

Specification for

Quenched and tempered steels —

**Part 1: Technical delivery conditions
for special steels**

The European Standard EN 10083-1:1991, together with its amendment A1:1996, has the status of a British Standard

ICS 77.140.10

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National foreword

This British Standard has been prepared by Technical Committee ISE/31 (formerly ISM/31). It is the English language version of EN 10083-1, *Quenched and tempered steels — Part 1: Technical delivery conditions for special steels*, together with its amendment A1, published by the European Committee for Standardization (CEN). Together with BS EN 10084:1998, BS EN 10087:1999, BS EN 10088-1:1995, BS EN 10088-2:1995 and BS EN 10088-3:1995 it supersedes BS 970-1:1996, which is withdrawn.

National annex NA describes steels used in the United Kingdom but not included in the European Standard.

At the time of publication of this standard not all of the referenced Euronorms (EU) in clause 2 had been transformed into mandatory European Standards (EN). Until each of the Euronorms is transformed into a European Standard, EN 10083-1 permits either implementation of the requirements of the Euronorm or the requirements of the corresponding British Standard (see footnote 1 to clause 2).

It should be noted that as each Euronorm is transformed into a European Standard the requirements become mandatory. This reprint of BS EN 10083-1 incorporates amendment A1 which introduces the steel designations in accordance with BS EN 10027 and removes references to cold rolled strip.

Cross-references. Details of international standards quoted in this British Standard for which there is an identical or technically equivalent British Standard are given in national annex NC.

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English version

Quenched and tempered steels — Part 1: Technical delivery conditions for special steels (includes amendment A1 : 1996)

Aciers pour trempe et revenu —
Partie 1. Conditions techniques de livraison des
aciers spéciaux
(inclut l'amendement A1 : 1996)

Vergütungsstähle —
Teil 1. Technische Lieferbedingungen für Edelstähle
(enthält Änderung A1 : 1996)

This European Standard including amendment A1 was approved by CEN on 1995-07-01. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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Foreword

This European Standard has been prepared by ECISS/TC23, Steels for heat treatment, alloy steels and free-cutting steels — Qualities, the Secretariat of which is held by DIN.

When the European Committee for Iron and Steel Standardization (ECISS) was formed and its programme of work was drawn up, Technical Committee TC23 was requested to replace EURONORM 83-70 *Quenched and tempered steels; Quality specifications* by a European Standard.

The discussions within ECISS/TC23 were based on the International Standard ISO/683-1 : 1987 *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*.

The amendment to European Standard EN 10083-1 : 1991 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1997, and conflicting national standards shall be withdrawn at the latest by February 1997.

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

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1 Scope

1.1 This European Standard gives the technical delivery requirements for:

- semi-finished products, hot formed, for example blooms, billets, slabs (see notes 3 and 4);
- bars (see note 3)
- rod;
- wide flats;
- hot rolled sheet/plate and strip;
- hammer and drop forgings (see note 3)

manufactured from the direct hardening unalloyed or alloyed steels (see note 5) listed in table 3 and supplied in one of the heat treatment conditions given for the different types of products in table 1, lines 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 note 2) machine parts, but are partly (see table 10) also used in the normalized condition.

The requirements for mechanical properties given in this European Standard are restricted to the sizes given in tables 9 and 10.

NOTE 1. EURONORMS and European Standards relating to steels complying with the requirements for the chemical composition in table 3 but which are supplied in other product forms or treatment conditions than given above or are intended for special applications, and EURONORMS for similar steel grades are listed in annex C.

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

NOTE 3. Hammer-forged semi-finished products (blooms, billets, slabs, etc.) and hammer forged bars are included under semi-finished products or bars and not under the term 'hammer and drop forgings'.

NOTE 4. Special agreements shall be made when ordering unworked continuously cast semi-finished products.

NOTE 5. In accordance with EN 10020, the steels covered by this European Standard are special steels. Unalloyed quality steels are standardized in EN 10083-2. The differences between special steels and quality steels are:

- the minimum impact values in the quenched and tempered condition (for unalloyed special steels only in the case of mean percentages by mass of carbon < 0,50 %);
- limiting hardenability values in the Jominy test (for unalloyed special steels only in the case of percentages by mass of carbon > 0,30 %);
- limited oxide inclusion content;
- lower maximum contents for phosphorus and sulfur cast.

NOTE 6. Boron steels for quenching and tempering are standardized in EN 10083-3.

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 the specifications of this European Standard, the general technical delivery requirements of EN 10021 are applicable, unless otherwise specified.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate points in the text and the publications are listed hereafter. Subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. In the case of undated references, the most recent edition of the publication referred to applies.

EURONORM 18 ¹⁾	<i>Selection and preparation of samples and test pieces for steel and iron and steel products</i>
EURONORM 23 ¹⁾	<i>End quench hardenability test for steel (Jominy test)</i>
EURONORM 103 ¹⁾	<i>Micrographic determination of the ferritic or austenitic grain size of steels</i>
EURONORM 104 ¹⁾	<i>Determination of the depth of decarburization of non-alloy and low alloy structural steels</i>
EN 10002-1	<i>Metallic materials – tensile test Part 1: Method of test at ambient temperature</i>
EN 10003-1	<i>Metallic materials – Brinell hardness test — Part 1: Test method</i>
EN 10020	<i>Definition and classification of grades of steel</i>
EN 10021	<i>General technical delivery conditions for steel and iron and steel products</i>
EN 10027-1	<i>Designation systems for steels – Part 1: Steel names, principal symbols</i>
EN 10027-2	<i>Designation systems for steels – Part 2: Steel numbers</i>
EN 10045-1	<i>Metallic materials – Charpy impact test Part 1: Test method</i>
EN 10052	<i>Vocabulary of heat treatment terms for ferrous products</i>
EN 10079	<i>Definition of steel products</i>

¹⁾ It may be agreed at the time of ordering, until this has been adopted as a European Standard, that either this EURONORM or a corresponding national standard should be applied.

EN 10109-1	<i>Metallic materials — Hardness test — Part 1: Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T, 45T)</i>
EN 10163-2	<i>Delivery requirements for surface condition of hot rolled steel plates, wide flats, and sections — Part 2: Plates and wide flats</i>
EN 10204	<i>Metallic products — Types of inspection documents</i>
EN 10221	<i>Surface quality classes for hot rolled bars and rods — Technical delivery conditions</i>
CR 10260 ECISS IC 10	<i>Designation systems for steels — Additional symbols for steel names</i>

3 Definitions

3.1 quenched and tempered steels

For the purposes of this 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.

3.2 product form

The definitions of EN 10079 shall apply for the product forms.

3.3 types of heat treatment

The definitions of EN 10052 shall apply for the types of heat treatment mentioned in this standard.

3.4 unalloyed and alloy steel

The definitions of EN 10020 shall apply for the classification into unalloyed and alloy steel.

3.5 ruling section for heat treatment

The ruling section of a product is the section for which the mechanical properties have been specified (see annex A).

Whatever the actual shape and dimensions of the cross-section of the product, the size of its ruling section is always expressed as 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 test pieces for mechanical tests, will, when being cooled from the austenitizing temperature, show the same cooling rate as the actual ruling section of the product concerned at its position for taking test pieces.

4 Designation and ordering

4.1 The steel names are allocated in accordance with EN 10027-1 and ECISS information circular IC10; the steel numbers are allocated in accordance with EN 10027-2.

4.2 In accordance with the following examples, the standard designation of a steel specified in this EN consists of:

- the term 'steel';
- the number of this EN;
- the name or number for the steel grade (see table 3);
- if appropriate, the symbol for hardenability requirements (see **5.2.3**);
- if appropriate, the symbol for restricted hardenability requirements (see **5.2.3**);
- if appropriate, the designation of the heat treatment condition (see table 1);

Example 1: Steel EN 10083-1 – C45E +N
or Steel EN 10083-1-1.1191 + N

Example 2: Steel EN 10083-1 – C45E +H +A
or Steel EN 10083-1-1.1191 +H + A

4.3 The information in the relevant dimensional standard shall apply to the standard designation of the products.

4.4 The order shall contain all the information necessary to describe the required products and their condition (see table 2) and testing clearly. If additional or special requirements are to be met, the relevant clause number from annex B shall be given to indicate this, with details if necessary.

5 Requirements

5.1 Manufacturing process

5.1.1 General

The manufacturing process of the steel and of the products is left to the discretion of the manufacturer with the restrictions given by the requirements in **5.1.2** and **5.1.3**.

5.1.2 Deoxidation

All steels shall be 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, i.e. hot worked, condition.

NOTE. Depending on product shape and dimensions, not all steel grades can be delivered in the hot worked untreated condition (e.g. steel grade 30CrNiMo8).

5.1.3.2 Particular heat-treatment condition

If so agreed at the time of 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 condition

If so agreed at the time of the order, the products shall be delivered with one of the particular surface conditions given in table 2, lines 3 to 8.

5.2 Chemical composition, hardenability and mechanical properties

5.2.1 Except where the steels are ordered in the quenched and tempered condition, the unalloyed steels C35E to 28Mn6 (see table 3) and all alloy steels may be supplied with or without hardenability requirements (see table 1, columns 9 and 10).

5.2.2 Where the steel is ordered without hardenability requirements – i.e. where the steel grade 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 hardenability values 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 restricted (see tables 6 and 7) hardenability requirements, the hardenability values given in those tables apply in addition to the requirements specified in table 1, column 9. (See footnote 4 to table 3.)

5.2.4 The mechanical property values given in tables 9 and 10 apply to specimens in the ‘quenched and tempered’ and ‘normalized’ heat-treatment conditions which have been taken and prepared in accordance with figures 2 or 3 and 4 and table 12 (see also footnote 1 of table 1).

5.3 Technological properties

5.3.1 Machinability

All steels are machinable in the ‘soft-annealed’ condition.

Where improved machinability is required, the grades with a specified sulfur range should be ordered. (See also table 1, line 7, and table 3, footnote 3.)

5.3.2 Shearability of semi-finished products and steel bars

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 steel grades are shearable in the soft-annealed condition and unalloyed steels are also shearable in the normalized condition.

5.3.2.2 Steel grades C45E to 42CrMoS4 (see table 8) and the corresponding grades with requirements on hardenability (see tables 5 to 7) are also shearable under suitable conditions, if they are supplied in the ‘treated for shearability’ condition with the hardness requirements as specified in table 8.

5.3.2.3 The steel grades C22E to C40R (see table 8) and the corresponding grades with hardenability requirements (see tables 5 and 6) are shearable in the untreated condition under suitable conditions.

Shearability may also be assumed for steel grades C45E and C45R with dimensions greater than 80 mm and in the untreated condition.

5.4 Structure

5.4.1 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.3 shall be ordered.

5.4.2 The steels shall have a degree of cleanness corresponding to the special steel quality (see annex F).

5.5 Internal soundness

Requirements for internal soundness may be agreed upon at the time of ordering, e.g. on the basis of non-destructive tests (see annex B, clause B.5).

5.6 Surface quality

5.6.1 All products shall have a smooth finish appropriate to the shaping processes applied.

5.6.2 Minor surface imperfections, which may occur also under normal manufacturing conditions, such as scores originating from rolled-in scale in the case of hot-rolled products, shall not be regarded as defects.

5.6.3 Where appropriate, requirements relating to surface quality of the products shall be agreed on at the time of enquiry and order, if possible with reference to European Standards.

NOTE 1. EN 10163-2 specifies requirements for the surface quality of hot-rolled sheet/plate and wide flats. EN 10221 contains surface quality classification for hot-rolled bars and rods.

NOTE 2. Bar and rod for cold heading and cold extrusion are specified in EURONORM 119.

NOTE 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.

5.6.4 Requirements may be specified at the time of enquiry and order regarding the permissible depth of decarburization.

NOTE. The depth of decarburization shall be determined in accordance with the micrographic method specified in EURONORM 104.

5.6.5 If suitability of bars and rods for bright drawing is required, this shall be agreed at the time of enquiry and order.

5.6.6 The removal of surface defects by welding is only permitted with the approval of the customer or his representative.

Until a relevant European Standard is published, the process and permissible depth of defect removal, where appropriate, shall be agreed at the time of enquiry and order.

5.7 Dimensions, tolerances on dimensions and shape tolerances

The nominal dimensions, tolerances on dimensions and shape tolerances for the products shall be agreed at the time of enquiry and order, wherever possible with reference to the dimensional standards applicable (see annex D).

5.8 Cast separation

The products shall be delivered separated by cast.

6 Testing and conformity of products with the requirements

6.1 Testing procedures and types of documents

6.1.1 Products complying with this European Standard shall be ordered and delivered with one of the test certificates as specified in EN 10204. The type of documents shall be agreed at the time of enquiry and order. If the order does not contain any specification of this type, a test report shall be issued.

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

- a) the statement that the material complies with the requirements of the order;
- b) the results of the cast analysis for all elements specified in table 3 for the steel grade concerned.

6.1.3 If, in accordance with the agreements on the order, an inspection certificate, or an inspection report is to be provided, the specific inspections described in **6.2** shall be carried out and their results shall be certified in the document.

In addition, the document shall include the following information:

- a) the manufacturer's results for the cast analysis of all elements specified in table 3 for the steel grade concerned;
- b) the results of all inspections and tests ordered in 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 hardenability, hardness and mechanical properties*

6.2.1.1 For steels being ordered without hardenability requirements, i.e. 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 (mechanical properties of reference test pieces), is only to be verified if a supplementary requirement specified in annex B clause **B.1** or **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 hardenability requirements according to tables 5, 6 or 7 shall be verified.

NOTE. If so agreed at the time of enquiry and order, verification of hardenability may be provided by calculation. The calculation method shall also be agreed upon in this case.

6.2.1.2 The amount of testing, the sampling conditions and the test methods to be applied for the verification of requirements shall be as specified in table 11.

6.2.2 *Visual and dimensional inspection*

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

6.2.3 *Retests*

See EN 10021.

7 Marking

The manufacturer shall mark the products or the bundles or boxes in a suitable way such that it is possible to determine the cast, the steel grade and the origin of the delivery. (See annex B clause **B.7**).

Table 1. Combinations of usual heat-treatment conditions at delivery product forms and requirements as specified in tables 3 to 10												
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				
			Semi-finished products	Bars	Rod	Flat products	Hammer and drop forgings					
			Table 3			Table 5, 6 or 7						
			9.1	9.2			10.1	10.2	10.3			
2	Untreated	none or U	x	x	x	x	x	Chemical composition according to tables 3 and 4	1)		As in columns 9.1 and 9.2 (see footnote 4 in table 3)	Hardenability values according to table 5, 6 or 7
3	Treated to improve shearability	+S	x	x	—	—	—		Maximum hardness	Table 8 column +S ¹⁾		
4	Soft annealed	+A	x	x	x	x ²⁾	x			Table 8 column +A ¹⁾		
5	Normalized ³⁾	+N	—	x	—	x ²⁾	x		Mechanical properties according to	Table 10		
6	Quenched and tempered ⁴⁾	+QT ⁴⁾	—	x	x	x ²⁾	x			Table 9		
7	Others	Other treatment conditions, e.g. certain annealing conditions to achieve a certain structure may be agreed at the time of enquiry and order. The treatment condition annealed for spheroidal carbide (+AC) as required for cold upsetting and cold extrusion is covered by EURONORM 119.										

¹⁾ For deliveries in the untreated condition and in the ‘treated to improve shearability’ and ‘soft annealed’ condition the mechanical properties specified in tables 9 and 10 shall be achievable for the ruling end cross-section after appropriate heat treatment (for verification on reference test pieces, see annex B, clauses **B.1** and **B.2**).

²⁾ It is not possible to deliver all shapes of flat products in this heat-treatment condition.

³⁾ For unalloyed steels (carbon steels), normalizing may be replaced by normalizing forming.

⁴⁾ See also note 2 to 1.1.

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 (such as blooms, billets)	Bars	Rod	Flat products	Hammer and drop forgings (see note 3 to 1.1)	
2	Unless otherwise agreed	As hot worked	None or + HW	x	x	x	x	x	—
3	Particular conditions supplied by agreement	deformed continuously cast	+ CC	x	—	—	—	—	—
4		Hot worked and pickled	+ P	x	x	x	x	x	2)
5		Hot worked and blast cleaned	+ BC	x	x	x	x	x	
6		Hot worked and rough machined	1)	—	x	x	—	x	
7		Others							
¹⁾ 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. ²⁾ In addition it may be agreed that the products be e.g. oiled, limed or phosphated.									

Table 3. Steel grades and chemical composition (cast analysis)

Steel designation		Chemical composition % (m/m) ¹⁾²⁾³⁾⁴⁾									
Name	Number	C ⁵⁾	Si max.	Mn	P max.	S	Cr	Mo	Ni	V	Cr + Mo + Ni max. ⁵⁾
C22E	1.1151	0,17 to 0,24	0,40	0,40 to 0,70	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
C22R	1.1149					0,020 to 0,040					
(C25E) ⁶⁾	(1.1158) ⁶⁾	0,22 to 0,29	0,40	0,40 to 0,70	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
(C25R) ⁶⁾	(1.1163) ⁶⁾					0,020 to 0,040					
(C30E) ⁶⁾	(1.1178) ⁶⁾	0,27 to 0,34	0,40	0,50 to 0,80	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
(C30R) ⁶⁾	(1.1179) ⁶⁾					0,020 to 0,040					
C35E	1.1181	0,32 to 0,39	0,40	0,50 to 0,80	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
C35R	1.1180					0,020 to 0,040					
(C40E) ⁶⁾	(1.1186) ⁶⁾	0,37 to 0,44	0,40	0,50 to 0,80	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
(C40R) ⁶⁾	1.1189 ⁶⁾					0,020 to 0,040					
C45E	1.1191	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
C45R	1.1201					0,020 to 0,040					
(C50E) ⁶⁾	(1.1206) ⁶⁾	0,47 to 0,55	0,40	0,60 to 0,90	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
(C50R) ⁶⁾	(1.1241) ⁶⁾					0,020 to 0,040					
(C55E) ⁶⁾	(1.1203) ⁶⁾	0,52 to 0,60	0,40	0,60 to 0,90	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
(C55R) ⁶⁾	(1.1209) ⁶⁾					0,020 to 0,040					
C60E	1.1221	0,57 to 0,65	0,40	0,60 to 0,90	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
C60R	1.1223					0,020 to 0,040					
28Mn6	1.1170	0,25 to 0,32	0,40	1,30 to 1,65	0,035	max. 0,035	max. 0,40	max. 0,10	max. 0,40	–	0,63
38Cr2	1.7003	0,35 to 0,42	0,40	0,50 to 0,80	0,035	max. 0,035	0,40 to 0,60	–	–	–	–
38CrS2	1.7023					0,020 to 0,040					
46Cr2	1.7006	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,035	0,40 to 0,60	–	–	–	–
46CrS2	1.7025					0,020 to 0,040					
34Cr4	1.7033	0,30 to 0,37	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	–	–	–	–
34CrS4	1.7037					0,020 to 0,040					
37Cr4	1.7034	0,34 to 0,41	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	–	–	–	–
37CrS4	1.7038					0,020 to 0,040					
41Cr4	1.7035	0,38 to 0,45	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	–	–	–	–
41CrS4	1.7039					0,020 to 0,040					
25CrMo4	1.7218	0,22 to 0,29	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	0,15 to 0,30	–	–	–
25CrMoS4	1.7213					0,020 to 0,040					

¹⁾ to ⁶⁾ See footnotes on page 10.

Table 3. Steel grades and chemical composition (cast analysis) (concluded)

Steel designation		Chemical composition % (m/m) ¹⁾²⁾³⁾⁴⁾									
Name	Number	C ⁵⁾	Si max.	Mn	P max.	S	Cr	Mo	Ni	V	Cr + Mo + Ni max. ⁵⁾
34CrMo4	1.7220	0,30 to 0,37	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	0,15 to 0,30	–	–	–
34CrMoS4	1.7226					0,020 to 0,040					
42CrMo4	1.7225	0,38 to 0,45	0,40	0,60 to 0,90	0,035	max. 0,035	0,90 to 1,20	0,15 to 0,30	–	–	–
42CrMoS4	1.7227					0,020 to 0,040					
50CrMo4	1.7228	0,46 to 0,54	0,40	0,50 to 0,80	0,035	max. 0,035	0,90 to 1,20	0,15 to 0,30	–	–	–
36CrNiMo4	1.6511	0,32 to 0,40	0,40	0,50 to 0,80	0,035	max. 0,035	0,90 to 1,20	0,15 to 0,30	0,90 to 1,20		–
34CrNiMo6	1.6582	0,30 to 0,38	0,40	0,50 to 0,80	0,035	max. 0,035	1,30 to 1,70	0,15 to 0,30	1,30 to 1,70	–	–
30CrNiMo8	1.6580	0,26 to 0,34	0,40	0,30 to 0,60	0,035	max. 0,035	1,80 to 2,20	0,30 to 0,50	1,80 to 2,20	–	–
36NiCrMo16	1.6773	0,32 to 0,39	0,40	0,30 to 0,60	0,030	max. 0,025	1,60 to 2,00	0,25 to 0,45	3,60 to 4,10		–
51CrV4	1.8159	0,47 to 0,55	0,40	0,70 to 1,10	0,035	max. 0,035	0,90 to 1,20	–	–	0,10 to 0,25	–

¹⁾ 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.

²⁾ See note 6 in 1.1 for steels containing boron.

³⁾ Steels with improved machinability as a result of the addition of lead or higher sulfur contents, depending on the manufacturing process up to and around 0,100 % S (including controlled sulfide and oxide formation, e.g. calcium treatment, may be supplied on request).

⁴⁾ Where requirements are made on hardenability (see tables 5 to 7), slight deviations from the limits for the cast analysis are permissible, except for the elements, carbon (see footnote 5), phosphorous and sulfur, the deviations shall not exceed the specifications of table 4.

⁵⁾ If the unalloyed steels including grade 28Mn6 are ordered without hardenability requirements (symbols +H, +HH, +HL) or without requirements on the mechanical properties in the quenched and tempered or normalized condition, restriction in the carbon range to 0.05 % and/or the total sum of the elements Cr, Mo and Ni to < 0,45 % may be agreed at the time of ordering.

⁶⁾ Some of the steel grades given in brackets have been included in this EN for the first time; they are not available from stock in all countries.

Table 4. Permissible deviations between the product analysis and the limiting values given in table 3 for the cast analysis

Element	Permissible content in the cast analysis % (m/m)		Permissible deviation ¹⁾ % (m/m)
C	> 0,55	$\leq 0,55$ $\leq 0,65$	$\pm 0,02$ $\pm 0,03$
Si		$\leq 0,40$	+ 0,03
Mn	> 1,00	$\leq 1,00$ $\leq 1,65$	$\pm 0,04$ $\pm 0,05$
P		$\leq 0,035$	+ 0,005
S		$\leq 0,040$	+ 0,005 ²⁾
Cr	> 2,00	$\leq 2,00$ $\leq 2,20$	$\pm 0,05$ $\pm 0,10$
Mo	> 0,30	$\leq 0,30$ $\leq 0,50$	$\pm 0,03$ $\pm 0,04$
Ni	> 2,00	$\leq 2,00$ $\leq 4,10$	$\pm 0,05$ $\pm 0,07$
V		$\leq 0,25$	$\pm 0,02$

¹⁾ $\pm$ 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 $\pm 0,005$ % (m/m).