Standards are given in annex C.

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

3 The term "plate" includes in the following, unless otherwise stated, also wide flats.

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

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

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

2 References

ISO 83, *Steel — Charpy impact test (U-notch).*

ISO 148, *Steel — Charpy impact test (V-notch).*

ISO 377, *Wrought steel — Selection and preparation of samples and test pieces.*

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 ferritic or austenitic grain size.*

ISO 1035, *Hot-rolled steel bars*

— *Part 1 : Dimensions of round bars.*

— *Part 2 : Dimensions of square bars.*

— *Part 3 : Dimensions of flat bars.*

— *Part 4 : Tolerances.*

ISO 3887, *Steel, non-alloy and low-alloy — Determination of depth of decarburization.*

ISO 4948, *Steels — Classification*

— *Part 1 : Classification of steels into unalloyed and alloy steels based on chemical composition.*

— *Part 2 : Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics.*

ISO 4954, *Steels for cold heading and cold extruding.*

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

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

ISO 6892, *Metallic materials — Tensile testing.*

ISO 6929, *Definition of steel products by shape and dimensions.* [1)]

ISO 7452, *Hot-rolled structural steel plates — Tolerances on dimensions and shape.*

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

3 Definitions

For deviations from normal definitions, see notes 2, 3 and 4 to 1.1.

For the purpose of this part of ISO 683, the definitions of ISO 6929, and the following, apply.

3.1 ruling section : That section for which the specified mechanical properties shall apply.

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

3.2 austempering : An austenitization of a steel with a subsequent cooling to a temperature in the Bainite region and holding at this temperature until a desired degree of transformation is obtained.

The subsequent cooling to room temperature can be carried out in any manner desired.

3.3 unalloyed steel : See ISO 4948/1.

3.4 alloyed steel : See ISO 4948/1.

3.5 special steel : See ISO 4948/2.

4 Ordering and designation

The designation of the product in an order shall cover the following :

a) the designation of the product form (bloom, bar, wire rod, etc.) followed by

— either the designation of the dimensional standard and the dimensions and tolerances selected from this (see 5.7),

— or, for example in the case of drop forgings, by the designation of the drawing or any other document covering the dimensions and tolerances required for the product;

b) if another surface condition than "hot worked" or a special surface quality is required

— the surface condition (see table 2),

— the surface quality (see 5.6);

c) a description of the steel comprising

1) a reference to this part of ISO 683,

2) the designation of the steel type given in table 3 and, where appropriate, the symbols for the hardenability grade (see 5.2.3 and tables 5 to 7),

3) if a heat-treatment condition other than the untreated condition is required, the symbol for this other condition (see table 1, column 3),

4) if a document is required, the symbol for the required type of document (see table 11),

5) if any supplementary requirement shall be complied with, the symbol and, where necessary, the details of this supplementary requirement (see annex B).

Example

To be ordered are :

Hot-rolled round bars,

according to ISO 1035/1,

with a nominal diameter of 40,0 mm,

a nominal length of 8 000 mm,

with a diameter tolerance of ± 0,40 mm (= class S according to ISO 1035/4),

length tolerance of $^{\ 0}_{+100}$ mm (= class L2 of ISO 1035/4),

all other tolerances given in ISO 1035/4 for normal cases.

Surface

blast cleaned (symbol BC, see table 2).

Steel

according to this part of ISO 683,

type C45 E4 (see table 3),

heat-treatment condition : normalized (symbol N, see table 1),

with an inspection certificate of type IC (see table 11),

ultrasonically tested (supplementary requirement specified in clause B.6) in accordance with test sheet *xy*.

Designation

Rounds : ISO 1035/1-40,0 S × 8 000 L2

Surface : BC

Steel : ISO 683/1-C45 E4-N-IC-S6

Details : for ultrasonic test, see test sheet *xy*

1) At present at the stage of draft.

5 Requirements

5.1 Manufacturing process

5.1.1 General

The manufacturing process of the steel and of the products is with the restrictions given by the requirements in 5.1.2 to 5.1.4 left to the discretion of the manufacturer.

5.1.2 Deoxidation

All steels shall be fully killed.

5.1.3 Heat treatment and surface condition at delivery

5.1.3.1 Normal condition at delivery

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

5.1.3.2 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 7.

5.1.3.3 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.

5.1.4 Cast separation

The steels shall be delivered separated by casts.

5.2 Chemical composition, hardenability and mechanical properties

5.2.1 Except where steels are ordered in the quenched and tempered condition, this part of ISO 683 makes for the steel types 22 Mn 6 and 28 Mn 6, for the unalloyed special steels with carbon contents equal or higher than the contents of type C 35 and for the alloyed steels provisions to be supplied with or without hardenability requirements (see table 1, columns 9 and 10).

5.2.2 Where the steel is not ordered to hardenability requirements — that means where the steel type designations of table 3 and not the designations given in tables 5 to 7 are applied — the requirements for chemical composition, hardness and mechanical properties cited in table 1, column 9, apply as appropriate for the particular heat-treatment condition. In this case the values of hardenability given in table 5 are for guidance purposes only.

5.2.3 Where the steel is ordered by using the designations given in table 5, 6 or 7 to normal (see table 5) or to narrowed (see tables 6 and 7) hardenability requirements, the values of hardenability given in table 5, 6 or 7 respectively apply in addition to the requirements cited in table 1, column 9. [See footnote 3) to table 3.]

5.3 Technological properties

5.3.1 Machinability

All steels are machinable in the condition "annealed to maximum hardness requirements".

Where improved machinability is required the grades with a specified sulfur range should be ordered. (See also table 1, line 7.)

5.3.2 Shearability

5.3.2.1 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 shearable in the annealed condition.

5.3.2.2 The steel types C 45, C 50, C 55, C 60, 28 Mn 6, 36 Mn 6, 42 Mn 6, 34 Cr 4, 37 Cr 4, 41 Cr 4, 25 CrMo 4, 34 CrMo 4, 42 CrMo 4 and 41 CrNiMo 2, and the corresponding E4-, M2-, S-, H-, HH- and HL-grades (see tables 3 and 5 to 7) are, under suitable conditions, also shearable when being delivered in the condition "treated to improve shearability" with the hardness requirements given in table 8.

5.3.2.3 The steels C 25, C 30, C 35, C 40 and 22 Mn 6 and the corresponding E4-, M2-, S-, H-, HH- and HL-grades (see tables 3 and 5 to 7) are, under suitable conditions, shearable when being delivered in the untreated condition.

Also for the various grades of steel C 45, in sizes of 80 mm and larger, shearability can be presumed in the untreated condition.

5.4 Structure

5.4.1 For grain size, see annex B, clauses B.3 and B.4.

5.4.2 For the non-metallic inclusion content, see annex B, clause B.5.

5.5 Internal soundness

The steel shall be free from internal defects likely to have an adverse effect (see annex B, clause B.6).

5.6 Surface quality and decarburization

5.6.1 All products shall have a workmanlike finish.

5.6.2 Minor surface discontinuities, which may occur also under normal manufacturing conditions, such as scores originating in the case of black steel from rolled-in scale, are not to be regarded as defects.

5.6.3 As long as 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.

NOTES

1 For bars and wire rod included in this part of ISO 683, a separate International Standard on surface quality is in preparation.

2 The bars and wire rod for cold heading and cold extrusion are in total handled by ISO 4954.

3 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.

4 For hot-rolled plates, the requirements for surface finish are specified in ISO 7788.

5 Agreements for the admissible surface decarburization should, where appropriate, be based on one of the testing methods given in ISO 3887.

5.6.4 Removal of surface discontinuities by welding is not permitted.

Pending publication of a separate International Standard, the kind and permissible depth for removal of surface discontinuities should, where appropriate, be agreed at the time of enquiry and order.

5.7 Shape, dimensions and tolerances

The shape, dimensions and tolerances of the products shall comply with the requirements agreed at the time of enquiry and order. The agreements shall, as far as possible, be based on corresponding International Standards, otherwise on suitable national standards.

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

- for bars : ISO 1035/1 to 4
- for plates (except for wide flats) : ISO 7452.

6 Inspection, testing and conforming of products

6.1 Inspection and testing procedures and types of documents

6.1.1 Table 11 gives a survey of the inspection procedures and the type of documents of ISO 404 which may be agreed at the time of enquiry and order for deliveries according to this part of ISO 683.

6.1.2 If, in accordance with the agreements at the time of enquiry and order, a test report (TR) is to be provided this shall cover

a) the statement that the material complies with the requirements of the order;

b) the results of the cast analysis for all elements specified for the steel type supplied.

6.1.3 If, in accordance with the agreements in the order, an inspection certificate (IC or ICP) or an inspection report (IR) (see table 11) is to be provided, the specific inspections and tests described in 6.2 shall be carried out and their results shall be certified in the document.

In addition the document shall cover

a) for all elements specified for the steel type concerned the results of the cast analysis given by the manufacturer;

b) the result of all inspections and tests ordered by supplementary requirements (see annex B);

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

6.2 Specific inspection and testing

6.2.1 Verification of the hardenability, hardness and mechanical properties

6.2.1.1 For steels being ordered without hardenability requirements, that means without the symbol H, HH or HL in the designation, the hardness requirements or mechanical properties given for the relevant heat-treatment condition in table 1, column 9, subclause 2, shall, with the following exception, be verified. The requirement given in table 1, footnote 1 (mechanical properties of reference test pieces), is only to be verified if a supplementary requirement specified in annex B, clause B.1 or clause B.2 is ordered.

For steels being ordered with the symbol H, HH or HL in the designation (see tables 5 to 7), unless otherwise agreed, only the hardenability requirements according to table 5, 6 or 7 are to be verified.

6.2.1.2 The amount of testing, the sampling conditions and the test methods to be applied for the verification of the requirements shall be in accordance with the prescriptions of table 12.

6.2.2 Visual and dimensional inspection

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

6.2.3 Retests

6.2.3.1 Where for one or more test units one or more tests give unsatisfactory results the manufacturer has the choice of withdrawing the test units concerned (for example for retreatment or sorting in accordance with ISO 404) or of retaining them. If they are retained, retests are to be carried out according to the following rules.

6.2.3.2 If — as in the case of tensile tests or product analysis (see annex B, clause B.7) — only one test of the type concerned was carried out on the sample concerned and gave the unsatisfactory result, two new tests of the same type shall be carried out.

6.2.3.3 If one or more of the three individual impact tests to be carried out on test pieces from one sample was lower than 70 % of the specified mean value or if the mean value of these three impact tests was too low, two new series each consisting of the three impact tests shall be carried out.

6.2.3.4 If the test unit consists of more than one product and if the product from which the unsatisfactory test result stems is not withdrawn from the test unit one of the two new tests or test series shall be made on test pieces taken from the originally tested sample or product.

6.2.3.5 All retests shall give satisfactory results. Otherwise the test unit concerned is to be rejected.

7 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 annex B, clause B.8).

Table 1 — Combinations 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		
1	**Heat-treatment condition at delivery**	**Symbol**	x indicates applicable for					**Applicable requirements if the steel is ordered with the designation given in**					
			Billets, blooms, slabs	Bars	Wire rod	Flat products	Hammer and drop forgings	table 3			table 5, 6 or 7		
								1.	2.		1.	2.	3.
2	Untreated	none or U	x	x	x	x	x	Chemical composition according to tables 3 and 4	—[1]		As in column 9 (See footnote 3 in table 3)		Hardenability values according to table 5, 6 or 7
3	Treated to improve shearability	S	x	x	—	—	—		Maximum Brinell hardness according to table 8	column S[1]			
4	Annealed to maximum hardness requirements	A	x	x	x	x	x			column A[1]			
5	Normalized	N	—	x	—	x	x		Mechanical properties according to	table 10			
6	Quenched and tempered	Q + T	—	x	—	x	x			table 11			
7	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", as required for cold heading and cold extrusion, is covered in ISO 4954.											

1) The mechanical properties specified in table 9 for the quenched and tempered condition and in table 10 for the normalized condition must be achievable after appropriate heat treatment if so agreed at the time of enquiry and order (see annex B, clauses B.1 and B.2).

Table 2 — Surface condition at delivery

1	2	3	4	5	6	7	8	9	10
1	**Surface condition at delivery**		**Symbol**	x indicates in general applicable for					**Notes**
				Semi-finished products as blooms, billets	Bars	Wire rod	Plates	Hammer and drop forgings (see note 4 to 1.1)	
2	Unless otherwise agreed	as hot worked	None or HW	x[1]	x	x	x	x	
3	Particular conditions supplied by agreement	HW + pickled	PI	x	x	x	x	x	—[3]
4		HW + blast cleaned	BC	x	x	x	x	x	
5		HW + rough machined	—[2]	—	x	x	—	x	
6		others							

1) The term "hot worked" includes in the case of the semi-finished products also the continuously cast condition.

2) 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.

3) In addition, it may be agreed that the products be oiled or, where appropriate, limed or phosphated.

Table 3 — Types of steel and specified chemical composition (applicable to cast analysis)

Type of steel[1]	Chemical composition[2)3)4)5)] [% (*m*/*m*)]								
	C	Si	Mn	P max.	S	Cr	Mo	Ni	V
C 25	0,22 to 0,29	0,10 to 0,40	0,40 to 0,70	0,045	< 0,045				
C 25 E4				0,035	< 0,035				
C 25 M2					0,020 to 0,040				
(C 30)	0,27 to 0,34	0,10 to 0,40	0,50 to 0,80	0,045	< 0,045				
(C 30 E4)				0,035	< 0,035				
(C 30 M2)					0,020 to 0,040				
C 35	0,32 to 0,39	0,10 to 0,40	0,50 to 0,80	0,045	< 0,045				
C 35 E4				0,035	< 0,035				
C 35 M2					0,020 to 0,040				
(C 40)	0,37 to 0,44	0,10 to 0,40	0,50 to 0,80	0,045	⩽ 0,045				
(C 40 E4)				0,035	< 0,035				
(C 40 M2)					0,020 to 0,040				
C 45	0,42 to 0,50	0,10 to 0,40	0,50 to 0,80	0,045	⩽ 0,045				
C 45 E4				0,035	< 0,035				
C 45 M2					0,020 to 0,040				
(C 50)	0,47 to 0,55	0,10 to 0,40	0,60 to 0,90	0,045	⩽ 0,045				
(C 50 E4)				0,035	< 0,035				
(C 50 M2)					0,020 to 0,040				
C 55	0,52 to 0,60	0,10 to 0,40	0,60 to 0,90	0,045	< 0,045				
C 55 E4				0,035	⩽ 0,035				
C 55 M2					0,020 to 0,040				
C 60	0,57 to 0,65	0,10 to 0,40	0,60 to 0,90	0,045	< 0,045				
C 60 E4				0,035	< 0,035				
C 60 M2					0,020 to 0,040				
22 Mn 6	0,19 to 0,26	0,10 to 0,40[6)]	1,30 to 1,65	0,035	< 0,035				
28 Mn 6	0,25 to 0,32	0,10 to 0,40[6)]	1,30 to 1,65	0,035	< 0,035				
36 Mn 6	0,33 to 0,40	0,10 to 0,40[6)]	1,30 to 1,65	0,035	< 0,035				
42 Mn 6	0,39 to 0,46	0,10 to 0,40[6)]	1,30 to 1,65	0,035	< 0,035				
34 Cr 4	0,30 to 0,37	0,10 to 0,40[6)]	0,60 to 0,90	0,035	< 0,035	0,90 to 1,20			
34 CrS 4					0,020 to 0,040				
37 Cr 4	0,34 to 0,41	0,10 to 0,40[6)]	0,60 to 0,90	0,035	< 0,035	0,90 to 1,20			
37 CrS 4					0,020 to 0,040				
41 Cr 4	0,38 to 0,45	0,10 to 0,40[6)]	0,60 to 0,90	0,035	⩽ 0,035	0,90 to 1,20			
41 CrS 4					0,020 to 0,040				
25 CrMo 4	0,22 to 0,29	0,10 to 0,40[6)]	0,60 to 0,90	0,035	< 0,035	0,90 to 1,20	0,15 to 0,30		
25 CrMoS 4					0,020 to 0,040				
34 CrMo 4	0,30 to 0,37	0,10 to 0,40[6)]	0,60 to 0,90	0,035	< 0,035	0,90 to 1,20	0,15 to 0,30		
34 CrMoS 4					0,020 to 0,040				
42 CrMo 4	0,38 to 0,45	0,10 to 0,40[6)]	0,60 to 0,90	0,035	< 0,035	0,90 to 1,20	0,15 to 0,30		
42 CrMoS 4					0,020 to 0,040				
50 CrMo 4	0,46 to 0,54	0,10 to 0,40[6)]	0,50 to 0,80	0,035	< 0,035	0,90 to 1,20	0,15 to 0,30		
41 CrNiMo 2	0,37 to 0,44	0,10 to 0,40[6)]	0,70 to 1,00	0,035	< 0,035	0,40 to 0,60	0,15 to 0,30	0,40 to 0,70	
41 CrNiMoS 2					0,020 to 0,040				
36 CrNiMo 4	0,32 to 0,40	0,10 to 0,40[6)]	0,50 to 0,80	0,035	< 0,035	0,90 to 1,20	0,15 to 0,30	0,90 to 1,20	
36 CrNiMo 6	0,32 to 0,39	0,10 to 0,40[6)]	0,50 to 0,80	0,035	< 0,035	1,30 to 1,70	0,15 to 0,30	1,30 to 1,70	
31 CrNiMo 8	0,27 to 0,34	0,10 to 0,40[6)]	0,30 to 0,60	0,035	⩽ 0,035	1,80 to 2,20	0,30 to 0,50	1,80 to 2,20	
51 CrV 4	0,47 to 0,55	0,10 to 0,40[6)]	0,60 to 1,00	0,035	⩽ 0,035	0,80 to 1,10			0,10 to 0,25

1) The designations are in accordance with the system proposed by ISO/TC 17/SC 2.

2) Elements not quoted should 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 the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

3) In the case of the grades with specified hardenability requirements (see tables 5 to 7), 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 % (*m*/*m*) and in all other cases the values according to table 4.

4) For boron-treated steels, see ISO 4954.

5) Steels with improved machinability by either lead additions or higher sulfur levels up to about 0,100 % (*m*/*m*) S (including controlled sulfide morphology) may be available on request.

6) Steels may be supplied with a lower silicon content. In this case, alternative means of deoxidation shall be used.

Table 4 — Permissible deviations between specified analysis and product analysis

Element	Permissible maximum content according to cast analysis [% (m/m)]	Permissible deviation[1] [% (m/m)]
C	⩽ 0,30 0,30 < ⩽ 0,55 0,55 < ⩽ 0,65	± 0,02 ± 0,03 ± 0,04
Si	⩽ 0,40	± 0,03
Mn	⩽ 1,00 1,00 < 1,65	± 0,04 ± 0,06
P	⩽ 0,045	+ 0,005
S	⩽ 0,045	+ 0,005[2]
Cr	⩽ 2,00 2,00 < 2,20	± 0,05 ± 0,10
Mo	⩽ 0,30 0,30 < 0,50	± 0,03 ± 0,04
Ni	⩽ 1,00 1,00 < ⩽ 2,00 2,00 < ⩽ 2,20	± 0,03 ± 0,05 ± 0,07
V	⩽ 0,25	± 0,02

1) ± 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.

2) For steels with a specified sulfur range [0,020 to 0,040 % (m/m) according to cast analysis], the permissible deviation is ± 0,005 % (m/m).

Table 5 — Hardness limits for steel types with specified (normal) hardenability (H-grades; see 5.2)

Type of steel	Limits of range	Hardness HRC at a distance, in millimetres, from quenched end of test piece of															
		1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30
C 35 E4 H, C 35 M2 H[1)]	max.	58	57	55	53	49	41	34	31	28	27	26	25	24	23	20	—
	min.	48	40	33	24	22	20	—	—	—	—	—	—	—	—	—	—
C 40 E4 H, C 40 M2 H[1)]	max.	60	60	59	57	53	47	39	34	31	30	29	28	27	26	25	24
	min.	51	46	35	27	25	24	23	22	21	20	—	—	—	—	—	—
C 45 E4 H, C 45 M2 H[1)]	max.	62	61	61	60	57	51	44	37	34	33	32	31	30	29	28	27
	min.	55	51	37	30	28	27	26	25	24	23	22	21	20	—	—	—
C 50 E4 H, C 50 M2 H[1)]	max.	63	62	61	60	58	55	50	43	36	35	34	33	32	31	29	28
	min.	56	53	44	34	31	30	30	29	28	27	26	25	24	23	20	—
C 55 E4 H, C 55 M2 H[1)]	max.	65	64	63	62	60	57	52	45	37	36	35	34	33	32	30	29
	min.	58	55	47	37	33	32	31	30	29	28	27	26	25	24	22	20
C 60 E4 H, C 60 M2 H[1)]	max.	67	66	65	63	62	59	54	47	39	37	36	35	34	33	31	30
	min.	60	57	50	39	35	33	32	31	30	29	28	27	26	25	23	21

Type of steel	Limits of range	Hardness HRC at a distance, in milimetres, from quenched end of test piece of														
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
22 Mn 6 H	max.	51	48	44	37	33	30	28	26	25	23	—	—	—	—	—
	min.	42	38	28	22	—	—	—	—	—	—	—	—	—	—	—
28 Mn 6 H	max.	54	53	50	48	44	41	38	35	31	29	27	26	25	25	24
	min.	45	42	36	27	21	—	—	—	—	—	—	—	—	—	—
36 Mn 6 H	max.	59	58	57	54	49	45	41	38	35	33	31	30	30	30	30
	min.	51	48	42	35	27	23	20	—	—	—	—	—	—	—	—
42 Mn 6 H	max.	62	61	60	59	57	54	50	45	37	34	32	31	30	29	28
	min.	55	53	49	39	33	29	27	26	23	22	20	—	—	—	—
34 Cr 4 H	max.	57	57	56	54	52	49	46	44	39	37	35	34	33	32	31
34 CrS 4 H	min.	49	48	45	41	35	32	29	27	23	21	20	—	—	—	—
37 Cr 4 H	max.	59	59	58	57	55	52	50	48	42	39	37	36	35	34	33
37 CrS 4 H	min.	51	50	48	44	39	36	33	31	26	24	22	20	—	—	—
41 Cr 4 H	max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35
41 CrS 4 H	min.	53	52	50	47	41	37	34	32	29	26	23	21	—	—	—
25 CrMo 4 H	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31	31
25 CrMoS 4 H	min.	44	43	40	37	34	32	29	27	23	21	20	—	—	—	—
34 CrMo 4 H	max.	57	57	57	56	55	54	53	52	48	45	43	41	40	40	39
34 CrMoS 4 H	min.	49	49	48	45	42	39	36	34	30	28	27	26	25	24	24
42 CrMo 4 H	max.	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45
42 CrMoS 4 H	min.	53	53	52	51	49	43	40	37	34	32	31	30	30	29	29
50 CrMo 4 H	max.	65	65	64	64	63	63	63	62	61	60	58	57	55	54	54
	min.	58	58	57	55	54	53	51	48	45	41	39	38	37	36	36
41 CrNiMo 2 H	max.	60	60	60	59	58	57	55	54	48	42	40	38	37	37	36
41 CrNiMoS 2 H	min.	53	53	52	50	47	42	38	35	30	28	26	25	24	24	23
36 CrNiMo 4 H	max.	59	59	58	58	57	57	57	56	55	54	53	52	51	50	49
	min.	51	50	49	49	48	47	46	45	43	41	39	38	36	34	33
36 CrNiMo 6 H	max.	58	58	58	58	57	57	57	57	57	57	57	57	57	57	57
	min.	50	50	50	50	49	48	48	48	48	47	47	47	46	45	44
31 CrNiMo 8 H	max.	56	56	56	56	55	55	55	55	55	54	54	54	54	54	54
	min.	48	48	48	48	47	47	47	46	46	45	45	44	44	43	43
51 CrV 4 H	max.	65	65	64	64	63	62	62	61	60	58	57	55	54	53	53
	min.	57	56	55	54	53	52	50	48	44	41	37	35	34	33	32

1) The hardenability values for the unalloyed steels are tentative and may be adjusted as more information becomes available. If the hardenability scatterband for the H-grade of the relevant steel of a manufacturer falls outside the limits given above the manufacturer has to inform the purchaser accordingly at the time of enquiry and order.

Table 6 — Tentative hardness limits for unalloyed steel types with narrowed hardenability scatterbands (HH- and HL-grades)

Type of steel	Tentative values of hardness HRC at a distance, in millimetres, from quenched end of test piece of		
	1	4	5
C 35 E4 HH4, C 35 M2 HH4	–	34 to 53	–
C 35 E4 HH14, C 35 M2 HH14	51 to 58	34 to 53	–
C 35 E4 HL4, C 35 M2 HL4	–	24 to 43	–
C 35 E4 HL14, C 35 M2 HL14	48 to 55	24 to 43	–
C 40 E4 HH4, C 40 M2 HH4	–	38 to 57	–
C 40 E4 HH14, C 40 M2 HH14	54 to 60	38 to 57	–
C 40 E4 HL4, C 40 M2 HL4	–	27 to 46	–
C 40 E4 HL14, C 40 M2 HL14	51 to 57	27 to 46	–
C 45 E4 HH4, C 45 M2 HH4	–	41 to 60	–
C 45 E4 HH14, C 45 M2 HH14	57 to 62	41 to 60	–
C 45 E4 HL4, C 45 M2 HL4	–	30 to 49	–
C 45 E4 HL14, C 45 M2 HL14	55 to 60	30 to 49	–
C 50 E4 HH5, C 50 M2 HL5	–	–	40 to 58
C 50 E4 HH15, C 50 M2 HH15	58 to 63	–	40 to 58
C 50 E4 HL5, C 50 M2 HL5	–	–	31 to 49
C 50 E4 HL15, C 50 M2 HL15	56 to 61	–	31 to 49
C 55 E4 HH5, C 55 M2 HH5	–	–	42 to 60
C 55 E4 HH15, C 55 M2 HH15	60 to 65	–	42 to 60
C 55 E4 HL 5, C 55 M2 HL5	–	–	33 to 51
C 55 E4 HL15, C 55 M2 HL15	58 to 63	–	33 to 51
C 60 E4 HH5, C 60 M2 HH5	–	–	44 to 62
C 60 E4 HH15, C 60 M2 HH15	62 to 67	–	44 to 62
C 60 E4 HL5, C 60 M2 HL5	–	–	35 to 53
C 60 E4 HL15, C 60 M2 HL15	60 to 65	–	35 to 53