

Steel rod, bars and wire for cold heading and cold extrusion —

Part 4: Technical delivery conditions for steels for quenching and tempering

The European Standard EN 10263-4:2001 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 10263-4:2001, including Corrigendum July 2002. Together with BS EN 10263-1:2001, BS EN 10263-2:2001 and BS EN 10263-3:2001 it supersedes BS 3111-1:1987, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/71, Steel rods for wire drawing, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Steel rod, bars and wire for cold heading and cold extrusion —
Part 4: Technical delivery conditions for steels for quenching and
tempering

Barres, fil machine et fils en acier pour transformation à
froid et extrusion à froid — Partie 4: Conditions techniques
de livraison des aciers pour trempe et revenu

Walzdraht, Stäbe und Draht aus Kaltstauch- und
Kaltfließpreßstählen — Teil 4: Technische
Lieferbedingungen für Vergütungsstähle

This European Standard was approved by CEN on 19 April 2001.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Contents**Page**

Foreword	3
1 Scope	4
2 Normative references	4
3 Terms and definitions	4
4 Classification and designation	4
4.1 Classification	4
4.2 Designation	4
5 Production process	4
5.1 Steelmaking process	4
5.2 Deoxidation	5
6 Requirements	5
6.1 Delivery conditions	5
6.2 Chemical composition	5
6.3 Mechanical properties	5
6.4 Hardenability	5
6.5 Surface requirements	6
6.6 Supplementary or special requirements	6

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 15, Wire-rod - Qualities, dimensions, tolerances and specific tests, the Secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2001, and conflicting national standards shall be withdrawn at the latest by December 2001.

This European Standard EN 10263 is subdivided as follows:

- *Part 1: General technical delivery conditions;*
- *Part 2: Technical delivery conditions for steels not intended for heat treatment after cold working;*
- *Part 3: Technical delivery conditions for case hardening steels;*
- *Part 4: Technical delivery conditions for steels for quenching and tempering;*
- *Part 5: Technical delivery conditions for stainless steels.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

1.1 This part of EN 10263 is applicable to round rod and round bars and wire with a diameter up to and including 100 mm, of non-alloy and alloy steel, intended for cold heading and cold extrusion and subsequent quenching and tempering.

1.2 This part of EN 10263 is complemented by EN 10263-1.

2 Normative references

This European Standard incorporates by date or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For date references, subsequent amendments to or revisions of, any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10020	<i>Definitions and classification of grades of steel.</i>
EN 10263-1	<i>Steel rod, bars and wire for cold heading and cold extrusion — Part 1: General technical delivery conditions.</i>

3 Terms and definitions

For the purposes of this standard the definitions in EN 10263-1 and the following apply.

3.1

quenched and tempered steels

for the purpose of this European Standard quenched and tempered steels are engineering steels which, because of their chemical composition, are suitable for hardening and in the quenched and tempered condition have good toughness at a given tensile strength

4 Classification and designation

4.1 Classification

All steels covered by this part of EN 10263 are special steels according to EN 10020.

Steel grades from C35EC to C45RC as quoted in Table 2 are non-alloy steels and all others are alloy steels according to EN 10020.

4.2 Designation

See EN 10263-1:2001.

5 Production process

5.1 Steelmaking process

See EN 10263-1:2001.

5.2 Deoxidation

All steels shall be killed with aluminium and/or silicon. Aluminium and/or silicon may be replaced by another element having a similar effect.

6 Requirements

6.1 Delivery conditions

The delivery conditions in which the products covered by this part of EN 10263 are normally supplied, the product forms and the applicable requirements, are given in Table 1.

6.2 Chemical composition

6.2.1 Heat analysis

The chemical composition for the heat analysis shall be in accordance with the values specified in Table 2 and Table 3.

6.2.2 Product analysis

In cases where a product analysis is requested, the admissible deviations from the values specified for the cast/heat analysis are indicated in Table 4.

6.3 Mechanical properties

The mechanical properties of the products, to be determined by the tensile test, shall be in accordance with the prescriptions given in Table 1 for that which concerns the delivery condition, and in Tables 5 and 6.

6.4 Hardenability

6.4.1 In the case of products ordered with standard requirements regarding hardenability, that is, when the steel names or numbers as quoted in Tables 2 and 3 are supplemented by the symbol "+H", the hardness values obtained in the end quench test (Jominy test) (see Table 1 of EN 10263-1:2001) shall be in compliance with the values given in Tables 7 and 9.

6.4.2 In the case of products ordered with restricted requirements regarding the scatter bands of the hardness values obtained by the Jominy test, that is when the steel name or number as quoted in Table 2 is supplemented by the symbol "+HH" or "+HL", the above hardness values shall be in compliance with the values given in Table 8.

NOTE 1 The symbol "+HH" denotes that the upper limit of the scatter band coincides with the upper limit for the corresponding steel "+H".

NOTE 2 The symbol "+HL" denotes that the lower limit of the scatter band coincides with the lower limit for the corresponding steel "+H".

NOTE 3 See EN 10263-1:2001, 7.7.4.

6.4.3 The austenitizing temperatures for the Jominy test are given in Tables 7, 8 and 9.

6.4.4 Core hardening

In the case of products ordered with requirements regarding core hardening, that is, when the steel name or number, as quoted in Tables 2 and 3, is supplemented by the symbol “+CH”, the core hardening temperature, the hardness values and the corresponding maximum diameters shall be in compliance with the values given in Table 10.

6.5 Surface requirements

For any particular surface requirement to be agreed at the time of ordering see EN 10263-1:2001, 7.10.

6.6 Supplementary or special requirements

Other requirements that can be agreed at the time of enquiry and order are described in EN 10263-1:2001, annex B.

Table 1 — Summary of delivery conditions, product forms and applicable requirements

Delivery condition	Symbols	products form ^a			Applicable requirements in cases where the steel concerned has been ordered with reference to the steel names indicated in:									
		rod	bar	wire	Table 2 or 3 or 5 or 6		Table 7 or 8 or 9			Table 10			Table 2,4,5,6,7,8,9 or 10	
					Chemical composition as specified in Tables 2 or 3 and 4	Mechanical properties as specified in Table 5 or 6	Chemical composition as specified in Tables 2 or 3 and 4	Mechanical properties as specified in Table 5 or 6	Values for hardenability according to Tables 7 or 8 or 9	Chemical composition as specified in Tables 2 or 3 and 4	Mechanical properties as specified in Table 5 or 6	Minimum core hardness and maximum diameter according to Table 10		
Untreated	as hot rolled or peeled	X	X	—									Supplementary or special requirements as specified in annex B of EN 10263-1: 2001 ^b	
	+cold drawn	—	X	X										
	+cold drawn +spheroidized	—	X	X										
	+cold drawn +spheroidized +skin passed	—	X	X										
	as treated	X	X	—										
Spheroidized	+peeled	X	X	—									EN 10263-1: 2001 ^b	
	+cold drawn	—	X	X										
	+cold drawn +spheroidized	—	X	X										
	+cold drawn +spheroidized +skin passed	—	X	X										
	other													
Other delivery conditions can be agreed at the time of ordering														
^a X = applicable. — = not applicable.														
^b If agreed at the time of ordering.														

Table 2 — Steel grades and chemical composition for steel grades without boron — Heat analysis, % by mass^{a b}

Steel grade		Steel name	Steel number	C ^c	Si max ^d	Mn	P max	S	Cr	Mo	Ni	Cu max
C35EC			1.1172	0,32/0,39	0,30	0,50/0,80	0,025	0,025 max				0,25
C35RC			1.1060	0,32/0,39	0,30	0,50/0,80	0,025	0,020/0,035				0,25
C45EC			1.1192	0,42/0,50	0,30	0,50/0,80	0,025	0,025 max				0,25
C45RC			1.1061	0,42/0,50	0,30	0,50/0,80	0,025	0,020/0,035				0,25
37Mo2			1.5418	0,35/0,40	0,30	0,60/0,90	0,025	0,025 max		0,20/0,30		0,25
38Cr2			1.7003	0,35/0,42	0,30	0,50/0,80	0,025	0,025 max	0,40/0,60			0,25
46Cr2			1.7006	0,42/0,50	0,30	0,50/0,80	0,025	0,025 max	0,40/0,60			0,25
34Cr4			1.7033	0,30/0,37	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20			0,25
37Cr4			1.7034	0,34/0,41	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20			0,25
41Cr4			1.7035	0,38/0,45	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20			0,25
41CrS4			1.7039	0,38/0,45	0,30	0,60/0,90	0,025	0,020/0,040	0,90/1,20			0,25
25CrMo4			1.7218	0,22/0,29	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20	0,15/0,30		0,25
25CrMoS4			1.7213	0,22/0,29	0,30	0,60/0,90	0,025	0,020/0,040	0,90/1,20	0,15/0,30		0,25
34CrMo4			1.7220	0,30/0,37	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20	0,15/0,30		0,25
37CrMo4			1.7202	0,35/0,40	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20	0,15/0,30		0,25
42CrMo4			1.7225	0,38/0,45	0,30	0,60/0,90	0,025	0,025 max	0,90/1,20	0,15/0,30		0,25
42CrMoS4			1.7227	0,38/0,45	0,30	0,60/0,90	0,025	0,020/0,040	0,90/1,20	0,15/0,30		0,25
34CrNiMo6			1.6582	0,30/0,38	0,30	0,50/0,80	0,025	0,025 max	1,30/1,70	0,15/0,30	1,30/1,70	0,25
41NiCrMo7-3-2			1.6563	0,38/0,44	0,30	0,60/0,90	0,025	0,025 max	0,70/0,90	0,15/0,30	1,65/2,00	0,25

^a Elements not quoted in this table should not be intentionally added to the steel without the agreement of the purchaser, except those intended for finishing the heat. All reasonable precaution shall be taken in order to prevent the addition of elements from scrap or other material used in the production process. However, residual elements may be present provided that they do not affect the hardenability, mechanical properties and applicability.

^b In the case of steels with hardenability requirements (see Tables 7 to 9) minor deviation from the specified limits are permitted (with the exception of sulfur and phosphorus), provided that they do not exceed 0,01 % for carbon and the values indicated in Table 4 for the other elements.

^c A carbon range of 0,04 % (i.e. 0,33 – 0,37 %) may be agreed at the time of enquiry and order.

^d Lower silicon contents may be agreed at the time of ordering, in which case due consideration should be given to the effects that could result from what concerns the specified properties such as, for example, hardenability.

Table 3 — Steel grades and chemical composition for steels grades containing boron — Heat analysis, % by mass^{a b}

Steel grade		C	Si ^c	Mn	P _{max}	S _{max}	Cr ^d	Mo	Cu _{max}	B
Steel name	Steel number									
17B2	1.5502	0,15/0,20	≤ 0,30	0,60/0,90	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
23B2	1.5508	0,20/0,25	≤ 0,30	0,60/0,90	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
28B2	1.5510	0,25/0,30	≤ 0,30	0,60/0,90	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
33B2	1.5514	0,30/0,35	≤ 0,30	0,60/0,90	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
38B2	1.5515	0,35/0,40	0,15/0,30	0,60/0,90	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
17MnB4	1.5520	0,15/0,20	≤ 0,30	0,90/1,20	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
20MnB4	1.5525	0,18/0,23	≤ 0,30	0,90/1,20	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
23MnB4	1.5535	0,20/0,25	≤ 0,30	0,90/1,20	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
27MnB4	1.5536	0,25/0,30	0,15/0,30	0,90/1,20	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
30MnB4	1.5526	0,27/0,32	≤ 0,30	0,80/1,10	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
36MnB4	1.5537	0,33/0,38	≤ 0,30	0,80/1,10	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
37MnB5	1.5538	0,35/0,40	≤ 0,30	1,15/1,45	0,025	0,025	≤ 0,30		0,25	0,000 8/0,005
30MoB1	1.5408	0,28/0,32	≤ 0,30	0,80/1,00	0,025	0,025	≤ 0,30	0,08/0,12	0,25	0,000 8/0,005
32CrB4	1.7076	0,30/0,34	≤ 0,30	0,60/0,90	0,025	0,025	0,90/1,20		0,25	0,000 8/0,005
36CrB4	1.7077	0,34/0,38	≤ 0,30	0,70/1,00	0,025	0,025	0,90/1,20		0,25	0,000 8/0,005
31CrMoB2-1	1.7272	0,28/0,33	≤ 0,30	0,90/1,20	0,025	0,025	0,40/0,55	0,10/0,15	0,25	0,000 8/0,005

^a Elements not quoted in this table should not be intentionally added to the steel without the agreement of the purchaser, except those intended for finishing the heat. All reasonable precaution shall be taken in order to prevent the addition of elements from scrap or other material used in the production process. However, residual elements may be present provided that they do not affect the hardenability, mechanical properties and applicability.

^b In the case of steels with hardenability requirements (see Tables 7 to 9) minor deviation from the specified limits are permitted (with the exception of sulfur and phosphorus), provided that they do not exceed 0,01 % for carbon and the values indicated in Table 4 for the other elements.

^c Lower silicon contents may be agreed at the time of ordering, in which case due consideration should be given to the effects that could result from what concerns the specified properties such as, for example, hardenability.

^d Where a maximum chromium content of 0,30 % is specified, a minimum level may also be agreed at the time of enquiry and order.

Table 4 — Permissible deviations between product analysis and the limiting values specified in Tables 2 and 3 for the heat analysis

Elements	Limiting values of heat analysis % by mass	Permissible deviation for the product analysis % by mass ^a
C	≤ 0,50	±0,02
Si	≤ 0,30	±0,03
Mn	≤ 1,00	±0,04
	> 1,00 ≤ 1,45	±0,05
P	≤ 0,025	+0,005
S	≤ 0,025	+0,005 ^b
Cr	≤ 1,70	±0,05
Mo	≤ 0,30	±0,03
Ni	≤ 2,00	±0,05
B	≤ 0,005 0	±0,000 3
Cu	≤ 0,25	+0,03
^a ± means that in one heat the deviation of the product analysis for a given element may occur over the upper value or under the lower value of the specified range in Tables 2 and 3, but not both at the same time. ^b For steels with a specified sulfur range (0,020 to 0,035 % or 0,020 to 0,040 % according to heat analysis) the permissible deviation is ±0,005 %.		

Table 5 — Mechanical properties for steel grades without boron

Steel grade		Diameter		Delivery condition							
				+AC or +AC+PE		+U+C+AC		+U+C+AC+LC		+AC+C	
Steel name	Steel number	above	up to	Mechanical properties							
				R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z min
		mm	mm	MPa	%	MPa	%	MPa	%	MPa	%
C35EC C35RC	1.1172 1.1060	2	5	-	-	550	62	590	60	-	-
		5	10	560	60	540	62	580	60	670	-
		10	40	560	60	540	62	580	60	660	-
C45EC C45RC	1.1192 1.1061	2	5	-	-	590	62	630	60	-	-
		5	10	600	60	580	62	620	60	720	-
		10	40	600	60	580	62	620	60	710	-
1 Mpa = 1 N/mm ² .											

1 MPa = 1 N/mm².

Steel grade		Diameter		Delivery condition					
				+AC or +AC+PE		+AC+C+AC		+AC+C+AC+LC	
Steel name	Steel number	above	up to	Mechanical properties					
				<i>R</i> _m max	<i>Z</i> min	<i>R</i> _m max	<i>Z</i> min	<i>R</i> _m max	<i>Z</i> min
		mm	mm	MPa	%	MPa	%	MPa	%
37Mo2	1.5418	2	5	-	-	560	61	600	59
		5	40	570	59	550	61	590	59
38Cr2	1.7003	2	5	-	-	590	62	630	60
		5	40	600	60	580	62	620	60
46Cr2	1.7006	2	5	-	-	610	60	650	58
		5	40	620	58	600	60	640	58
34Cr4	1.7033	2	5	-	-	570	64	610	62
		5	40	580	62	560	64	600	62
37Cr4	1.7034	2	5	-	-	580	62	620	60
		5	40	590	60	570	62	610	60
41Cr4	1.7035	2	5	-	-	610	60	650	58
41CrS4	1.7039	5	40	620	58	600	60	640	58
25CrMo4	1.7218	2	5	-	-	570	62	610	60
25CrMoS4	1.7213	5	40	580	60	560	62	600	60
34CrMo4	1.7220	2	5	-	-	590	62	630	60
		5	40	600	60	580	62	620	60
37CrMo4	1.7202	2	5	-	-	610	62	650	60
		5	40	620	60	600	62	640	60
42CrMo4	1.7225	2	5	-	-	620	60	660	58
42CrMoS4	1.7227	5	40	630	58	610	60	650	58
34CrNiMo6	1.6582	2	5	-	-	710	60	750	58
		5	40	720	58	700	60	740	58
41NiCrMo7-3-2	1.6563	2	5	-	-	710	60	750	58
		5	40	720	58	700	60	740	58
1 MPa = 1 N/mm ²									

1 MPa = 1 N/mm².

Table 6 — Mechanical properties for steels grades containing boron

Steel grade		Diameter		Delivery condition											
				+U or +PE		+AC or +AC+PE		+U+C		+U+C+AC		+U+C+AC+LC		+AC+C	
				Mechanical properties											
Steel name	Steel number	above mm	up to mm	R _m max MPa	Z min %	R _m max MPa	Z min %	R _m max MPa	Z min %	R _m max MPa	Z min %	R _m max MPa	Z min %	R _m max MPa	Z min %
17B2	1.5502	2	5	-	-	-	-	-	-	450	70	490	68	-	-
		5	10	540	60	460	68	630	55	440	70	480	68	550	63
		10	25	540	60	460	68	620	55	440	70	480	68	540	63
23B2	1.5508	2	5	-	-	-	-	-	-	480	68	520	66	-	-
		5	10	600	60	490	66	690	55	470	68	510	66	580	61
		10	25	600	60	490	66	680	55	470	68	510	66	570	61
28B2	1.5510	2	5	-	-	-	-	-	-	510	66	550	64	-	-
		5	10	630	60	520	64	720	55	500	66	540	64	610	59
		10	25	630	60	520	64	710	55	500	66	540	64	600	59
33B2	1.5514	2	5	-	-	-	-	-	-	540	64	580	62	-	-
		5	10	-	-	550	62	-	-	530	64	570	62	640	57
		10	40	-	-	550	62	-	-	530	64	570	62	630	57
38B2	1.5515	2	5	-	-	-	-	-	-	560	64	600	62	-	-
		5	10	-	-	570	62	-	-	550	64	590	62	660	57
		10	40	-	-	570	62	-	-	550	64	590	62	650	57
17MnB4	1.5520	2	5	-	-	-	-	-	-	470	69	510	67	-	-
		5	10	570	60	480	67	660	55	460	69	500	67	570	62
		10	25	570	60	480	67	650	55	460	69	500	67	560	62
20MnB4	1.5525	2	5	-	-	-	-	-	-	490	68	530	66	-	-
		5	10	580	60	500	66	680	55	480	68	520	66	600	61
		10	25	580	60	500	66	670	55	480	68	520	66	590	61
23MnB4	1.5535	2	5	-	-	-	-	-	-	510	66	550	64	-	-
		5	10	600	60	520	64	700	55	500	66	540	64	620	59
		10	25	600	60	520	64	690	55	500	66	540	64	610	59
It should be recognized in the +U condition that the tensile strength values are not compatible with the whole range of composition given in Table 3 for a steel grade. Care should be taken that, depending on diameter and composition supplied, the tensile strength values are compatible with the hardenability requirements. 1 MPa = 1 N/mm ² .															

Table 6 (continued)

Steel grade		Diameter		Delivery condition									
				+U or +PE	+AC or +AC+PE		+U+C		+U+C+AC		+U+C+AC+LC		+AC+C
Steel name	Steel number	above	up to	Mechanical properties									
		mm	mm	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z min
27MnB4	1.5536	2	5	-	-	-	-	530	65	570	63	-	-
		5	40	-	-	540	63	520	65	560	63	640	58
30MnB4	1.5526	2	5	-	-	-	-	560	65	600	63	-	-
		5	40	-	-	570	63	550	65	590	63	670	58
36MnB4	1.5537	2	5	-	-	-	-	590	64	630	62	-	-
		5	40	-	-	600	62	580	64	620	62	700	57
37MnB5	1.5538	2	5	-	-	-	-	610	64	650	62	-	-
		5	40	-	-	620	62	600	64	640	62	720	57
30MoB1	1.5408	2	5	-	-	-	-	530	64	570	62	-	-
		5	40	-	-	530	62	510	64	550	62	630	57
32CrB4	1.7076	2	5	-	-	-	-	550	64	590	62	-	-
		5	40	-	-	550	62	530	64	570	62	670	57
36CrB4	1.7077	2	5	-	-	-	-	570	63	610	61	-	-
		5	40	-	-	570	61	550	63	590	61	690	56
31CrMoB2-1	1.7272	2	5	-	-	-	-	570	63	610	61	-	-
		5	40	-	-	570	61	550	63	590	61	690	56

It should be recognized in the +U condition that the tensile strength values are not compatible with the whole range of composition given in Table 3 for a steel grade. Care should be taken that, depending on diameter and composition supplied, the tensile strength values are compatible with the hardenability requirements.
1 MPa = 1 N/mm².

Table 7 — Hardness limits for steel grades without boron with specified (normal) hardenability (+H grades — see 6.4.1)

Steel grades		Symbol	Hardening temperature °C ± 5 °C	Limits of range	Hardness HRC at a distance from quenched end of test piece (in mm) of:																				
Steel name	Steel number				1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30	35	40	45	50	55
C35EC	1.1172	+H	870	max.	58	57	55	53	49	41	34	31	28	27	26	25	24	23	20						
C35RC	1.1060	+H		min.	48	40	33	24	22	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
C45EC	1.1192	+H	850	max.	61	60	59	57	53	47	39	34	31	30	29	28	27	26	25	24					
C45RC	1.1061	+H		min.	51	46	35	27	25	24	23	22	21	20	-	-	-	-	-	-	-	-	-	-	
Hardness HRC at a distance from quenched end of test piece (in mm) of:																									
1,5 3 5 7 9 11 13 15 20 25 30 35 40 45 50																									
37Mo2	1.5418	+H	850	max.	59	57	53	47	41	36	32	29	27	25	-	-	-	-	-	-	-	-	-	-	
				min.	51	48	41	33	27	26	22	20	-	-	-	-	-	-	-	-	-	-	-		
				max.	59	57	54	49	43	39	37	35	32	30	27	25	24	23	22						
38Cr2	1.7003	+H	850	min.	51	46	37	29	25	22	20	-	-	-	-	-	-	-	-	-	-	-	-		
				max.	63	61	57	52	46	42	40	38	35	33	31	29	28	27	26						
				min.	54	49	40	32	28	25	23	22	20	-	-	-	-	-	-	-	-	-	-	-	
34Cr4	1.7033	+H	850	max.	57	57	56	54	52	49	46	44	39	37	35	34	33	32	31						
				min.	49	48	45	41	35	32	29	27	23	21	20	-	-	-	-	-	-	-	-	-	
				max.	59	59	58	57	55	52	50	48	42	39	37	36	35	34	33						
37Cr4	1.7034	+H	850	min.	51	50	48	44	39	36	33	31	26	24	22	20	-	-	-	-	-	-	-		
				max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35						
				min.	53	52	50	47	44	40	37	35	30	27	25	23	22	21	20						
25CrMo4	1.7218	+H	850	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31							
				min.	44	43	40	37	34	32	29	27	23	21	20	-	-	-	-	-	-	-	-	-	
				max.	57	57	57	56	55	54	53	52	48	45	43	41	40	40	39						
34CrMo4	1.7220	+H	850	min.	49	49	48	45	42	39	36	34	30	28	27	26	25	24	24						
				max.	60	60	60	59	58	56	55	54	51	48	46	45	-	-	-	-	-	-	-	-	
				min.	52	50	49	47	45	43	40	37	34	32	31	30	-	-	-	-	-	-	-	-	
42CrMo4	1.7225	+H	850	max.	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45						
				min.	53	53	52	51	49	43	40	37	34	32	31	30	30	29	29						
				max.	58	58	58	58	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
34CrNiMo6	1.6582	+H	850	min.	50	50	50	50	49	48	48	48	48	47	47	47	46	45	44						
				max.	60	60	60	60	60	60	60	59	59	58	58	57	57	57	57	57	57	57	57	57	57
				min.	54	54	54	54	54	54	54	54	53	52	52	51	50	50	50	50	50	50	50	50	50
41NiCrMo7-3-2	1.6563	+H	860	max.	60	60	60	60	60	60	60	60	59	58	58	57	57	57	57	57	57	57	57		
				min.	54	54	54	54	54	54	54	54	54	53	52	52	51	50	50	50	50	50	50	50	50

**Table 8 — Hardness limits for steel grades without boron with restricted hardenability scatter bands
(+HH and +HL grades see 6.4.2) ^a**

Steel grades		Hardening temperature °C ± 5 °C	Symbol	Limits of range	Hardness IIRC at a distance from quenched end of test piece (in mm) of:															
Steel name	Steel number				1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	
					max.	59	57	53	47	41	36	32	29	27	25					
37Mo2	1.5418	850	+HH	min.	54	51	45	38	32	29	25	23								
37Mo2	1.5418			max.	56	54	49	42	36	33	29	26								
		850	+HL	min.	51	48	41	33	27	26	22	20								
38Cr2	1.7003			max.	59	57	54	49	43	39	37	35	32	30	27	25	24	23	22	
		850	+HH	min.	54	50	43	36	31	28	26	24	21	-	-	-	-	-		
38Cr2	1.7003			max.	56	53	48	42	37	33	31	29	26	24	21					
		850	+HL	min.	51	46	37	29	25	22	20			-	-	-	-	-		
46Cr2	1.7006			max.	61	59	56	51	46	41	39	37	33	31	29	27	26	25	24	
		850	+HH	min.	55	51	45	38	33	30	28	26	22	20						
46Cr2	1.7006			max.	56	55	50	44	39	35	33	31	27	25	23	21	20	-	-	
		850	+HL	min.	52	47	39	31	27	24	22									
34Cr4	1.7033			max.	57	57	56	54	52	49	46	44	39	37	35	34	33	32	31	
		850	+HH	min.	52	51	49	45	41	38	35	33	28	26	25	24	23	22		
34Cr4	1.7033			max.	54	54	52	50	46	43	40	38	34	32	30	29	28	27	26	
		850	+HL	min.	49	48	45	41	35	32	29	27	23	21	20		-	-		
37Cr4	1.7034			max.	59	59	58	57	55	52	50	48	42	39	37	36	35	34	33	
		850	+HH	min.	54	53	51	48	44	41	39	37	31	29	27	25	24	23		
37Cr4	1.7034			max.	56	56	55	53	50	47	44	42	37	34	32	31	30	29	28	
		850	+HL	min.	51	50	48	44	39	36	33	31	26	24	22	20				
41Cr4	1.7035			max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35	
41CrS4	1.7039	850	+HH	min.	56	55	53	51	47	43	41	39	35	31	29	27	26	25		
41Cr4	1.7035			max.	58	58	57	55	52	50	47	45	40	37	34	32	31	30	29	
41CrS4	1.7039	850	+HL	min.	53	52	50	47	44	40	37	35	30	27	25	23	22	21		

This table is not applicable to steels ordered with a restricted range of carbon content - See footnote c) in Table 2.

^a This table is not applicable to steels ordered with a restricted range of carbon content - See footnote c) in Table 2.

Table 8 (continued)^a

Steel grades		Symbol	Hardening temperature °C ± 5 °C	Limits of range	Hardness HRC at a distance from quenched end of test piece (in mm) of:															
Steel name	Steel number				1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	
25CrMo4	1.7218	+HH	850	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31		
25CrMoS4	1.7213	+HH		min.	47	46	44	41	39	37	34	32	28	26	24	23	22	22		
25CrMo4	1.7218	+HL	850	max.	49	49	47	46	43	41	38	36	32	30	29	28	27	27		
25CrMoS4	1.7213	+HL		min.	44	43	40	37	34	32	29	27	23	21	20					
34CrMo4	1.7220	+HH	850	max.	57	57	57	56	55	54	53	52	48	45	43	41	40	39		
				min.	52	52	51	49	46	44	42	40	36	34	32	31	30	29		
34CrMo4	1.7220	+HL	850	max.	54	54	54	52	51	49	47	46	42	39	38	36	35	34		
				min.	49	49	48	45	42	39	36	34	30	28	27	26	25	24		
37CrMo4	1.7202	+HH	850	max.	60	60	60	59	58	56	55	54	51	48	46	45				
				min.	55	53	53	51	49	47	45	45	40	39	36	36				
37CrMo4	1.7202	+HL	850	max.	57	57	56	55	54	52	50	46	44	41	41	39				
				min.	52	50	50	47	45	43	40	37	34	32	31	30				
42CrMo4	1.7225	+HH	850	max.	61	61	61	60	60	59	59	58	56	53	51	48	47	45		
42CrMoS4	1.7227	+HH		min.	56	56	55	54	52	48	46	44	41	39	38	36	35	34		
42CrMo4	1.7225	+HL	850	max.	58	58	58	57	56	54	53	51	49	46	44	42	41	40		
42CrMoS4	1.7227	+HL		min.	53	53	52	51	49	43	40	37	34	32	31	30	29	29		
34CrNiMo6	1.6582	+HH	850	max.	58	58	58	58	57	57	57	57	57	57	57	57	57	57		
				min.	53	53	53	53	52	51	51	51	51	50	50	50	49	48		
34CrNiMo6	1.6582	+HL	850	max.	55	55	55	55	54	54	54	54	54	54	54	54	53	53		
				min.	50	50	50	50	49	48	48	48	48	47	47	47	46	45		

^a This table is not applicable to steels ordered with a restricted range of carbon content - See footnote c) in Table 2.

Table 9 — Hardness limits for steel grades containing boron with specified (normal) hardenability (+H grades — see 6.4.1)

Steel grades		Symbol	Hardening temperature °C ± 5 °C	Limits of range	Hardness HRC at a distance from quenched end of test piece (in mm) of:																
Steel name	Steel number				1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50		
17B2	1.5502	+H	900	max.	46	45	45	41	35												
23B2	1.5508	+H	890	min.	39	34	30	20													
				max.	49	48	47	45	39												
				min.	41	39	37	21													
				max.	53	51	51	49	45	39	29	24	20								
28B2	1.5510	+H	880	min.	46	42	39	23													
33B2	1.5514	+H	870	max.	55	55	54	52	49	43											
				min.	49	45	43	27	20												
38B2	1.5515	+H	860	max.	58	57	56	55	51	49	44										
				min.	51	49	47	36	25	20											
17MnB4	1.5520	+H	890	max.	47	46	46	44	41	36											
				min.	40	38	37	30	20												
20MnB4	1.5525	+H	880	max.	48	48	47	46	44	39											
				min.	41	40	38	30	20												
23MnB4	1.5535	+H	880	max.	49	48	47	47	45	41											
				min.	43	41	40	32	23												
27MnB4	1.5536	+H	870	max.	53	52	51	50	48	45	41										
				min.	46	44	43	36	27	21											
30MnB4	1.5526	+H	860	max.	54	53	53	53	51	46	42										
				min.	48	46	44	36	25	20											
36MnB4	1.5537	+H	850	max.	58	57	57	56	54	52	48	43									
				min.	51	49	48	43	31	25	20										
37MnB5	1.5538	+H	850	max.	60	60	59	58	57	57	55	53	48								
				min.	52	51	50	48	43	37	32	29									
30MoB1	1.5408	+H	870	max.	53	52	52	51	49	48	46	43	34								
				min.	47	46	45	39	30	24	21										
32CrB4	1.7076	+H	860	max.	56	56	55	55	55	54	53	53	51	49	45	42	40	38			
				min.	49	48	47	46	46	45											
36CrB4+H	1.7077	+H	850	max.	58	58	57	56	56	55	55	55	53	51	48	46					
				min.	50	49	48	48	47	46	46	45	34	30	27						
31CrMoB2-1	1.7272	+H	860	max.	54	54	54	53	53	52	51	51	48	43	41						
				min.	48	48	47	47	45	45	41	39	31	27	25						

Table 10 — Maximum diameter for which at least 90 % martensite shall be attained in the core hardness test (+CH grades)

Steel grades		Symbol	Hardening temperature in the core hardening test ^a °C ± 5 °C	Core hardness (90 % martensite structure) H R C	Maximum diameter to ensure 90 % of martensite in the core _b mm
Steel name	Steel number				
Steels without boron					
37Mo2	1.5418		850	48	8
38Cr2	1.7003	+CH	850	48	8
46Cr2	1.7006	+CH	850	51	9
34Cr4	1.7033	+CH	850	46	14
37Cr4	1.7034	+CH	850	48	15
41Cr4	1.7035	+CH	850	50	16
41CrS4	1.7039	+CH	850	50	16
25CrMo4	1.7218	+CH	850	41	13
25CrMoS4	1.7213	+CH	850	41	13
34CrMo4	1.7220	+CH	850	45	18
37CrMo4	1.7202	+CH	850	48	18
42CrMo4	1.7225	+CH	850	50	21
42CrMoS4	1.7227	+CH	850	50	21
34CrNiMo6	1.6582	+CH	850	46	31
41NiCrMo 7-3-2	1.6563	+CH	850	50	34
Steels containing boron					
17B2	1.5502	+CH	900	37	9
23B2	1.5508	+CH	890	40	9
28B2	1.5510	+CH	880	43	10
33B2	1.5514	+CH	870	45	11
38B2	1.5515	+CH	860	48	11
17MnB4	1.5520	+CH	890	37	12
20MnB4	1.5525	+CH	880	39	14
23MnB4	1.5535	+CH	880	40	14
27MnB4	1.5536	+CH	870	43	14
30MnB4	1.5526	+CH	860	44	14
36MnB4	1.5537	+CH	850	47	14
37MnB5	1.5538	+CH	850	48	16
30MoB1	1.5408	+CH	870	45	18
32CrB4	1.7076	+CH	860	46	30
36CrB4	1.7077	+CH	850	48	30
31CrMoB2-1	1.7272	+CH	860	45	30

^a As a guideline an austenitizing time of at least 30 min is suggested.
^b The maximum diameters stated are those attainable with the minimum carbon content within each steel grade.

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