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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

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English Version

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

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Contents

Page

European 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 ... **4**

6 Requirements ... **4**
6.1 Delivery conditions ... **4**
6.2 Chemical composition ... **5**
6.3 Mechanical properties ... **5**
6.4 Hardenability ... **5**
6.5 Surface requirements ... **5**
6.6 Supplementary or special requirements ... **5**

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European foreword

This document (EN 10263-4:2017) has been prepared by Technical Committee ECISS/TC 106 “Wire rod and wires”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by May 2018, and conflicting national standards shall be withdrawn at the latest by May 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10263-4:2001.

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*

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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, cold extrusion, subsequent quenching and tempering or induction hardening or flame hardening.

1.2 EN 10263-1:2017 is indispensable for this part of EN 10263.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10020, *Definition and classification of grades of steel*

EN 10263-1:2017, *Steel rod, bars and wire for cold heading and cold extrusion — Part 1: General technical delivery conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10263-1:2017 and the following apply.

3.1
quenched and tempered steels
engineering steels which, because of their chemical composition, are suitable for hardening and in the quenched and tempered condition to provide enhanced 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 3 are non-alloy steels and all others are alloy steels according to EN 10020.

4.2 Designation

See EN 10263-1:2017.

5 Production Process

5.1 Steelmaking process

See EN 10263-1:2017.

5.2 Deoxidation

All steels according to this part of EN 10263 shall be deoxidised.

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 Tables 1 and 2.

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6.2 Chemical composition

6.2.1 Cast analysis

The chemical composition for the cast analysis shall be in accordance with the values specified in Tables 3 and 4.

6.2.2 Product analysis

In cases where a product analysis is requested, the permissible deviations from the values specified for the cast analysis are indicated in Table 5.

6.3 Mechanical properties

The mechanical properties of the products, to be determined by the tensile test, shall be in accordance with the Tables 6, 7 and 8 but by considering the prescriptions given in Table 1 and the delivery condition given in Table 2.

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 3 and 4 are supplemented by the symbol "+H", the hardness values obtained in the end quench test (Jominy test) (see Table 1 of EN 10263-1:2017) shall be in compliance with the values given in Tables 9 and 11.

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 3 is supplemented by the symbol "+HH" or "+HL", the above hardness values shall be in compliance with the values given in Table 10.

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 10263-1:2017, 7.7.4 and 10.2

6.4.3 The austenizing temperatures for the Jominy test are given in Tables 9, 10 and 11.

6.4.4 Core hardening

In the case of products ordered with requirements for core hardening, that is when the steel name or number, as quoted in Tables 3 and 4 is supplemented by the symbol "+CH", the core hardening temperature, the hardness values and the corresponding maximum diameters for the lowest hardenability shall be in compliance with the values given in Table 12.

6.5 Surface requirements

For any particular surface requirement to be agreed at the time of ordering, see EN 10263-1:2017, 7.10.

6.6 Supplementary or special requirements

Other requirements which can be agreed at the time of enquiry and order are described in EN 10263-1:2017, Annex A.

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

Heat-treatment condition at delivery	Symbol	Products form			Applicable requirements in cases where the steel concerned has been ordered with reference to the steel names indicated in								
		bar	rod	wire	Tables 3 and 4, 6 or 7 or 8		Tables 3 and 4, 6 or 7 or 8, 9 or 10 or 11			Tables 3 and 4, 6 or 7 or 8, 12			Tables 3,4,6,7,8,9, 10,11 or 12
untreated	None or +U	X	X	–	Chemical composition as specified in Tables 3 and 4	Mechanical properties as specified in Table 6 or 7 or 8	Chemical composition as specified in Tables 3 and 4	Mechanical properties as specified in Table 6 or 7 or 8	Values for hardenability according to Tables 9 or 10 or 11	Chemical composition as specified in Tables 3 and 4	Mechanical properties as specified in Table 6 or 7 or 8	Minimum core hardness and maximum diameter according to Table 12	Supplementary or special requirements as specified in Annex A of EN 10263-1 [a]
spheroidised	+AC	X	X	X									
Others	Other delivery conditions may be agreed at the time of ordering												

Key
X = applicable
– = not applicable

[a] If agreed at the time of the enquiry and order.

Table 2 — Surface condition at delivery

Surface condition at delivery		**Symbol**	**bar**	**rod**	**wire**
Unless otherwise agreed	as rolled	none or +AR	x	x	–
Particular surface conditions supplied by agreement	cold drawn	+C	–	–	x
	skin passed	+LC	x	–	x
	peeled	+PE	x	x	x

Table 3 — Chemical composition for steel grades without boron – cast analysis % by mass

Steel grade Steel name	Steel number	C [b]	Si max [a]	Mn	P max	S	Cr	Mo	Ni	Cu max
C35EC	1.1172	0,32 to 0,39	0,30	0,50 to 0,80	0,025	0,025 max				0,25
C35RC	1.1060	0.32 to 0,39	0,30	0,50 to 0,80	0,025	0.020 to 0,035				0,25
C45EC	1.1192	0,42 to 0,50	0,30	0,50 to 0,80	0,025	0,025 max				0,25
C45RC	1.1061	0,42 to 0,50	0,30	0,50 to 0,80	0,025	0.020 to 0,035				0,25
37Mo2	1.5418	0,35 to 0,40	0,30	0,60 to 0,90	0,025	0,025 max		0,20 to 0,30		0,25
38Cr2	1.7003	0,35 to 0,42	0,30	0,50 to 0,80	0,025	0,025 max	0,40 to 0,60			0,25
46Cr2	1.7006	0,42 to 0,50	0,30	0,50 to 0,80	0,025	0,025 max	0,40 to 0,60			0,25
34Cr4	1.7033	0,30 to 0,37	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20			0,25
37Cr4	1.7034	0,34 to 0,41	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20			0,25
41Cr4	1.7035	0,38 to 0,45	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20			0,25
41CrS4	1.7039	0,38 to 0,45	0,30	0,60 to 0,90	0,025	0.020 to 0,040	0,90 to 1,20			0,25
25CrMo4	1.7218	0,22 to 0,29	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20	0,15 to 0,30		0,25
25CrMoS4	1.7213	0,22 to 0,29	0,30	0,60 to 0,90	0,025	0.020 to 0,040	0,90 to 1,20	0,15 to 0,30		0,25
34CrMo4	1.7220	0,30 to 0,37	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20	0,15 to 0,30		0,25
37CrMo4	1.7202	0,35 to 0,40	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20	0,15 to 0,30		0,25
42CrMo4	1.7225	0,38 to 0,45	0,30	0,60 to 0,90	0,025	0,025 max	0,90 to 1,20	0,15 to 0,30		0,25
42CrMoS4	1.7227	0,38 to 0,45	0,30	0,60 to 0,90	0,025	0.020 to 0,040	0,90 to 1,20	0,15 to 0,30		0,25
34CrNiMo6	1.6582	0,30 to 0,38	0,30	0,50 to 0,80	0,025	0,025 max	1,30 to 1,70	0,15 to 0,30	1,30 to 1,70	0,25
41NiCrMo7–3–2	1.6563	0.38 to 0,44	0,30	0,60 to 0,90	0,025	0,025 max	0,70 to 0,90	0,15 to 0,30	1,65 to 2,00	0,25

a 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 for what concerns the specified properties such as, for example, hardenability.

b A carbon range of 0,04 % (e.g. 0,33 % - 0,37 %) may be agreed at the time of enquiry and order.

NOTE 1 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 precautions shall be taken in order to prevent the addition of such elements from scrap or other materials used in the production process, which may affect the hardenability, mechanical properties and applicability.

NOTE 2 In the case of steels with hardenability requirements (see Tables 9 to 11) minor deviation from the specified limits are permitted (with the exception of sulphur and phosphorus), provided that they do not exceed 0,01 % for carbon and the values indicated in Table 5 for the other elements.

NOTE 3 To improve the performance of cold heading, it is possible to add Aluminium Al: 0,020 to 0,050 %.

Table 4 — Chemical composition for boron alloyed steel grades – cast analysis % by mass

Steel grade		C	Si [a]	Mn	P max	S max	Cr [b]	Mo	Cu max	B
Steel name	Steel number									
17B2	1.5502	0,15 to 0,20	≤ 0,30	0,60 to 0,90	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
23B2	1.5508	0,20 to 0,25	≤ 0,30	0,60 to 0,90	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
28B2	1.5510	0,25 to 0,30	≤ 0,30	0,60 to 0,90	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
33B2	1.5514	0,30 to 0,35	≤ 0,30	0,60 to 0,90	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
38B2	1.5515	0,35 to 0,40	≤ 0,30	0,60 to 0,90	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
17MnB4	1.5520	0,15 to 0,20	≤ 0,30	0,90 to 1,20	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
23MnB3	1.5507	0,21 to 0,25	0,15 max.	0,80 to 1,00	0,015	0,015	0,25 to 0,35		0,25	0,0008 to 0,005
20MnB4	1.5525	0,18 to 0,23	≤ 0,30	0,90 to 1,20	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
23MnB4	1.5535	0,20 to 0,25	≤ 0,30	0,90 to 1,20	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
27MnB4	1.5536	0,25 to 0,30	0,15 to 0,30	0,90 to 1,20	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
30MnB4	1.5526	0,27 to 0,32	≤ 0,30	0,80 to 1,10	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
36MnB4	1.5537	0,33 to 0.38	≤ 0,30	0,80 to 1,10	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
37MnB5	1.5538	0,35 to 0,40	≤ 0,30	1,15 to 1,45	0,025	0,025	≤ 0,30		0,25	0,0008 to 0,005
30MoB1	1.5408	0,28 to 0,32	≤ 0,30	0,80 to 1,00	0,025	0,025	≤ 0,30 [b]	0,08 to 0,12	0,25	0,0008 to 0,005
32CrB4	1.7076	0,30 to 0,34	≤ 0,30	0,60 to 0,90	0,025	0,025	0,90 to 1,20		0,25	0,0008 to 0,005
36CrB4	1.7077	0,34 to 0,38	≤ 0,30	0,70 to 1,00	0,025	0,025	0,90 to 1,20		0,25	0,0008 to 0,005
31CrMoB2–1	1.7272	0,28 to 0,33	≤ 0,30	0,90 to 1,20	0,025	0,025	0,40 to 0,55	0,10 to 0,15	0,25	0,0008 to 0,005

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

[b] In order to obtain a core hardening for the steel grade 1.5408 the lower limit of Cr shall be 0,15 % and may be agreed at the time of enquiry and order. For certain applications the higher limit for Cr may also be lowered by agreement at time of enquiry and order.

NOTE 1 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 precautions shall be taken in order to prevent the addition of such elements from scrap or other materials used in the production process, which may affect the hardenability, mechanical properties and applicability.

NOTE 2 In the case of steels with hardenability requirements (see Tables 9 to 11) minor deviation from the specified limits are permitted (with the exception of sulphur and phosphorus), provided that they do not exceed 0,01 % for carbon and the values indicated in Table 5 for the other elements.

NOTE 3 To improve the performance of cold heading, it is possible to add Aluminium Al: 0,020 % to 0,050 %.

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Table 5 — Permissible deviations between product analysis and the limiting values specified in Tables 3 and 4 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 > 1,00 ≤ 1,45	±0,04 ±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 3 and 4, but not both at the same time.

[b] For steels with a specified sulphur range (0,020 % to 0,035 % or 0,020 % to 0,040 % according to heat analysis) the permissible deviation is ± 0,005 %.

Table 6 — Mechanical properties for non-alloy 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	-

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Table 7 — Mechanical properties for alloy steel grades without boron

Steel grade		Diameter		Delivery condition					
				+AC or +AC+PE		+AC+C+AC		+AC+C+AC+LC	
				Mechanical properties					
Steel name	Steel number	above	up to	R_m max	Z min	R_m max	Z min	R_m max	Z 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 41CrS4	1.7035 1.7039	2	5	-	-	610	60	650	58
		5	40	620	58	600	60	640	58
25CrMo4 25CrMoS4	1.7218 1.7213	2	5	-	-	570	62	610	60
		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 42CrMoS4	1.7225 1.7227	2	5	-	-	620	60	660	58
		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

Table 8 — Mechanical properties for boron alloyed steel grades

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	up to	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z %	R_m max	Z min
		mm	mm	MPa	%	MPa	%	MPa	%	MPa	%	MPa	min	MPa	%
		2	5	-	-	-	-	-		450	70	490	68	-	-
17B2	1.5502	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
		2	5	-	-	-	-			480	68	520	66	-	-
23B2	1.5508	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
		2	5	-	-	-	-	-	-	510	66	550	64	-	-
28B2	1.5510	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
		2	5	-	-	-	-	-	-	540	64	580	62	-	-
33B2	1.5514	5	10	-	-	550	62	-	-	530	64	570	62	640	57
		10	40	-	-	550	62	-	-	530	64	570	62	630	57
		2	5	-	-	-	-	-	-	560	64	600	62	-	-
38B2	1.5515	5	10	-	-	570	62	-	-	550	64	590	62	660	57
		10	40	-	-	570	62	-	-	550	64	590	62	650	57
		2	5	-	-	-	-	-	-	470	69	510	67	-	-
17MnB4	1.5520	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

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	up to	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z min	R_m max	Z %	R_m max	Z min
		mm	mm	MPa	%	MPa	%	MPa	%	MPa	%	MPa	min	MPa	%
		2	5	-	-	-	-	-	-	510	66	550	64	-	-
23MnB3	1.5507	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
		2	5	-	-	-	-	-	-	490	68	530	66	-	-
20MnB4	1.5525	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
		2	5	-	-	-	-	-	-	510	66	550	64	-	-
23MnB4	1.5535	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

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	up to	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	R_m max	Z min
		mm	mm	MPa	%	MPa	%	MPa	%	MPa	%	MPa	%	MPa	%
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 4 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.

Table 9 — Hardness limits for steel grades without boron with specified (normal) hardenability (+H grades - see 6.4.1)

Steel grades		Symbol	Austenizing 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
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	-	-	-	-	-	
					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	-		-	-	-	-	-	
38Cr2	1.7003	+H	850	max.	59	57	54	49	43	39	37	35	32	30	27	25	24	23	22	
				min.	51	46	37	29	25	22	20	-	-	-	-	-	-	-	-	
46Cr2	1.7006	+H	850	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	-	-	-	-	
37Cr4	1.7034	+H	850	max.	59	59	58	57	55	52	50	48	42	39	37	36	35	34	33	
				min.	51	50	48	44	39	36	33	31	26	24	22	20	-	-	-	
41Cr4	1.7035	+H	850	max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35	
41CrS4	1.7039			min.	53	52	50	47	41	37	34	32	29	26	23	21	-	-	-	
25CrMo4	1.7218	+H	850	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31	31	
25CrMoS4	1.7213			min.	44	43	40	37	34	32	29	27	23	21	20	-	-	-	-	

34CrMo4	1.7220	+H	850	max.	57	57	57	56	55	54	53	52	48	45	43	41	40	40	39	
				min.	49	49	48	45	42	39	36	34	30	28	27	26	25	24	24	
37CrMo4	1.7202	+H	850	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 42CrMoS4	1.7225 1.7227	+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	
34CrNiMo6	1.6582	+H	850	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	
41NiCrMo7–3–2	1.6563	+H	860	max.	60	60	60	60	60	60	60	59	59	58	58	57	57	-	-	
				min.	54	54	54	54	54	54	54	54	53	52	52	51	50	-	-	

Table 10 — Hardness limits for steel grades without boron with restricted hardenability scatter bands (+HH and +HL grades see 6.4.2)

Steel grades		Symbol	Austenizing temperature °C ± 5° C	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
37Mo2	1.5418	+HH	850	max.	59	57	53	47	41	36	32	29	27	25					
				min.	54	51	45	38	32	29	25	23							
37Mo2	1.5418	+HL	850	max.	56	54	49	42	36	33	29	26							
				min.	51	48	41	33	27	26	22	20							
38Cr2	1.7003	+HH	850	max.	59	57	54	49	43	39	37	35	32	30	27	25	24	23	22
				min.	54	50	43	36	31	28	26	24	21	-	-	-	-	-	-
38Cr2	1.7003	+HL	850	max.	56	53	48	42	37	33	31	29	26	24	21				
				min.	51	46	37	29	25	22	20			-	-	-	-	-	-
46Cr2	1.7006	+HH	850	max.	61	59	56	51	46	41	39	37	33	31	29	27	26	25	24
				min.	55	51	45	38	33	30	28	26	22	20					
46Cr2	1.7006	+HL	850	max.	56	55	50	44	39	35	33	31	27	25	23	21	20	-	-
				min.	52	47	39	31	27	24	22								
34Cr4	1.7033	+HH	850	max.	57	57	56	54	52	49	46	44	39	37	35	34	33	32	31
				min.	52	51	49	45	41	38	35	33	28	26	25	24	23	22	21
34Cr4	1.7033	+HL	850	max.	54	54	52	50	46	43	40	38	34	32	30	29	28	27	26
				min.	49	48	45	41	35	32	29	27	23	21	20		-	-	-
37Cr4	1.7034	+HH	850	max.	59	59	58	57	55	52	50	48	42	39	37	36	35	34	33
				min.	54	53	51	48	44	41	39	37	31	29	27	25	24	23	22
37Cr4	1.7034	+HL	850	max.	56	56	55	53	50	47	44	42	37	34	32	31	30	29	28
				min.	51	50	48	44	39	36	33	31	26	24	22	20			
41Cr4	1.7035	+HH	850	max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35
41CrS4	1.7039			min.	56	55	53	51	47	43	41	39	35	31	29	27	26	25	24
41Cr4	1.7035	+HL	850	max.	58	58	57	55	52	50	47	45	40	37	34	32	31	30	29
41CrS4	1.7039			min.	53	52	50	47	41	37	34	32	29	26	23	21	-	-	-

Steel grades		Symbol	Austenizing 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	31
25CrMoS4	1.7213			min.	47	46	44	41	39	37	34	32	28	26	24	23	22	22	22
25CrMo4	1.7218	+HL	850	max.	49	49	47	46	43	41	38	36	32	30	29	28	27	27	27
25CrMoS4	1.7213			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	40	39
				min.	52	52	51	49	46	44	42	40	36	34	32	31	30	29	29
34CrMo4	1.7220	+HL	850	max.	54	54	54	52	51	49	47	46	42	39	38	36	35	35	34
				min.	49	49	48	45	42	39	36	34	30	28	27	26	25	24	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	46	45
42CrMoS4	1.7227			min.	56	56	55	54	52	48	46	44	41	39	38	36	36	35	34
42CrMo4	1.7225	+HL	850	max.	58	58	58	57	56	54	53	51	49	46	44	42	41	40	40
42CrMoS4	1.7227			min.	53	53	52	51	49	43	40	37	34	32	31	30	30	29	29
34CrNiMo6	1.6582	+HH	850	max.	58	58	58	58	57	57	57	57	57	57	57	57	57	57	57
				min.	53	53	53	53	52	51	51	51	51	50	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	53
				min.	50	50	50	50	49	48	48	48	48	47	47	47	46	45	44

NOTE This table is not applicable to steels ordered with a restricted range of carbon content see footnote b) in Table 3.

Table 11 — Hardness limits for boron alloyed steel grades with standard hardenability (+H grades - see 6.4.1)

Steel grades		Symbol	Austenizing temperature	Limits of range	Hardness HRC at a distance from quenched end of test piece (in mm) of														
Steel name	Steel number		°C ± 5° C		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										
				min.	39	34	30	20											
23B2	1.5508	+H	890	max.	49	48	47	45	39										
				min.	41	39	37	21											
28B2	1.5510	+H	880	max.	53	51	51	49	45	39	29	24	20						
				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										
23MnB3	1.5507	+H	880	max.	49	48	47	47	45	41									
				min.	43	41	40	32	23										
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									

Steel grades		Symbol	Austenizing temperature	Limits of range	Hardness HRC at a distance from quenched end of test piece (in mm) of														
Steel name	Steel number		°C ± 5° C		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
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	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				

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Table 12 — Maximum diameter for which at least 90 % martensite shall be attained in the core hardness test (+CH grades)

Steel grades		Symbol	Austenizing temperature in the core hardening test [a] °C ± 5 °C	Min. 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
Boron alloyed steel grades					
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
23MnB3	1.5507	+CH	880	42	14
23MnB4	1.5535	+CH	880	42	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 guideline a hardening time at temperature of at least 30 min is recommended.

[b] The maximum diameters stated are those attainable with the lowest hardenability within each steel grade. Using +HH grades the maximum diameter can be increased.