

Bright steel products — Technical delivery conditions —

Part 5: Steels for quenching and tempering

The European Standard EN 10277-5:1999 has the status of a
British Standard

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 8, an inside back cover and a back cover.

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**Bright steel products — Technical delivery conditions —
Part 5: Steels for quenching and tempering**

Produits en acier transformés à froid —
Conditions techniques de livraison —
Partie 5: Aciers pour trempe et revenu

Blankstahlerzeugnisse — Technische
Lieferbedingungen —
Teil 5: Vergütungsstähle

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 23, Steels for heat treatment, alloy steels and free-cutting steels — Qualities and dimensions, the Secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by January 2000, and conflicting national standards shall be withdrawn at the latest by January 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those applications and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

This European Standard EN 10277, Bright steel products — Technical delivery conditions, is subdivided as follows:

- *Part 1: General;*
- *Part 2: Steels for general engineering purposes;*
- *Part 3: Free-cutting steels;*
- *Part 4: Case-hardening steels;*
- *Part 5: Steels for quenching and tempering.*

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1 Scope

1.1 This part of EN 10277 applies to bright steel bars in the drawn, turned or ground condition, in straight lengths of steels for quenching and tempering.

1.2 This EN 10277-5 is complemented by EN 10277-1.

2 Normative references

This European Standard incorporates by dated 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 dated 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.

EN 10083-1:1991+A1:1996, *Quenched and tempered steels — Part 1: Technical delivery conditions for special steels.*

EN 10277-1, *Bright steel products — Technical delivery conditions — Part 1: General.*

3 Definitions

For the purpose of this standard, the following definition applies in addition to the definitions in EN 10277-1.

3.1

steels for quenching and tempering

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

Steel grades C35E, C35R, C40E, C40R, C45E, C45R, C50E, C50R, C60E and C60R are non-alloy special steels. All other steel grades covered by this European Standard are alloy special steels.

4.2 Designation

See EN 10277-1.

5 Information to be supplied by the purchaser

See EN 10277-1.

6 Manufacturing process

See EN 10277-1.

7 Requirements

7.1 Chemical composition

7.1.1 *Cast analysis*

The chemical composition of the steel according to the cast analysis shall be as specified in Table 1.

7.1.2 *Product analysis*

The permissible deviations from the chemical composition as specified in Table 1 for cast analysis and the product analysis of the steel shall be as specified in Table 2.

7.2 Mechanical properties

The mechanical properties of the steels shall be as specified in Table 3, Table 4 and Table 5.

7.3 Hardenability

Where steels are ordered with hardenability requirements, the requirements of EN 10083-1 shall apply.

7.4 Grain size

Unless otherwise agreed at the time of ordering, the grain size shall be left to the discretion of the manufacturer. If a fine grain structure is required in accordance with a reference treatment, special requirement B.2 of EN 10277-1 shall be ordered.

7.5 Non-metallic inclusions

The degree of cleanness may be agreed in accordance with EN 10083-1:1991+A1:1996 corresponding to the special steel quality.

7.6 Supplementary or special requirements

See annex B of EN 10277-1.

8 Inspection and testing

See EN 10277-1.

9 Marking

See EN 10277-1.

Table 1 — Chemical composition (cast analysis) of steels for quenching and tempering

Designation		Steel grade according to	Chemical composition, % by mass ¹⁾²⁾										
Steel name	Steel number		C ³⁾	Si	Mn	P	S	Cr	Mo	Ni	V	Cr+Mo+Ni max. ³⁾	
C35E	L.1181	EN 10083-1:1991+AI:1996	0,32 to 0,39	max. 0,40	0,50 to 0,80	max. 0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C35R	L.1180	EN 10083-1:1991+AI:1996	0,32 to 0,39	0,40	0,50 to 0,80	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C40E	L.1186	EN 10083-1:1991+AI:1996	0,37 to 0,44	0,40	0,50 to 0,80	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C40R	L.1189	EN 10083-1:1991+AI:1996	0,37 to 0,44	0,40	0,50 to 0,80	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C45E	L.1191	EN 10083-1:1991+AI:1996	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C45R	L.1201	EN 10083-1:1991+AI:1996	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C50E	L.1206	EN 10083-1:1991+AI:1996	0,47 to 0,55	0,40	0,60 to 0,90	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C50R	L.1241	EN 10083-1:1991+AI:1996	0,47 to 0,55	0,40	0,60 to 0,90	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C60E	L.1221	EN 10083-1:1991+AI:1996	0,57 to 0,65	0,40	0,60 to 0,90	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
C60R	L.1223	EN 10083-1:1991+AI:1996	0,57 to 0,65	0,40	0,60 to 0,90	0,035	max. 0,40	max. 0,10	max. 0,40	—	0,63		
34CrS4	L.7037	EN 10083-1:1991+AI:1996	0,30 to 0,37	0,40	0,60 to 0,90	0,035	0,90 to 1,20	—	—	—	—		
41CrS4	L.7039	EN 10083-1:1991+AI:1996	0,38 to 0,45	0,40	0,60 to 0,90	0,035	0,90 to 1,20	—	—	—	—		
25CrMoS4	L.7213	EN 10083-1:1991+AI:1996	0,22 to 0,29	0,40	0,60 to 0,90	0,035	0,90 to 1,20	0,15 to 0,30	—	—	—		
42CrMoS4	L.7227	EN 10083-1:1991+AI:1996	0,38 to 0,45	0,40	0,60 to 0,90	0,035	0,90 to 1,20	0,15 to 0,30	—	—	—		
34CrNiMo6	L.6582	EN 10083-1:1991+AI:1996	0,30 to 0,38	0,40	0,50 to 0,80	0,035	max. 0,035	max. 0,035	max. 0,40	0,10 to 0,25	—		
51CrV4	L.8159	EN 10083-1:1991+AI:1996	0,47 to 0,55	0,40	0,70 to 1,10	0,035	max. 0,035	max. 0,035	max. 0,40	0,10 to 0,25	—		

1) Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall 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.

2) Where requirements are made on hardenability (see 7.3) slight deviations from the limits for the cast analysis are permissible, except for the elements carbon (see footnote³⁾), phosphorus and sulfur; the deviations shall not exceed the specifications of Table 2.

3) If the unalloyed steels are ordered without hardenability requirements (symbols +H, +HI, +HL) or without requirements on the mechanical properties in the quenched and tempered condition restriction in the carbon range to 0,45 % and/or the total sum of the elements Cr, Mo and Ni to ≤0,45 % may be agreed at the time of ordering.

Table 2 — Permissible deviations between the product analysis and the limiting values given in Table 1 for the cast analysis

Element	Permissible content in the cast analysis % by mass	Permissible deviations ¹⁾ % by mass
C	≤0,55	±0,02
	>0,55 ≤0,65	±0,03
Si	≤0,40	+0,03
Mn	≤0,90	+0,04
P	≤0,035	+0,005
S	≤0,040	±0,005 ²⁾
Cr	≤1,70	±0,05
Mo	≤0,30	±0,03
Ni	≤1,70	±0,05

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 1, but not both at the same time.

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

Table 3 — Mechanical properties of non-alloy steels for quenching and tempering

Designation Steel name	Steel number	Thickness ¹⁾²⁾ mm	Mechanical properties ³⁾							
			As rolled + turned ³⁾ (+SH) (+A +SH)			Cold drawn + quenched + tempered ⁴⁾ (+C +QT)			Quenched + tempered + cold drawn (+QT +C)	
			Hardness HB	R_m N/mm ²	$R_{p0.2}$ N/mm ² min.	R_m N/mm ²	A_f % min.	$R_{p0.2}$ ⁵⁾ N/mm ² min.	R_m ⁵⁾ N/mm ²	A_5 % min.
C35E C35R	1.1181 1.1180	≥5 ≤10						650	800 to 950	9
		>10 ≤16						600	750 to 900	9
C40E C40R	1.1186 1.1189	>16 ≤40	154 to 207	520 to 700	370	600 to 750	19	530	700 to 850	10
		>40 ≤63	154 to 207	520 to 700	320	550 to 700	20	430	590 to 740	11
		>63 ≤100	154 to 207	520 to 700	320	550 to 700	20	360	550 to 700	12
C45E C45R	1.1191 1.1201	≥5 ≤10						650	800 to 1 000	8
		>10 ≤16						580	750 to 950	8
		>16 ≤40	163 to 211	550 to 710	400	630 to 780	18	500	680 to 900	9
		>40 ≤63	163 to 211	550 to 710	350	600 to 750	19	450	620 to 820	10
C50 E C50 R	1.1206 1.1241	>63 ≤100	163 to 211	550 to 710	350	600 to 750	19	370	600 to 800	11
		≥5 ≤10						700	850 to 1 050	8
		>10 ≤16						650	800 to 1 010	8
C60E C60R	1.1221 1.1223	>16 ≤40	172 to 242	580 to 820	430	650 to 800	16	570	750 to 950	9
		>40 ≤63	172 to 242	580 to 820	370	630 to 780	17	470	700 to 880	10
		>63 ≤100	172 to 242	580 to 820	370	630 to 780	17	380	650 to 820	11
		≥5 ≤10						720	870 to 1 070	7
		>10 ≤16						670	820 to 1 030	7
C60E C60R	1.1221 1.1223	>16 ≤40	181 to 269	610 to 910	460	700 to 850	15	600	790 to 990	8
		>40 ≤63	181 to 269	610 to 910	400	650 to 800	16	540	730 to 930	9
		>63 ≤100	181 to 269	610 to 910	400	650 to 800	16	470	680 to 880	9
		≥5 ≤10						750	900 to 1 100	6
C60E C60R	1.1221 1.1223	>10 ≤16						720	880 to 1 080	6
		>16 ≤40	198 to 278	670 to 940	520	800 to 950	13	640	800 to 1 030	7
		>40 ≤63	198 to 278	670 to 940	450	750 to 900	14	560	750 to 980	8
C60E C60R	1.1221 1.1223	>63 ≤100	198 to 278	670 to 940	450	750 to 900	14	480	750 to 910	8

1) For non-round product S in the quenched and tempered conditions, see EN 10277-1, Figure A.1.

2) For thicknesses >5 mm the mechanical properties may be agreed at the time of enquiry and order.

3) "As rolled + turned" for unalloyed steels, "annealed + turned" for alloyed steels.

4) These values are also valid for the "quenched + tempered + turned" condition.

5) For flats the proof strength ($R_{p0.2}$) may deviate by -10% and the tensile strength (R_m) by ±10%.

Table 4 — Mechanical properties of alloy steels for quenching and tempering

Designation Steel name	Steel number	Thickness ¹⁾²⁾ mm	Mechanical properties ²⁾				Quenched + tempered + cold drawn (+QT +C)				Annealed + cold drawn (+A +C)	
			As rolled + turned ³⁾ (+SH) or annealed + turned ³⁾ (+A +SH) Hardness HB	$R_{p0.2}$ N/mm ² min.	R_m N/mm ²	A_5 % min.	$R_{p0.2}$ ⁵⁾ N/mm ² min.	R_m ⁵⁾ N/mm ²	A_5 % min.	Hardness HB max.		
34CrS4	1.7034	≥5 ≤10					800		900 to 1 100	8	285	
		>10 ≤16				800		900 to 1 100	9	275		
		>16 ≤40	max. 223	590	800 to 950	14	690		800 to 950	9	270	
		>40 ≤63	max. 223	460	700 to 850	15	560		700 to 850	10	265	
41CrS4	1.7039	>63 ≤100	max. 223	460	700 to 850	15	480		700 to 850	11	265	
		≥5 ≤10					900		1 000 to 1 200	8	295	
		>10 ≤16					850		1 000 to 1 200	8	285	
		>16 ≤40	max. 241	660	900 to 1 100	12	770		900 to 1 100	9	280	
25CrMoS4	1.7213	>40 ≤63	max. 241	560	800 to 950	14	640		800 to 950	10	270	
		>63 ≤100	max. 241	560	800 to 950	14	580		800 to 950	11	270	
		≥5 ≤10					800		900 to 1 100	9	270	
		>10 ≤16					770		900 to 1 100	9	260	
42CrMoS4	1.7227	>16 ≤40	max. 212	600	800 to 950	14	670		800 to 950	10	255	
		>40 ≤63	max. 212	450	700 to 850	15	520		700 to 850	11	250	
		>63 ≤100	max. 212	450	700 to 850	15	450		700 to 850	12	250	
		≥5 ≤10					920		1 000 to 1 200	8	300	
34CrNiMo6	1.6582	>10 ≤16					900		1 000 to 1 200	8	290	
		>16 ≤40	max. 241	750	1 000 to 1 200	11	830		1 000 to 1 200	9	285	
		>40 ≤63	max. 241	650	900 to 1 100	12	730		900 to 1 100	10	280	
		>63 ≤100	max. 241	650	900 to 1 100	12	650		900 to 1 100	10	280	
51CrV4	1.8159	≥5 ≤10					950		1 000 to 1 200	8	308	
		>10 ≤16					950		1 000 to 1 200	8	298	
		>16 ≤40	max. 248	900	1 100 to 1 300	10	950		1 000 to 1 200	9	293	
		>40 ≤63	max. 248	800	1 000 to 1 200	11	850		1 000 to 1 200	10	288	
		>63 ≤100	max. 248	800	1 000 to 1 200	11	820		1 000 to 1 200	10	288	
		≤16	max. 248	900	1 100 to 1 300	9					311	
		>16 ≤40		800	1 000 to 1 200	10					293	
		>40 ≤80		700	900 to 1 100	12					287	

1) For non-round products in the quenched and tempered conditions, see EN 10277-1, Figure A.1.

2) For thicknesses <5 mm the mechanical properties may be agreed at the time of enquiry and order.

3) "As rolled + turned" for unalloyed steels, "annealed + turned" for alloyed steels.

4) These values are also valid for the "quenched + tempered + turned" condition.

5) For flats the proof strength ($R_{p0.2}$) may deviate by -10% and the tensile strength (R_m) by ±10%.

Table 5 — Mechanical properties in the cold drawn (+C) condition

Designation		Thickness mm	Mechanical properties		
Steel name	Steel number		Cold drawn (+C)		
			Yield strength $R_{p0,2}$ N/mm ² min.	Tensile strength R_m N/mm ² min.	Elongation % min.
C35E C35R	1.1181 1.1180	$\geq 5 \leq 10$	510	650 to 1 000	6
		$> 10 \leq 16$	420	600 to 950	7
		$> 16 \leq 40$	320	580 to 880	8
		$> 40 \leq 63$	300	550 to 840	9
		> 63	270	520 to 800	9
C40E C40R	1.1186 1.1189	$\geq 5 \leq 10$	540	700 to 1 000	6
		$> 10 \leq 16$	460	650 to 980	7
		$> 16 \leq 40$	365	620 to 920	8
		$> 40 \leq 63$	330	590 to 840	9
		> 63	290	550 to 820	9
C45E C45R	1.1191 1.1201	$\geq 5 \leq 10$	565	750 to 1 050	5
		$> 10 \leq 16$	500	710 to 1 030	6
		$> 16 \leq 40$	410	650 to 1 000	7
		$> 40 \leq 63$	360	630 to 900	8
		> 63	310	580 to 850	8
C50E C50R	1.1206 1.1241	$\geq 5 \leq 10$	590	770 to 1 100	5
		$> 10 \leq 16$	520	730 to 1 080	6
		$> 16 \leq 40$	440	690 to 1 050	7
		$> 40 \leq 63$	390	650 to 1 030	8
		> 63	—	—	—
C60E C60R	1.1221 1.1223	$\geq 5 \leq 10$	630	800 to 1 150	5
		$> 10 \leq 16$	550	780 to 1 130	5
		$> 16 \leq 40$	480	730 to 1 100	6
		$> 40 \leq 63$	—	—	—
		> 63	—	—	—

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