

UDC 669.14.018.298.3 : 620.1

October 1991

	<p style="text-align: center;">Quenched and tempered steels Technical delivery conditions for special steels English version of DIN EN 10 083 Part 1</p>	<p style="text-align: center;">DIN EN 10083 Part 1</p>																														
	<p>Vergütungsstähle; technische Lieferbedingungen für Edeltähle</p> <p>European Standard EN 10 083-1 : 1991 has the status of a DIN Standard.</p> <p><i>A comma is used as the decimal marker.</i></p> <p>National foreword</p> <p>This standard has been prepared by ECISS/TC 23.</p> <p>The responsible German body involved in the preparation of this standard was the <i>Normenausschuß Eisen und Stahl</i> (Steel and Iron Standards Committee), Technical Committee 05 <i>Maschinenbaustähle</i>.</p> <p>a) Special steel and quality steel is now dealt with in DIN EN 10 083 Parts 1 and 2, a further standard covering boron steel for quenching and tempering is to be prepared as Part 3.</p> <p>b) The specifications for standard designations still conform with those given in EURONORM 27, which is in the process of being adopted as a European Standard (EN 10 027 Part 1). Since that European Standard will include changes to the symbols, it is not recommended that the symbols used hitherto be replaced by those specified in EURONORM 27 but, pending the publication of EN 10 027 Part 1, the material designations given in appendix E of this standard or the material numbers given in DIN 17 200 be used for a transitional period.</p> <p>Note. Part 2 of EN 10 027 will cover material designations and numbers.</p> <p>c) Annex F of this standard specifies requirements for the microscopic degree of purity, according to test methods described in a number of national standards. These standards will be withdrawn once a European Standard dealing with the determination of the non-metallic inclusions content (in course of preparation) has been issued.</p> <p>d) The DIN Standards corresponding to the European Standards (or EURONORMs) referred to in clause 2 of the EN are as follows:</p> <table border="0"> <thead> <tr> <th style="text-align: left;">European Standard/ EURONORM</th> <th style="text-align: left;">DIN Standard</th> </tr> </thead> <tbody> <tr> <td>EN 10 002-1</td> <td>DIN EN 10 002 Part 1</td> </tr> <tr> <td>EN 10 020</td> <td>DIN EN 10 020</td> </tr> <tr> <td>EN 10 045-1</td> <td>DIN EN 10 045 Part 1</td> </tr> <tr> <td>EN 10 083-2</td> <td>DIN EN 10 083 Part 2</td> </tr> <tr> <td>EN 10 204</td> <td>DIN 50 049</td> </tr> <tr> <td>EURONORM 3</td> <td>DIN 50 351</td> </tr> <tr> <td>EURONORM 4</td> <td>DIN EN 10 004 Part 1 (at present at the stage of draft)</td> </tr> <tr> <td>EURONORM 21</td> <td>DIN EN 10 021 (at present at the stage of draft)</td> </tr> <tr> <td>EURONORM 23</td> <td>DIN 50 191</td> </tr> <tr> <td>EURONORM 52</td> <td>DIN EN 10 052 (at present at the stage of draft)</td> </tr> <tr> <td>EURONORM 79</td> <td>DIN EN 10 079</td> </tr> <tr> <td>EURONORM 103</td> <td>DIN 50 601</td> </tr> <tr> <td>EURONORM 104</td> <td>DIN 50 192</td> </tr> <tr> <td>EURONORM 163</td> <td>DIN EN 10 163 Parts 1 und 2</td> </tr> </tbody> </table>	European Standard/ EURONORM	DIN Standard	EN 10 002-1	DIN EN 10 002 Part 1	EN 10 020	DIN EN 10 020	EN 10 045-1	DIN EN 10 045 Part 1	EN 10 083-2	DIN EN 10 083 Part 2	EN 10 204	DIN 50 049	EURONORM 3	DIN 50 351	EURONORM 4	DIN EN 10 004 Part 1 (at present at the stage of draft)	EURONORM 21	DIN EN 10 021 (at present at the stage of draft)	EURONORM 23	DIN 50 191	EURONORM 52	DIN EN 10 052 (at present at the stage of draft)	EURONORM 79	DIN EN 10 079	EURONORM 103	DIN 50 601	EURONORM 104	DIN 50 192	EURONORM 163	DIN EN 10 163 Parts 1 und 2	<p>This standard, together with DIN EN 10 083 Part 2, October 1991 edition, supersedes DIN 17 200, March 1987 edition.</p> <p style="text-align: right;">Continued on pages 2 and 3. EN comprises 38 pages.</p>
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EURONORM 104	DIN 50 192																															
EURONORM 163	DIN EN 10 163 Parts 1 und 2																															

Standards referred to

(and not included in Normative references)

DIN EN 10 004 Part 1	(at present at the stage of draft) Metallic materials; Rockwell hardness test (scales A, B, C, D, E, F, G, H, and K)
DIN EN 10 021	(at present at the stage of draft) General technical delivery conditions for steel and steel products
DIN EN 10 052	(at present at the stage of draft) Vocabulary of heat treatment terms for ferrous products
DIN EN 10 079	Definition and classification of steel products by shape and dimensions
DIN EN 10 163 Part 1	Technical delivery conditions for the surface condition of hot rolled steel plate, wide flats and sections; general requirements
DIN EN 10 163 Part 2	Technical delivery conditions for the surface condition of hot rolled steel plate, wide flats and sections; plate and wide flats
DIN 50 191	End quench hardenability testing of steel (Jominy test)
DIN 50 192	Determination of the depth of decarburization of steel
DIN 50 351	Brinell hardness testing of metallic materials
DIN 50 601	Micrographic determination of the ferritic or austenitic grain size of steel

Previous editions

DIN 1661: 09.24, 06.29; DIN 1662: 07.28, 06.30; DIN 1662, Supplements 5, 6, and 8 to 11: 05.32;
 DIN 1663: 05.36, 12.39x; DIN 1663, Supplements 5, and 7 to 9: 02.37x; DIN 1665: 05.41;
 DIN 1667: 11.43; DIN 17 200, Supplement: 05.52; DIN 17 200: 12.51, 12.69, 11.84, 03.87.

Amendments

In comparison with DIN 17 200, March 1987 edition, the following amendments have been made.

- a) The standard has been split up into two Parts (dealing with special steels and quality steels, respectively).
- b) 32 Cr 2, 32 CrS 2, 28 Cr 4, 28 CrS 4 and 30 CrMoV 9 steels are no longer included, 36 NiCrMo 16 steel having been introduced for the first time.
- c) The specifications relating to the chemical composition have been amended in some cases.
- d) The distinction between mandatory and supplementary requirements indicated by marking the respective subclauses has been dropped. Instead, supplementary requirements are now specified in the annexes.
- e) Some specifications for Rockwell C hardness (Jominy test) and maximum hardness in the soft annealed condition have been amended.
- f) Some specifications for mechanical properties of steel in the quenched and tempered condition have been amended.
- g) Details of test piece location and the ruling section have been amended.
- h) Table 13 showing minimum yield strength values of steels in their quenched and tempered condition is no longer included.
- i) The material designations have been changed to comply with the specifications of EURONORM 27; material numbers are no longer included and some symbols denoting the heat treatment condition have been changed.
- j) The specimen designation (cf. subclause 4.1) has been changed.
- k) The specifications relating to surface quality have been amended.
- l) The specifications relating to surface finish are now given in tabular form.
- m) Besides a number of other editorial changes required by the slightly different organization of the material, there are now no clauses dealing with mass, steel grades, weldability and complaints. The standard has also been editorially revised.

International Patent Classification

C 22 C 38/40
 G 01 B 21/00
 G 01 N 33/20

Editor's note

This standard reproduces the official text of the English version of EN 10 083-1 as issued by CEN. In its preparation for publication as DIN EN 10 083 Part 1 (English version), certain points have been noted which we consider to be in need of correction. These have been marked ⁺. The suggested amendments are given below and will be forwarded to the responsible CEN Secretariat for its consideration.

In presentation, orthography, punctuation and hyphenation, the aim has been to implement the PNE Rules consistently. Obvious errors (e.g. redundancies and omissions) have been rectified without further reference.

Suggested amendments

- 1 *In note 4 to subclause 1.1, 'undeformed' and in table 2, column 3, line 3, 'deformed' should preferably read 'unworked' and 'worked', respectively.*
- 2 *Subclause 1.2 should preferably read 'In special cases, deviations from, or supplements to, these technical delivery conditions may be agreed at the time of ordering (cf. DIN EN 10 083-2).'*
- 3 *Re note 1 to subclause 5.6.3: EN 10 163 Parts 1 to 3 is now available.*
- 4 *'Shape tolerances' has been used throughout instead of the common technical term 'form tolerances' (cf. ISO 1101).*
- 5 *The heading of clause 6 should preferably read 'Testing for conformity...'*
- 6 *To complete the sense of note 5 to table 3, 'a restriction' must be inserted after 'condition' and 'of' after 'and/or'.*
- 7 *For ease of reading, in the heading of table 9, 'or' has been added here five times and 'with a' inserted after 'flat products'.*
- 8 *In table 12, column 2, item 4b should read 'normalized products'.*

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10083-1

February 1991

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Descriptors: Iron and steel products, steels, heat treatable steels, quenching (cooling), tempering, delivery condition, specifications, designation, marking.

English version

Quenched and tempered steels

Part 1: Technical delivery conditions for special steels

Aciers pour trempe et revenu. Partie 1:
Conditions techniques de livraison des
aciers spéciaux

Vergütungsstähle. Teil 1: Technische Lie-
ferbedingungen für Edelstähle

This European Standard was approved by CEN on 1991-02-12. 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.

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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization

Comité Européen de Normalisation

Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Foreword

This European Standard has been prepared by ECiSS/TC23 'Heat treatable alloy steels and free-cutting steels; quality standards', 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 TC 23 was requested to replace EURONORM 83-70, Quenched and tempered steels; quality specifications, by a European Standard.

The discussions within ECiSS/TC 23 were based on the International Standard ISO 683-1 : 1987, Heat-treatable steels, alloy steels and free-cutting steel. Part 1: Direct hardening unalloyed and low-alloy wrought steel in form of different black products.

In accordance with the CEN/CENELEC Internal Regulations, the following member countries are bound to adopt this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This European Standard gives the technical delivery requirements for

- semi-finished products, hot formed, e.g. blooms, billets, slabs (see notes 3 and 4),
- bars (see note 3),
- rod,
- wide flats,
- hot or cold rolled sheet/plate and strip,
- hammer and drop forgings (see note 3),

manufactured from the direct hardening unalloyed or alloy 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 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 undeformed*) continuously cast semi-finished products.

NOTE 5: In accordance with EN 10 020, the steels covered by this European Standard are special steels. Unalloyed quality steels are standardized in EN 10 083-2. 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 oxidic inclusions content,
- lower maximum contents for phosphorus and sulfur.

NOTE 6: A standard on boron steels for quenching and tempering is being prepared as Part 3 of EN 10 083.

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 ordering (see annex B).*)

1.3 In addition to the specifications of this European Standard, the general technical delivery requirements of EURONORM 21 are applicable unless otherwise specified.

2 Normative references

EURONORM 3 ¹⁾	Brinell hardness test for steel
EURONORM 4 ¹⁾	Rockwell hardness test for steel (scales A,B,C,F)
EURONORM 18 ¹⁾	Selection and preparation of samples and test pieces for steel and iron and steel products
EURONORM 21 ¹⁾	General technical delivery conditions for steel and iron and steel products
EURONORM 23 ¹⁾	End quench hardenability test for steel (Jominy test)
EURONORM 52 ¹⁾	Vocabulary of heat treatment terms for ferrous products
EURONORM 60 ¹⁾	Hot rolled round bars for general purposes
EURONORM 79	Definition and classification of steel products by shape and dimensions
EURONORM 103 ¹⁾	Micrographic determination of the ferritic or austenitic grain size of steels
EURONORM 104 ¹⁾	Determination of the depth of decarburization of non-alloy and low-alloy structural steels
EURONORM 119 ¹⁾	Steels for cold heading and cold extrusion; quality requirements
EURONORM 163 ¹⁾	Delivery conditions for the surface finish of hot rolled plates and wide flats
EN 10 002-1	Metallic materials; tensile test; Part 1: Methods of test at ambient temperature
EN 10 020	Definition and classification of grades of steel
EN 10 045-1	Metallic materials; Charpy notched bar impact test. Part 1: Methods of test
EN 10 083-2	Quenched and tempered steels. Part 2: Technical delivery conditions for unalloyed quality steels
EN 10 204	Metallic materials; types of inspection documents

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

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 EURONORM 79 shall apply for product forms.

3.3 types of heat treatment: The definitions of EURONORM 52 shall apply for the types of heat treatment mentioned in this standard.

3.4 unalloyed and alloy steel: The definitions of EN 10 020 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 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 symbol 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 10 083 — 2 C 45 — TN

EXAMPLE 2:

Steel EN 10 083 — 2 C 45 H — TA

NOTE: European Standards are being prepared on the formation of alphanumeric and numbering systems for the designation of steels. Until the publication of these standards, the previous national designations listed in annex E may be used instead of the alphanumeric symbols used in EN 10 083-1; if these previous national designations are used, the corresponding grade specified in EN 10 083-1 will automatically be supplied. After publication of the standards on the formation of symbols and designations, EN 10 083-1 will be revised at short notice to introduce the new designations.

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

4.3 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 ordering, 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 30 CrNiMo 8).

5.1.3.2 Particular heat treatment condition

If so agreed at the time of ordering, 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 ordering, 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 2 C 35 to 28 Mn 6 (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 2 C 45 to 42 CrMoS 4 (see table 8) and the corresponding grades with hardenability requirements (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 Steel grades 2 C 22 to 3 C 40 (see table 8) and the corresponding grades with hardenability requirements (see tables 5 and 6) are, under suitable conditions, shearable in the untreated condition.

Shearability may also be assumed for steel grades 2 C 45 and 3 C 45 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 purity 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 also occur 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 the surface quality of the products shall be agreed on at the time of ordering, if possible with reference to European Standards.

NOTE 1: EURONORM 163 specifies requirements for the surface quality of hot rolled sheet/plate and wide flats. It will be transformed into a EN subsequently and will then also contain requirements for the surface quality of sectional products.*

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 length. This should be taken into account when agreements on surface quality are made.

5.6.4 Requirements may be specified at the time of ordering 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 rod for bright drawing is required, this shall be agreed at the time of ordering.

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 ordering.

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 ordering, wherever possible with reference to the applicable dimensional standards (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 10 204. The type of documents shall be agreed at the time of ordering. 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 ordering, 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 inspection described in 6.2 shall be carried out and the 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 9.2, shall, with the following exception, be verified. The requirement given in table 1, footnote 1 (mechanical properties of reference test pieces), is only to be verified if a supplementary requirement specified in annex B, clause B.1 or B.2, is ordered. When delivering strip made of the steel grades listed in table 11 up to the maximum thickness given in table 11, the hardness in the hardened condition shall be verified.

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

NOTE: If so agreed at the time of ordering, proof 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 12.

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 EURONORM 21.

7 Marking

The manufacturer shall mark the products, or the bundles or boxes, in a suitable way so 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 11

1	2	3	4	5	6	7	8	9	10			
Heat treatment condition at delivery	Symbol ¹⁾	X indicates applicable for					Applicable requirements if the steel is ordered with the designation given in table 5, 6 or 7					
		semi-finished products	bars	rod	flat products	hammer and drop forgings	9.1	9.2	10.1	10.2	10.3	
2 Untreated	None or TU	X	X	X	X	X	X	9.1	9.2	10.1	10.2	10.3
3 Treated to improve shearability	TS	X	X	-	-	-	-	Chemical composition according to tables 3 and 4	--- ^{1),2)}	As in columns 9.1 and 9.2 (see footnote 4 to table 3)	Hardenability values according to table 5, 6 or 7	
4 Soft annealed	TA	X	X	X	X ³⁾	X	Maximum hardness according to table 8, column TS ¹⁾					table 8, column TA ^{1),2)}
5 Normalized ⁴⁾	TN ⁴⁾	-	X	-	X ³⁾	X	X	Mechanical properties according to table 10	table 10			
6 Quenched and tempered ⁵⁾	TQ + T ⁵⁾	-	X	X	X ³⁾	X	X	Mechanical properties according to table 9	table 9			
7 Others	Other treatment conditions, e.g. certain annealing conditions to achieve a certain structure, may be agreed at the time of ordering. The treatment condition 'annealed for spheroidal carbide' (TAC) as required for cold upsetting and cold extrusion is covered by EURONORM 119.											

¹⁾ The note to 4.1 applies analogously to the symbols listed here for heat treatment.

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

³⁾ For deliveries of strip made of the steel grades listed in table 11 up to the maximum thicknesses in table 11, the hardness shall also be verified in the hardened condition.

⁴⁾ For unalloyed steels (carbon steels), normalizing may be replaced by normalizing forming.

⁵⁾ 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	Hot worked	None or HW	x	x	x	x	x	—
3	Particular conditions to be supplied by agreement	Deformed*), continuously cast	CC	x	—	—	—	—	—
4		Hot worked and pickled	PI	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		Cold rolled	CW	—	—	—	x	—	
8		Others							
¹⁾ Until the term 'rough machined' is defined by, for example, machining allowances, the details are to be agreed at the time of ordering. ²⁾ In addition, it may be agreed that the products be, for example, oiled, limed or phosphated.									

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

Steel grade symbol	Chemical composition (% by mass) ^{1), 2), 3), 4)}										
	C ⁵⁾	Si max	Mn	P max.	S	Cr	Mo	Ni	V	Cr + Mo + Ni max. ⁵⁾	
2 C 22	0,17 to 0,24	0,40	0,40 to 0,70	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
3 C 22											
(2 C 25) ⁶⁾	0,22 to 0,29	0,40	0,40 to 0,70	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
(3 C 25) ⁶⁾											
(2 C 30) ⁶⁾	0,27 to 0,34	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
(3 C 30) ⁶⁾											
2 C 35	0,32 to 0,39	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
3 C 35											
(2 C 40) ⁶⁾	0,37 to 0,44	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
(3 C 40) ⁶⁾											
2 C 45	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
3 C 45											
(2 C 50) ⁶⁾	0,47 to 0,55	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
(3 C 50) ⁶⁾											
(2 C 55) ⁶⁾	0,52 to 0,60	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
(3 C 55) ⁶⁾											
2 C 60	0,57 to 0,65	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	max. 0,40	max. 0,10	max. 0,40	-	0,63	
3 C 60											
28 Mn 6	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	
38 Cr 2	0,35 to 0,42	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	0,40 to 0,60	-	-	-	-	
38 CrS 2											

46 Cr 2	0,42 to 0,50	0,40	0,50 to 0,80	0,035	max. 0,035 0,020 to 0,040	0,40 to 0,60	-	-	-
46 CrS 2									
34 Cr 4	0,30 to 0,37	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	-	-	-
34 CrS 4									
37 Cr 4	0,34 to 0,41	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	-	-	-
37 CrS 4									
41 Cr 4	0,38 to 0,45	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	-	-	-
41 CrS 4									
25 CrMo 4	0,22 to 0,29	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	0,15 to 0,30	-	-
25 CrMoS 4									
34 CrMo 4	0,30 to 0,37	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	0,15 to 0,30	-	-
34 CrMoS 4									
42 CrMo 4	0,38 to 0,45	0,40	0,60 to 0,90	0,035	max. 0,035 0,020 to 0,040	0,90 to 1,20	0,15 to 0,30	-	-
42 CrMoS 4									
50 CrMo 4	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	-	-
36 CrNiMo 4	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	-
34 CrNiMo 8	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	-
30 CrNiMo 8	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	-
36 NiCrMo 16	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	-
51 CrV 4	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 added intentionally 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 the 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 around 0,100 % S (including controlled sulfide and oxide formation, e.g. Ca 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), phosphorus and sulfur; the deviations shall not exceed the specifications of table 4.

5) If the unalloy steels including grade 28 Mn 6 are ordered without hardenability requirements (symbols H, HH, HL) or without requirements on the mechanical properties in the quenched and tempered or normalized condition,*) in the carbon range to 0,05 % and/or*) the total sum of the elements Cr, Mo and Ni to 50,45 % may be agreed at the time of ordering.

6) Some of the steel grades given in brackets have been included in this European Standard 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 % by mass	Permissible deviation ¹⁾ % by mass
C	$\leq 0,55$ $> 0,55 \leq 0,65$	$\pm 0,02$ $\pm 0,03$
Si	$\leq 0,40$	+ 0,03
Mn	$\leq 1,00$ $> 1,00 \leq 1,65$	$\pm 0,04$ $\pm 0,05$
P	$\leq 0,035$	+ 0,005
S	$\leq 0,040$	+ 0,005 ²⁾
Cr	$\leq 2,00$ $> 2,00 \leq 2,20$	$\pm 0,05$ $\pm 0,10$
Mo	$\leq 0,30$ $> 0,30 \leq 0,50$	$\pm 0,03$ $\pm 0,04$
Ni	$\leq 2,00$ $> 2,00 \leq 4,10$	$\pm 0,05$ $\pm 0,07$
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 % according to cast analysis, the permissible deviation is $\pm 0,005$ %.

Table 5. Limiting values for the C scale Rockwell hardness for steel grades with (normal) hardness requirements (H grades; see 5.2)

Steel grade symbol	Limits of range	Distance, in mm, from the quenched end															
		Hardness, in HRC															
		1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30
2 C35H, 3 C35H ¹⁾	max.	58	57	55	53	49	41	34	31	28	27	26	25	24	23	20	—
	min.	48	40	33	24	22	20	—	—	—	—	—	—	—	—	—	—
2 C40H, 3 C40H ¹⁾	max.	60	60	59	57	53	47	39	34	31	30	29	28	27	26	25	24
	min.	51	46	35	27	25	24	23	22	21	20	—	—	—	—	—	—
2 C45H, 3 C45H ¹⁾	max.	62	61	61	60	57	51	44	37	34	33	32	31	30	29	28	27
	min.	55	51	37	30	28	27	26	25	24	23	22	21	20	—	—	—
2 C50H, 3 C50H ¹⁾	max.	63	62	61	60	58	55	50	43	36	35	34	33	32	31	29	28
	min.	56	53	44	34	31	30	30	29	28	27	26	25	24	23	20	—
2 C55H, 3 C55H ¹⁾	max.	65	64	63	62	60	57	52	45	37	36	35	34	33	32	30	29
	min.	58	55	47	37	33	32	31	30	29	28	27	26	25	24	22	20
2 C60H, 3 C60H ¹⁾	max.	67	66	65	63	62	59	54	47	39	37	36	35	34	33	31	30
	min.	60	57	50	39	35	33	32	31	30	29	28	27	26	25	23	21
Steel grade symbol	Limits of range	Distance, in mm, from the quenched end															
		Hardness, in HRC															
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	
28 Mn 6 H	max.	54	53	51	48	44	41	38	35	31	29	27	26	25	25	24	
	min.	45	42	37	27	21	—	—	—	—	—	—	—	—	—	—	
38 Cr 2 H 38 CrS 2 H	max.	59	57	54	49	43	39	37	35	32	30	27	25	24	23	22	
	min.	51	46	37	29	25	22	20	—	—	—	—	—	—	—	—	
46 Cr 2 H 46 CrS 2 H	max.	63	61	59	57	53	47	42	39	36	33	32	31	30	29	29	
	min.	54	49	40	32	28	25	23	22	20	—	—	—	—	—	—	
34 Cr 4 H 34 CrS 4 H	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	—	—	—	—	
37 Cr 4 H 37 CrS 4 H	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	—	—	—	
41 Cr 4 H 41 CrS 4 H	max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35	
	min.	53	52	50	47	41	37	34	32	29	26	23	21	—	—	—	
25 CrMo 4 H 25 CrMoS 4 H	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31	31	
	min.	44	43	40	37	34	32	29	27	23	21	20	—	—	—	—	
34 CrMo 4 H 34 CrMoS 4 H	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	
42 CrMo 4 H 42 CrMoS 4 H	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	
50 CrMo 4 H	max.	65	65	64	64	63	63	63	62	61	60	58	57	55	54	54	
	min.	58	58	57	55	54	53	51	48	45	41	39	38	37	36	36	
38 CrNiMo 4 H	max.	59	59	58	58	57	57	57	56	55	54	53	52	51	50	49	
	min.	51	50	49	49	48	47	46	45	43	41	39	38	36	34	33	
34 CrNiMo 6 H	max.	58	58	58	58	57	57	57	57	57	57	57	57	57	57	57	
	min.	50	50	50	50	49	48	48	48	48	47	47	47	46	45	44	
30 CrNiMo 8 H	max.	56	56	56	56	55	55	55	55	55	54	54	54	54	54	54	
	min.	48	48	48	48	47	47	47	46	46	45	45	44	44	43	43	
36 NiCrMo 16 H	max.	57	56	56	56	56	56	55	55	55	55	55	55	55	55	55	
	min.	50	49	48	48	48	48	47	47	47	47	47	47	47	47	47	
51 CrV 4 H	max.	65	65	64	64	63	63	63	62	62	62	61	60	60	59	58	
	min.	57	56	56	55	53	52	50	48	44	41	37	35	34	33	32	

¹⁾ The hardenability values for the unalloyed steels are tentative and may be adjusted as more information becomes available. If the hardenability scattered for the H grade of the relevant steel of a manufacturer falls outside the limits given above, the manufacturer shall inform the purchaser accordingly at the time of ordering.

Table 6. Tentative values for the C scale Rockwell hardness for unalloyed steel grades with restricted hardenability scatter-bands (HH and HL grades)

Steel grade symbol	Distance, in mm, from the quenched end		
	1	4	5
2 C 35 HH 4, 3 C 35 HH 4 2 C 35 HH 14, 3 C 35 HH 14	— 51 to 58	34 to 53 34 to 53	— —
2 C 35 HL 4, 3 C 35 HL 4 2 C 35 HL 14, 3 C 35 HL 14	— 48 to 55	24 to 43 24 to 43	— —
2 C 40 HH 4, 3 C 40 HH 4 2 C 40 HH 14, 3 C 40 HH 14	— 54 to 60	38 to 57 38 to 57	— —
2 C 40 HL 4, 3 C 40 HL 4 2 C 40 HL 14, 3 C 40 HL 14	— 51 to 57	27 to 46 27 to 46	— —
2 C 45 HH 4, 3 C 45 HH 4 2 C 45 HH 14, 3 C 45 HH 14	— 57 to 62	41 to 60 41 to 60	— —
2 C 45 HL 4, 3 C 45 HL 4 2 C 45 HL 14, 3 C 45 HL 14	— 55 to 60	30 to 49 30 to 49	— —
2 C 50 HH 5, 3 C 50 HH 5 2 C 50 HH 15, 3 C 50 HH 15	— 58 to 63	— —	40 to 58 40 to 58
2 C 50 HL 5, 3 C 50 HL 5 2 C 50 HL 15, 3 C 50 HL 15	— 56 to 61	— —	31 to 49 31 to 49
2 C 55 HH 5, 3 C 55 HH 5 2 C 55 HH 15, 3 C 55 HH 15	— 60 to 65	— —	42 to 60 42 to 60
2 C 55 HL 5, 3 C 55 HL 5 2 C 55 HL 15, 3 C 55 HL 15	— 58 to 63	— —	33 to 51 33 to 51
2 C 60 HH 5, 3 C 60 HH 5 2 C 60 HH 15, 3 C 60 HH 15	— 62 to 67	— —	44 to 62 44 to 62
2 C 60 HL 5, 3 C 60 HL 5 2 C 60 HL 15, 3 C 60 HL 15	— 60 to 65	— —	35 to 53 35 to 53

Table 7. Limiting values for the C scale Rockwell hardness for steel with 1,30 % to 1,85 % Mn and for alloy steels, with restricted hardenability scatterbands (HH and HL grades)

Steel grade symbol	Limits of range	Distance, in mm, from the quenched end														
		Hardness, in HRC														
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
28 Mn 6 HH	max.	54	53	51	48	44	41	38	35	31	29	27	26	25	25	24
	min.	48	46	42	34	30	27	24	21	-	-	-	-	-	-	-
28 Mn 6 HL	max.	51	49	46	41	35	32	29	26	22	20	-	-	-	-	-
	min.	45	42	37	27	21	-	-	-	-	-	-	-	-	-	-
38 Cr 2 HH	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	-	-	-	-	-	-
38 CrS 2 HH	max.	56	53	48	42	37	33	31	29	26	24	21	-	-	-	-
	min.	51	46	37	29	25	22	20	-	-	-	-	-	-	-	-
46 Cr 2 HH	max.	63	61	59	57	53	47	42	39	36	33	32	31	30	29	29
	min.	57	53	46	40	36	32	29	28	25	22	21	20	-	-	-
46 CrS 2 HH	max.	60	57	53	49	45	40	36	33	31	28	27	26	25	24	24
	min.	54	49	40	32	28	25	23	22	20	-	-	-	-	-	-
34 Cr 4 HH	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
34 CrS 4 HH	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	-	-	-	-
37 Cr 4 HH	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
37 CrS 4 HH	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	-	-	-
41 Cr 4 HH	max.	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35
	min.	56	55	53	51	47	43	41	39	35	31	29	27	26	25	24
41 CrS 4 HH	max.	58	58	57	55	52	50	47	45	40	37	34	32	31	30	29
	min.	53	52	50	47	41	37	34	32	29	26	23	21	-	-	-
25 CrMo 4 HH	max.	52	52	51	50	48	46	43	41	37	35	33	32	31	31	31
	min.	47	46	44	41	39	37	34	32	28	26	24	23	22	22	22
25 CrMoS 4 HH	max.	49	49	47	46	43	41	38	36	32	30	29	28	27	27	27
	min.	44	43	40	37	34	32	29	27	23	21	20	-	-	-	-
34 CrMo 4 HH	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
34 CrMoS 4 HH	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
42 CrMo 4 HH	max.	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45
	min.	56	56	55	54	52	48	46	44	41	39	38	36	36	35	34

Table 7 (concluded).

Steel grade symbol	Limits of range	Distance, in mm, from the quenched end														
		Hardness, in HRC														
		1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
42 CrMo 4 HL	max.	58	58	58	57	56	54	53	51	49	46	44	42	41	40	40
	min.	53	53	52	51	49	43	40	37	34	32	31	30	30	29	29
42 CrMoS 4 HL	max.	65	65	64	64	63	63	63	62	61	60	58	57	55	54	54
	min.	60	60	59	58	57	56	55	53	50	47	45	44	43	42	42
50 CrMo 4 HH	max.	63	63	62	61	60	60	59	57	56	54	52	51	49	48	48
	min.	58	58	57	55	54	53	51	48	45	41	39	38	37	36	36
50 CrMo 4 HL	max.	59	59	58	58	57	57	57	56	55	54	53	52	51	50	49
	min.	54	53	52	52	51	50	50	49	47	45	44	43	41	39	38
36 CrNiMo 4 HH	max.	56	56	55	55	54	54	53	52	51	50	48	47	46	45	44
	min.	51	50	49	49	48	47	46	45	43	41	39	38	36	34	33
36 CrNiMo 4 HL	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
34 CrNiMo 6 HH	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
34 CrNiMo 6 HL	max.	56	56	56	56	55	55	55	55	55	54	54	54	54	54	54
	min.	51	51	51	51	50	50	50	49	49	48	48	47	47	47	47
30 CrNiMo 8 HH	max.	53	53	53	53	52	52	52	52	52	51	51	51	51	50	50
	min.	48	48	48	48	47	47	47	46	46	45	45	44	44	43	43
30 CrNiMo 8 HL	max.	57	56	56	56	56	56	56	55	55	55	55	55	55	55	55
	min.	52	51	51	51	51	51	51	50	50	50	50	50	50	50	50
36 NiCrMo 16 HL	max.	55	54	53	53	53	53	53	52	52	52	52	52	52	52	52
	min.	50	49	48	48	48	48	48	47	47	47	47	47	47	47	47
51 CrV 4 HH	max.	65	65	64	64	63	63	63	62	62	62	61	60	60	59	58
	min.	60	59	59	58	56	56	54	53	50	48	45	43	43	42	41
51 CrV 4 HL	max.	62	62	61	61	60	59	59	57	56	55	53	52	51	50	49
	min.	57	56	56	55	53	52	50	48	44	41	37	35	34	33	32

Table 8. Maximum hardness for products to be supplied in the 'treated to improve shearability' (TS) or 'soft annealed' (TA) condition

Steel grade ¹⁾ symbol	Max. HB in condition ²⁾		Steel grade ¹⁾ symbol	Max. HB in condition ²⁾	
	TS	TA		TS	TA
2 C 22, 3 C 22	— ³⁾	—	34 Cr 4, 34 CrS 4	255	223
2 C 25, 3 C 25	— ³⁾	—	37 Cr 4, 37 CrS 4	255	235
2 C 30, 3 C 30	— ³⁾	—	41 Cr 4, 41 CrS 4	255 ⁴⁾	241
2 C 35, 3 C 35	— ³⁾	—	25 CrMo 4, 25 CrMoS 4	255	212
2 C 40, 3 C 40	— ³⁾	—	34 CrMo 4, 34 CrMoS 4	255 ⁴⁾	223
2 C 45, 3 C 45	255 ³⁾	207	42 CrMo 4, 42 CrMoS 4	255 ⁴⁾	241
2 C 50, 3 C 50	255	217	50 CrMo 4	— ⁵⁾	248
2 C 55, 3 C 55	255 ⁴⁾	229	36 CrNiMo 4	— ⁵⁾	248
2 C 60, 3 C 60	255 ⁴⁾	241	34 CrNiMo 6	— ⁵⁾	248
28 Mn 6	255	223	30 CrNiMo 8	— ⁵⁾	248
38 Cr 2, 38 CrS 2	255	207	36 NiCrMo 16	— ⁵⁾	269
46 Cr 2, 46 CrS 2	255	223	51 CrV 4	— ⁵⁾	248

1) The values also apply for the various grades with hardenability requirements (H, HH and HL grades) covered in tables 5 to 7; see, however, footnote 4.
2) The values are not applicable to slabs which have been continuously cast and not further deformed*.
3) See 5.3.2.3.
4) Depending on the chemical composition of the cast, and on the dimensions, particularly in the case of the HH grades, soft annealing may be necessary.
5) Where the shearability is of importance, this steel should be ordered in the 'soft annealed' condition.

Table 9. Mechanical properties^{1), 2)} in the quenched and tempered condition

Steel grade symbol	Mechanical properties for the rulling sections (see annex B) with a diameter (d) or for flat products with a thickness (t) of ¹⁾																					
	$d \leq 16 \text{ mm or } t \leq 8 \text{ mm}$				$16 \text{ mm} < d \leq 40 \text{ mm or } 8 \text{ mm} < t \leq 20 \text{ mm}$				$40 \text{ mm} < d \leq 100 \text{ mm or } 20 \text{ mm} < t \leq 60 \text{ mm}$				$100 \text{ mm} < d \leq 160 \text{ mm or } 60 \text{ mm} < t \leq 100 \text{ mm}$				$160 \text{ mm} < d \leq 250 \text{ mm or } 100 \text{ mm} < t \leq 160 \text{ mm}$					
	R_c min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.		
2 C 22 3 C 22	340	500 to 650	20	50	50	280	470 to 620	22	50	50	-	-	-	-	-	-	-	-	-	-	-	
	370	550 to 700	19	45	45	320	500 to 650	21	50	45	-	-	-	-	-	-	-	-	-	-	-	
2 C 30 3 C 30	400	500 to 750	18	40	40	350	550 to 700	20	45	40	300 ²⁾	500 to 650 ²⁾	21 ³⁾	50 ³⁾	40 ³⁾	-	-	-	-	-	-	-
	430	530 to 780	17	40	35	380	600 to 750	19	45	35	320	550 to 700	20	50	35	-	-	-	-	-	-	
2 C 40 3 C 40	460	650 to 800	16	35	30	400	630 to 780	18	40	30	350	600 to 750	19	45	30	-	-	-	-	-	-	
	490	700 to 850	14	35	25	430	650 to 800	16	40	25	370	630 to 780	17	45	25	-	-	-	-	-	-	
2 C 50 3 C 50	520	750 to 900	13	30	-	460	700 to 850	15	35	-	400	650 to 800	16	40	-	-	-	-	-	-	-	
	550	800 to 950	12	30	-	490	750 to 900	14	35	-	420	700 to 850	15	40	-	-	-	-	-	-	-	
2 C 60 3 C 60	580	850 to 1000	11	25	-	520	800 to 950	13	30	-	450	750 to 900	14	35	-	-	-	-	-	-	-	
	590	800 to 950	13	40	35	490	700 to 850	15	45	40	440	650 to 800	16	50	40	-	-	-	-	-	-	

For 1) to 4), see page 18.

Table 9 (continued).

Steel grade symbol	Mechanical properties for the ruling sections (see annex B) with a diameter (d) or for flat products with a thickness (t) of ⁽¹⁾																									
	$d \leq 16 \text{ mm or } t \leq 8 \text{ mm}$				$16 \text{ mm} < d \leq 40 \text{ mm or } 8 \text{ mm} < t \leq 20 \text{ mm}$				$40 \text{ mm} < d \leq 100 \text{ mm or } 20 \text{ mm} < t \leq 60 \text{ mm}$				$100 \text{ mm} < d \leq 160 \text{ mm or } 60 \text{ mm} < t \leq 100 \text{ mm}$				$160 \text{ mm} < d \leq 250 \text{ mm or } 100 \text{ mm} < t \leq 160 \text{ mm}$									
	R_c min.	R_m	A min.	Z min.	KV min.	R_e min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.	R_c min.	R_m	A min.	Z min.	KV min.	
38 Cr 2 38 CrS 2	550	800 to 950	14	35	35	450	700 to 850	15	40	35	350	600 to 750	17	45	35	—	—	—	—	—	—	—	—	—	—	—
	650	900 to 1100	12	35	30	550	800 to 950	14	40	35	400	650 to 800	15	45	35	—	—	—	—	—	—	—	—	—	—	—
34 Cr 4 34 CrS 4	700	900 to 1100	12	35	35	580	800 to 950	14	40	40	460	700 to 850	15	45	40	—	—	—	—	—	—	—	—	—	—	—
	750	950 to 1150	11	35	30	630	850 to 1000	13	40	35	510	750 to 900	14	40	35	—	—	—	—	—	—	—	—	—	—	—
41 Cr 4 41 CrS 4	800	1000 to 1200	11	30	30	660	900 to 1100	12	35	35	560	800 to 950	14	40	35	—	—	—	—	—	—	—	—	—	—	—
	700	900 to 1100	12	50	45	600	800 to 950	14	55	50	450	700 to 850	15	60	50	400	650 to 800	16	60	45	—	—	—	—	—	
25 CrMo 4 25 CrMoS 4	800	1000 to 1200	11	45	35	650	900 to 1100	12	50	40	550	800 to 950	14	55	45	500	750 to 900	15	55	45	—	—	—	—	—	
	900	1100 to 1300	10	40	30	750	1000 to 1200	11	45	35	650	900 to 1100	12	50	35	550	800 to 950	13	50	35	—	—	—	—	—	
42 CrMo 4 42 CrMoS 4	900	1100 to 1300	9	40	30 ⁽¹⁾	780	1000 to 1200	10	45	30 ⁽¹⁾	700	900 to 1100	12	50	30 ⁽¹⁾	650	850 to 1000	13	50	30 ⁽¹⁾	—	—	—	—	—	
	900	1100 to 1300	10	45	35	800	1000 to 1200	11	50	40	700	900 to 1100	12	55	45	600	800 to 950	13	60	45	—	—	—	—	—	
36 CrNiMo 4	900	1100 to 1300	10	45	35	800	1000 to 1200	11	50	40	700	900 to 1100	12	55	45	600	800 to 950	13	60	45	—	—	—	—	—	
	900	1100 to 1300	10	45	35	800	1000 to 1200	11	50	40	700	900 to 1100	12	55	45	600	800 to 950	13	60	45	—	—	—	—	—	

For ⁽¹⁾ to ⁽³⁾, see page 18.

Table 9 (concluded).

Steel grade symbol	Mechanical properties for the rolling sections (see annex B) with a diameter (d) or for flat products with a thickness (t) of 1)																								
	$d \leq 16 \text{ mm}$ or $t \leq 8 \text{ mm}$				$16 \text{ mm} < d \leq 40 \text{ mm}$ or $8 \text{ mm} < t \leq 20 \text{ mm}$				$40 \text{ mm} < d \leq 100 \text{ mm}$ or $20 \text{ mm} < t \leq 80 \text{ mm}$				$100 \text{ mm} < d \leq 160 \text{ mm}$ or $80 \text{ mm} < t \leq 100 \text{ mm}$				$160 \text{ mm} < d \leq 250 \text{ mm}$ or $100 \text{ mm} < t \leq 160 \text{ mm}$								
	R_{eL} min.	R_m	A min.	Z min.	KV min.	R_{eL} min.	R_m	A min.	Z min.	KV min.	R_{eL} min.	R_m	A min.	Z min.	KV min.	R_{eL} min.	R_m	A min.	Z min.	KV min.	R_{eL} min.	R_m	A min.	Z min.	KV min.
34 CrNiMo 6	1000	1200 to 1400	9	40	35	900	1100 to 1300	11	50	45	600	1000 to 1200	11	50	45	700	900 to 1100	12	55	45	600	800 to 950	13	55	45
	1050	1250 to 1450	9	40	30	1050	1250 to 1450	10	45	35	800	1100 to 1300	10	45	35	800	1000 to 1200	11	50	45	700	900 to 1100	12	50	45
36 NiCrMo 16	1050	1250 to 1450	9	40	30	1050	1250 to 1450	10	45	30	900	1100 to 1300	10	45	35	800	1000 to 1200	11	50	45	800	1000 to 1200	11	50	45
	900	1100 to 1300	9	40	30 ⁴⁾	800	1000 to 1200	12	50	30 ⁴⁾	700	900 to 1100	12	50	30 ⁴⁾	650	850 to 1000	13	50	30 ⁴⁾	600	800 to 950	13	50	30 ⁴⁾

1) R_{eL} : Upper yield stress or, if no yield phenomenon occurs, the 0,2 % proof stress, $R_{p0.2}$.
 R_m : Tensile strength.

A: Percentage elongation after fracture (initial gauge length, $L_0 = 5,65 \cdot \sqrt{S_0}$; see table 12, column 7a, line T4).
 Z: Reduction in cross section on fracture.

KV: Impact strength of longitudinal ISO V-notch test pieces (average of 3 individual values; no individual value shall be lower than 70 % of the minimum average value).

2) Specifying the dimensional limits does not mean that quenching and tempering can give a martensitic structure through to the specified sample taking point. The depth of hardness results from the end quenching curves (see figures 1a to 1u).

3) Applies to diameters up to 63 mm or thicknesses up to 35 mm.

4) Tentative values.

Table 10. Mechanical properties ¹⁾ in the normalized condition

Steel grade ²⁾ symbol	For products with a diameter (d) or for flat products with a thickness (t) of								
	$d \leq 16 \text{ mm}$ $t \leq 16 \text{ mm}$			$16 \text{ mm} < d \leq 100 \text{ mm}$ $16 \text{ mm} < t \leq 100 \text{ mm}$			$100 \text{ mm} < d \leq 250 \text{ mm}$ $100 \text{ mm} < t \leq 250 \text{ mm}$		
	R_e min. N/mm ²	R_m min. N/mm ²	A min. %	R_e min. N/mm ²	R_m min. N/mm ²	A min. %	R_e min. N/mm ²	R_m min. N/mm ²	A min. %
2 C 22, 3 C 22	240	430	24	210	410	25	—	—	—
2 C 25, 3 C 25	260	470	22	230	440	23	—	—	—
2 C 30, 3 C 30	280	510	20	250	480	21	230	460	21
2 C 35, 3 C 35	300	550	18	270	520	19	245	500	19
2 C 40, 3 C 40	320	580	16	290	550	17	260	530	17
2 C 45, 3 C 45	340	620	14	305	580	16	275	560	16
2 C 50, 3 C 50	355	650	12	320	610	14	290	590	14
2 C 55, 3 C 55	370	680	11	330	640	12	300	620	12
2 C 60, 3 C 60	380	710	10	340	670	11	310	650	11
28 Mn 6	345	630	17	310	600	18	290	590	18

¹⁾ R_e : Upper yield stress or, if no yield phenomenon occurs, the 0,2 % proof stress, $R_{p0,2}$.
 R_m : Tensile strength.
 A : Percentage elongation after fracture (initial gauge length, $L_0 = 5,65 \cdot \sqrt{S_0}$; see table 12, column 7a, line T4).
²⁾ The values also apply for the various grades with hardenability requirements (H, HH, and HL grades) as specified in tables 5 to 7.

Table 11. Minimum hardness of strip in the hardened condition¹⁾

Steel grade symbol	Minimum hardness HV	Max. strip thickness mm
2 C 40	510	2
2 C 45	560	2
2 C 50	600	2
2 C 55	650	2
2 C 60	670	2
34 Cr 4	510	2
37 Cr 4	530	2
41 Cr 4	560	2
25 CrMo 4	430	2
34 CrMo 4	510	2
42 CrMo 4	560	2
50 CrMo 4	680	3
51 CrV 4	680	3

¹⁾ The values apply for the hardening temperatures given in table 13 and hardening in oil (see also footnote 3 to table 13).

Table 12. Test conditions for the verification of the requirements given in column 2

NOTE: Verification of the requirements is only necessary if an inspection certificate or an inspection report is ordered and if the requirement is applicable according to table 1, column 9 or 10. (Supplement to table 12, columns 6 and 7)

1	2	3	4	5	6	7	Line	6a	7a
No.	Requirement	Test unit 1)	Extent of testing		Sampling and sample preparation	Test method to be applied	Line	Sampling and sample preparation	Test method to be applied
			Number of products per test unit	Number of tests per product					
1	Chemical composition	C	The cast analysis is given by the manufacturer; for a possible product analysis, see clause B.6 in annex B.				T1	General conditions The general conditions for selection and preparation of test samples and test pieces for steel shall be in accordance with EURONORM 18.	
2	Hardenability	C	1	1		T2	T2	End quench hardenability test In cases of dispute, the sampling method given below shall be used, if possible: a) the test piece shall be produced by machining in the case of diameters ≤ 40 mm; b) the bar shall be reduced by forging to a diameter of 40 mm in the case of diameters > 40 and ≤ 150 mm; c) in the case of diameters > 150 mm, the test piece shall be taken so that its axis lies 20 mm below the surface. In all other cases, the sampling method including the method which starts from separately cast and subsequently hot worked test ingots or from cast and not hot worked samples is, unless otherwise agreed at the time of ordering, left to the discretion of the manufacturer.	In accordance with the EURO-NORM 23. The temperature for quenching shall comply with table 13. The hardness values shall be determined in accordance with EURONORM 4, method C.

1) The tests shall be carried out separately for each cast as indicated by 'C', for each dimension as indicated by 'D' and for each heat treatment batch as indicated by 'T'. Products of different thicknesses may be grouped if the thicknesses lie in the same dimensional range for mechanical properties and if the differences do not affect the properties.

Table 12 (continued).

1	2	3	4	5	6	7	Line	6a	7a
No.	Requirement	Test unit ¹⁾	Extent of testing Number of products per test unit	Number of tests per product	Sampling and sample preparation (See in the supplement to this table, line T1 and line ...)	Test method to be applied		Sampling and sample preparation	Test method to be applied
3	Hardness in the condition TS or TA and for strip in the hardened condition	C +D +T	1	1		T3	T3	<p>Hardness tests</p> <p>In cases of dispute, the hardness shall, where possible, be determined at the following point on the surface:</p> <p>— at a distance of 1 x diameter from one end of the bar in the case of round bars;</p> <p>— at a distance of 1 x thickness from one end and 0,25 x thickness from one longitudinal edge of the product in the case of bars with square or rectangular cross section and also in the case of flat products.</p> <p>Should it be impossible to comply with the above, e.g. in the case of hammer or drop forgings, the most appropriate position for the hardness indentations shall be agreed at the time of ordering.</p> <p>Specimen preparation shall be in accordance with EURONORM 3.</p>	As specified in EURONORM 3

For ¹⁾, see page 21.

Table 12 (concluded).

1	2	3	4	5	6	7	Line	6a	7a
No.	Requirement	Test unit ¹⁾	Extent of testing		Sampling and sample preparation	Test method to be applied		Sampling and sample preparation	Test method to be applied
	See table		Number of products per test unit	Number of tests per product	(See in the supplement to this table, line T1 and line ...)				
4	Mechanical properties of						T4	Tensile test and impact tests	
4a	quenched and tempered products	C +D +T	1	1 tensile and 3 ISO V-notch impact tests	T4a	T4a and T4b	The test pieces for tensile test, and where applicable, the ISO V-notch impact tests shall be taken as follows: — for bars and rod, in proportional accordance with figure 2; — for flat products, in accordance with figures 3 and 4; — in the case of hammer and drop forgings (see note 3 in 1.1), the test pieces shall be taken from a cross-position agreed at the time of ordering in such a way that their longitudinal axis lies in the direction of principal grain flow. The tensile test pieces shall be prepared in accordance with EN 10 002-1, and the impact test pieces, in accordance with EN 10 045-1.	In cases of dispute, the tensile test shall be carried out on proportional test pieces having an initial gauge length $L_0 = 5,65 \cdot \sqrt{S_0}$ (where S_0 is the original cross-sectional area). Where this is not possible, i.e. for flat products with a thickness of <3 mm, a test piece with constant gauge length as specified in EN 10 002-1 shall be agreed at the time of ordering. In this case, the minimum percentage elongation value to be obtained for these test pieces shall also be agreed. The impact test shall be carried out on ISO V-notch test pieces in accordance with EN 10 045-1.	
4b	products ²⁾	C +D +T	1 ²⁾	1 tensile test	T4b				

For 1), see page 21.

2) If the product is continuously heat treated, one test piece shall be taken for each 25 t or part thereof, but at least one test piece shall be taken per cast.

Table 13. Heat treatment¹⁾

Steel grade ²⁾ symbol	Hardening ^{3), 4)} °C	Quenching agent ⁵⁾	Tempering ⁶⁾ °C	End quench test °C	Normalizing ⁴⁾ °C
2 C 22, 3 C 22	860 to 900	Water	550 to 660	—	880 to 920
2 C 25, 3 C 25	860 to 900			—	880 to 920
2 C 30, 3 C 30	850 to 890			—	870 to 910
2 C 35, 3 C 35	840 to 880	Water or oil		870 ± 5	860 to 900
2 C 40, 3 C 40	830 to 870			870 ± 5	850 to 890
2 C 45, 3 C 45	820 to 860			850 ± 5	840 to 880
2 C 50, 3 C 50	810 to 850	Oil or water		850 ± 5	830 to 870
2 C 55, 3 C 55	805 to 845			830 ± 5	825 to 865
2 C 60, 3 C 60	800 to 840			830 ± 5	820 to 860
28 Mn 6	830 to 870	Water or oil	540 to 680	850 ± 5	850 to 890
38 Cr 2, 38 CrS 2	830 to 870	Oil or water	540 to 680	850 ± 5	—
46 Cr 2, 46 CrS 2	820 to 860	Oil or water	540 to 680	850 ± 5	—
34 Cr 4, 34 CrS 4	830 to 870	Water or oil	540 to 680	850 ± 5	—
37 Cr 4, 37 CrS 4	825 to 865	Oil or water	540 to 680	850 ± 5	—
41 Cr 4, 41 CrS 4	820 to 860	Oil or water	540 to 680	850 ± 5	—
25 CrMo 4, 25 CrMoS 4	840 to 880	Water or oil	540 to 680	850 ± 5	—
34 CrMo 4, 34 CrMoS 4	830 to 870	Oil or water	540 to 680	850 ± 5	—
42 CrMo 4, 42 CrMoS 4	820 to 860	Oil or water	540 to 680	850 ± 5	—
50 CrMo 4	820 to 860	Oil	540 to 680	850 ± 5	—
36 CrNiMo 4	820 to 850	Oil or water	540 to 680	850 ± 5	—
34 CrNiMo 6	830 to 860	Oil	540 to 660	850 ± 5	—
30 CrNiMo 8	830 to 860	Oil	540 to 660	850 ± 5	—
36 NiCrMo 16	865 to 885	Air or oil	550 to 650	850 ± 5	—
51 CrV 4	820 to 860	Oil	540 to 680	850 ± 5	—

1) The conditions given in this table are for guidance. However, the temperatures specified for the end quench test are mandatory.

2) This table also applies for the various grades with specified hardenability (H, HH and HL grades) covered in tables 5 to 7.

3) The temperatures at the lower end of the range are generally applicable to hardening in water and those at the upper end, for hardening in oil.

4) Austenitizing period: at least 30 min (guideline value).

5) When choosing the quenching agent, the influence of other parameters, such as shape, dimensions, and quenching temperature on properties and susceptibility to cracking should be taken into account. Other quenching agents such as synthetic quenchants may also be used.

6) Tempering period: at least 60 min (guideline value).

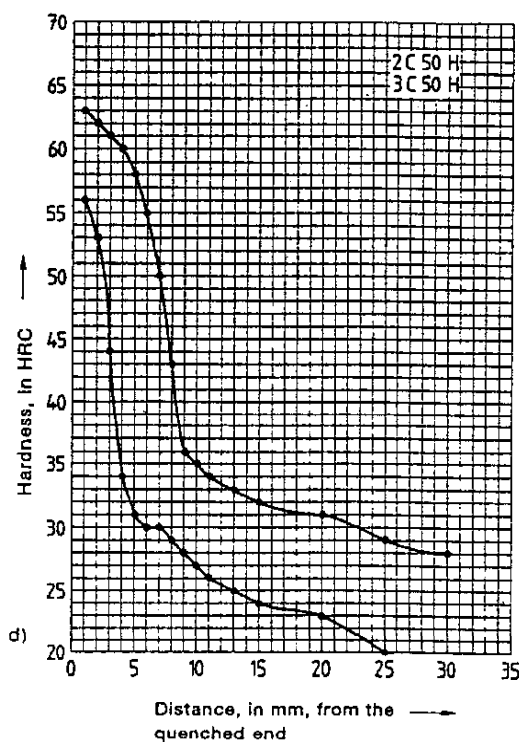
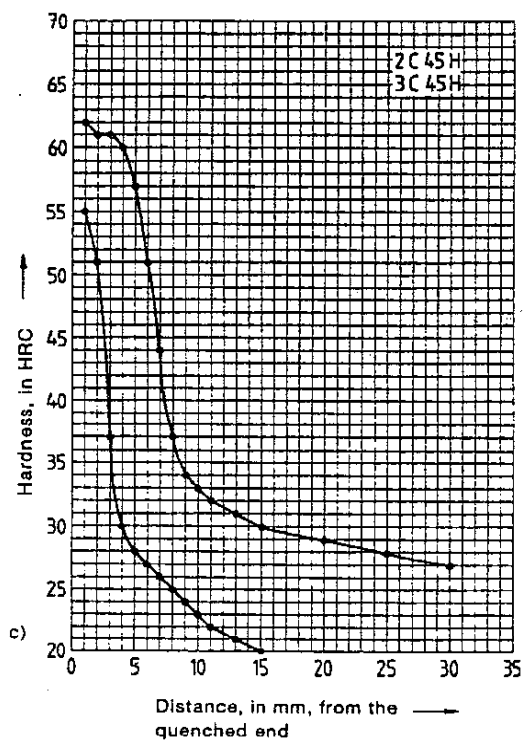
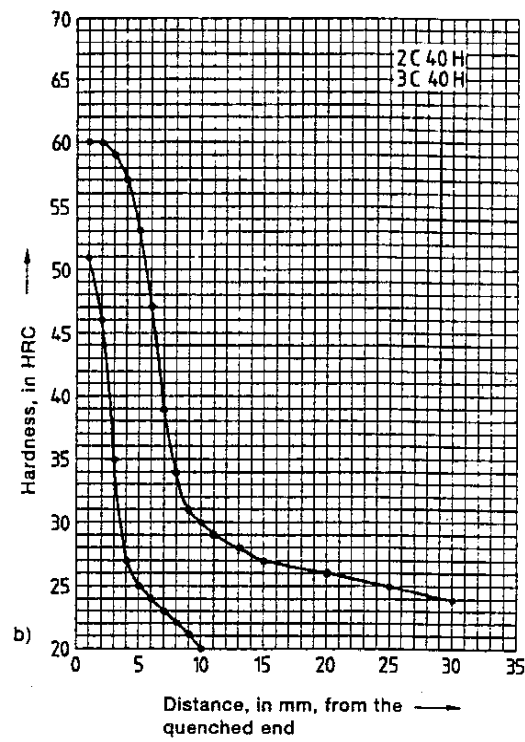
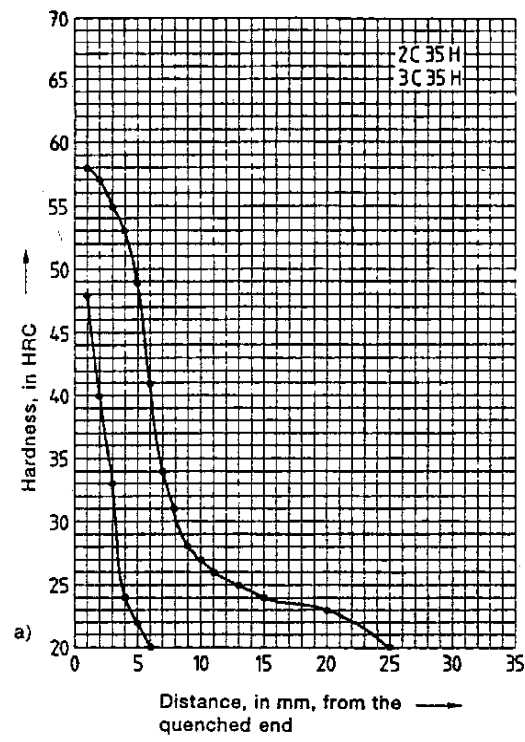
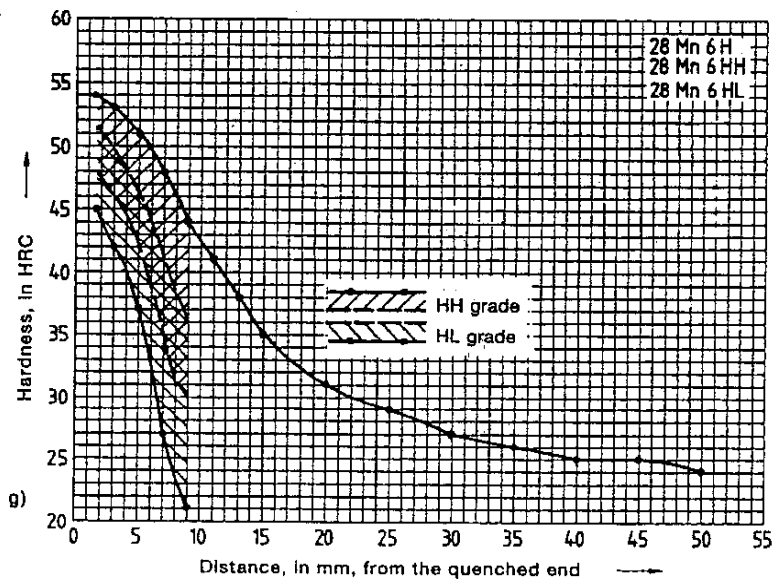
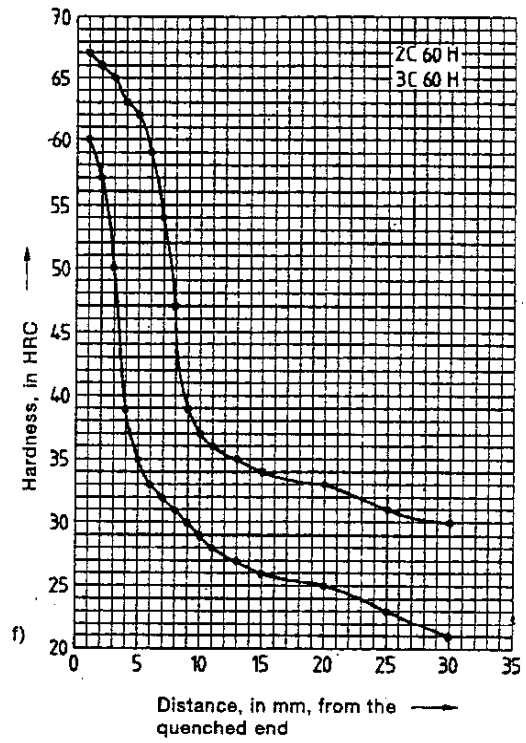
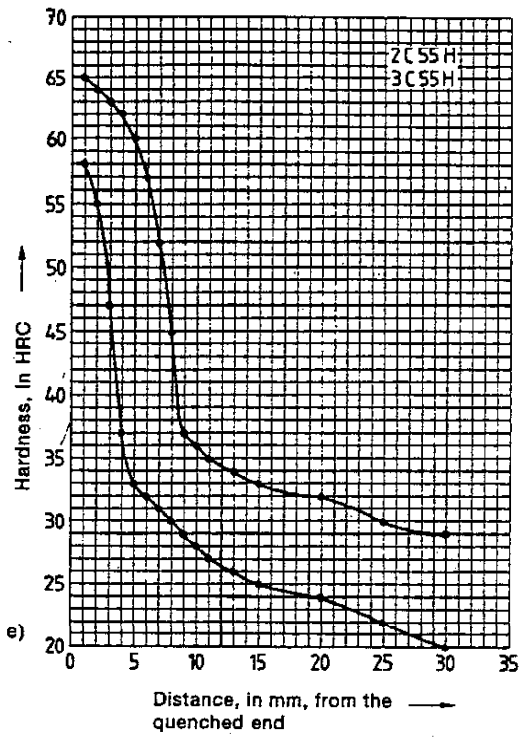
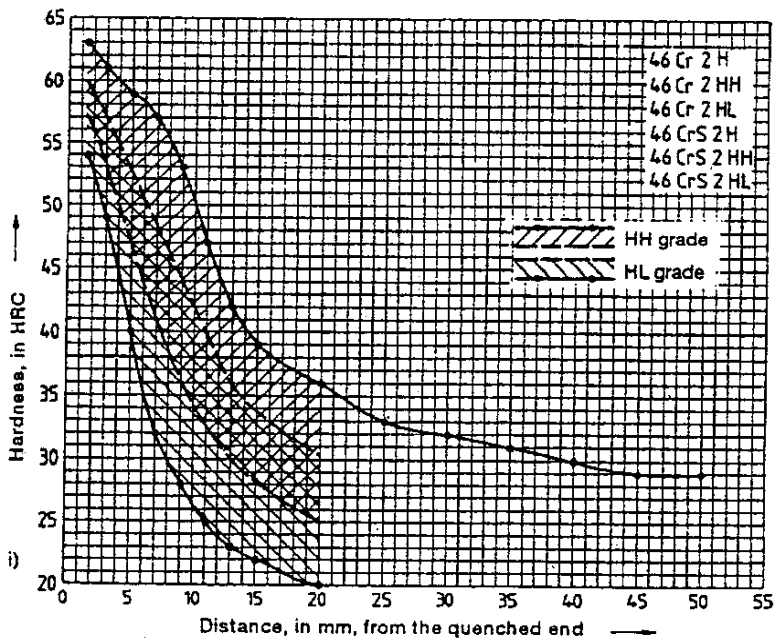
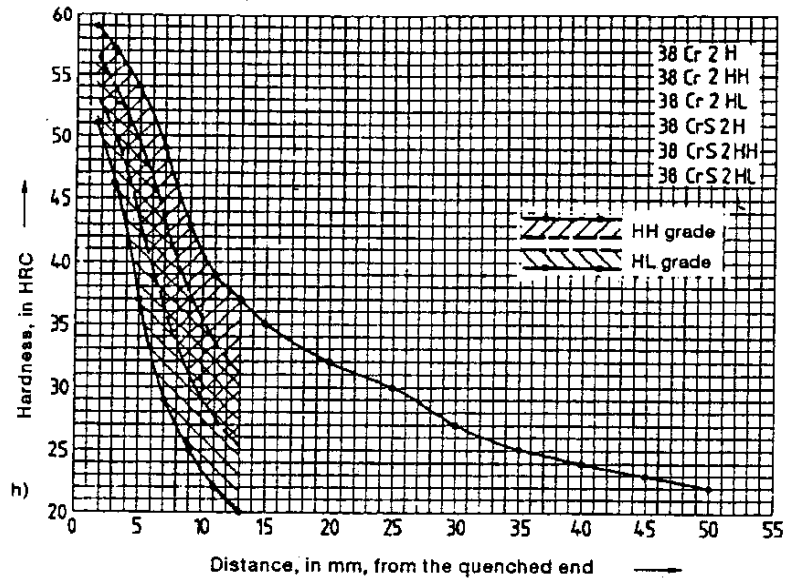
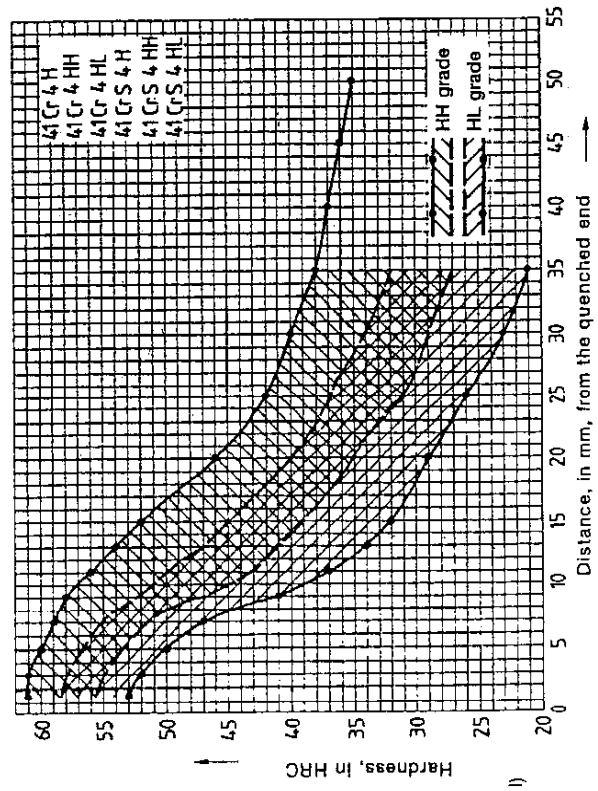
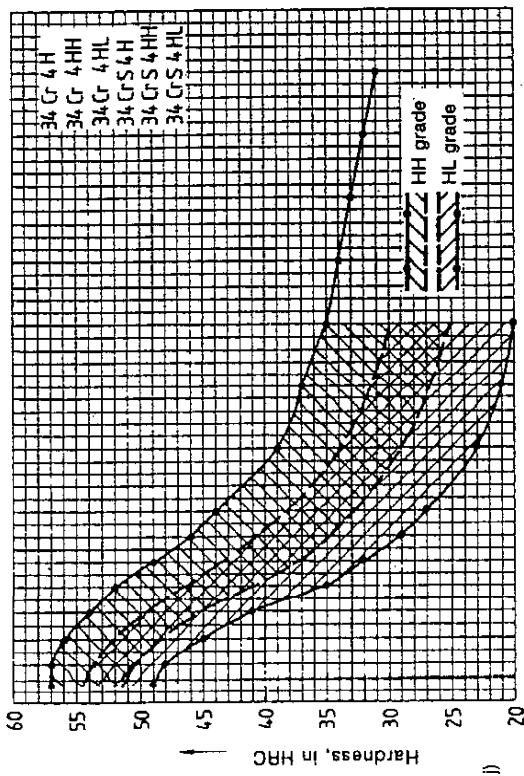
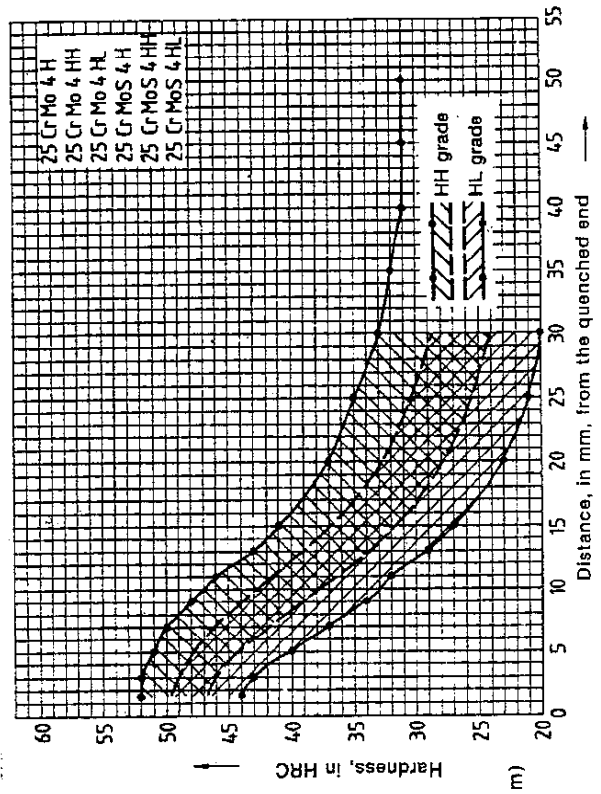
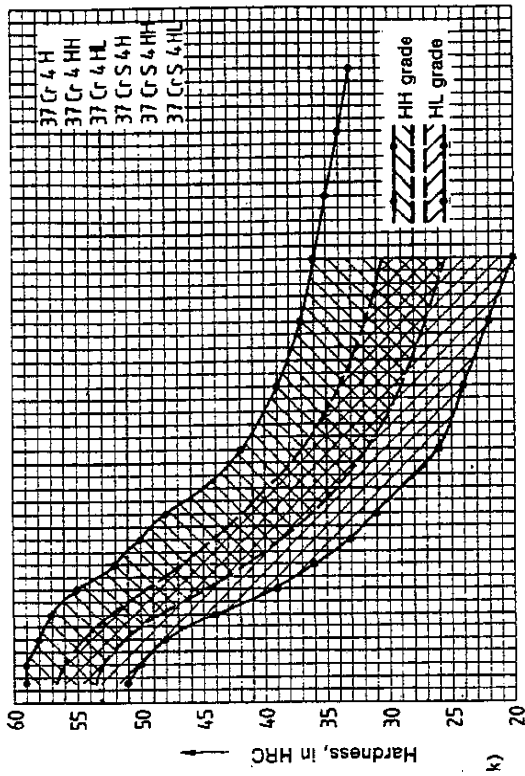
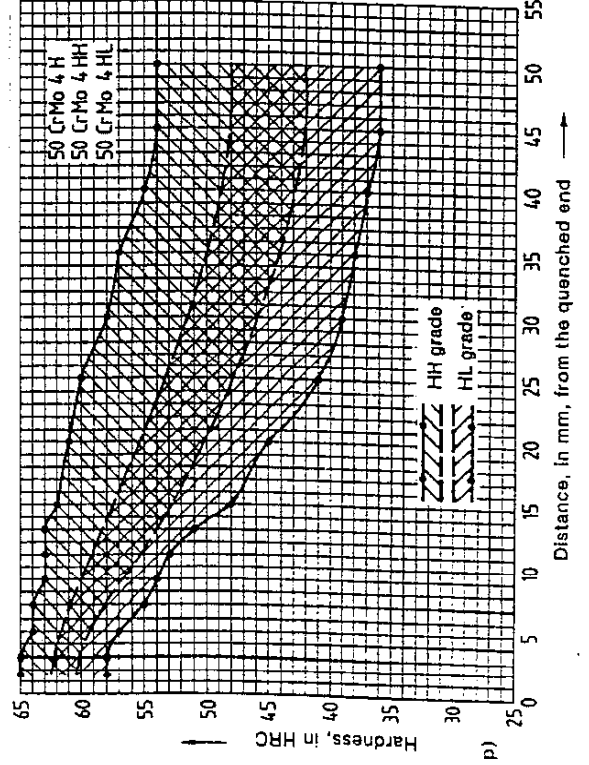
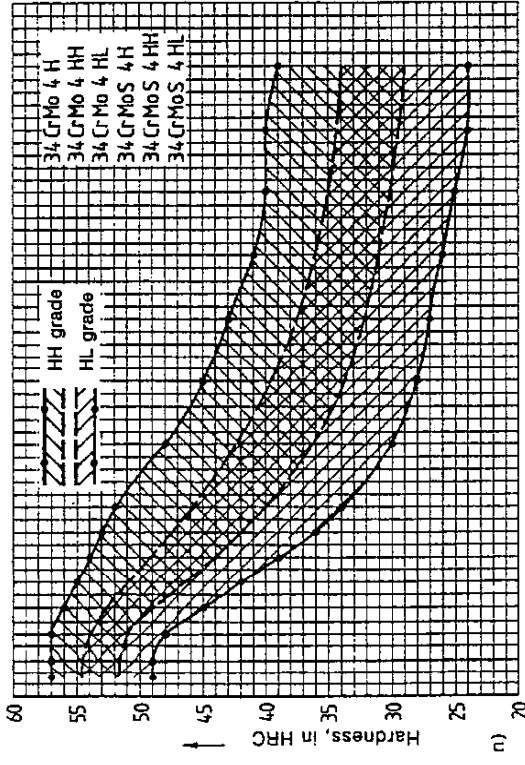
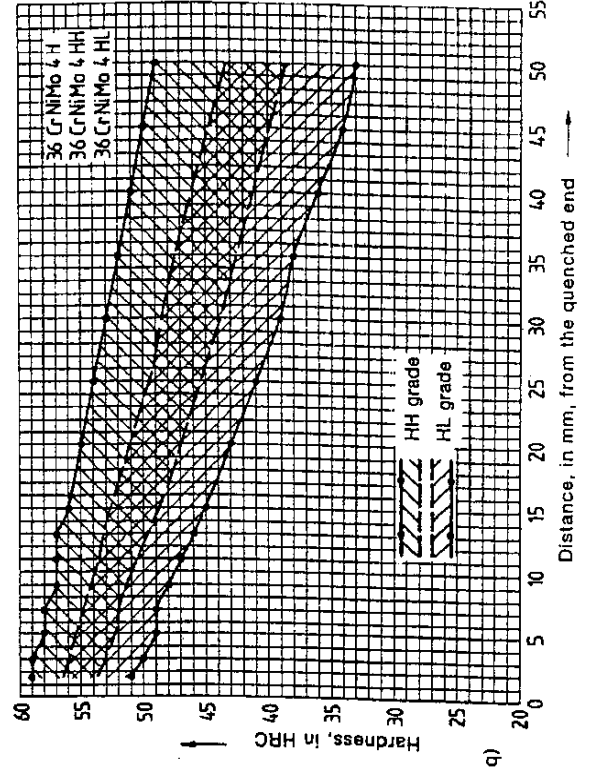
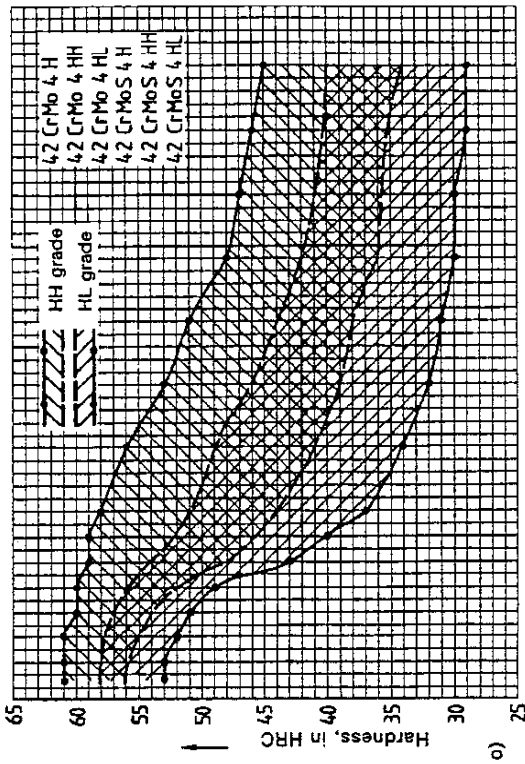


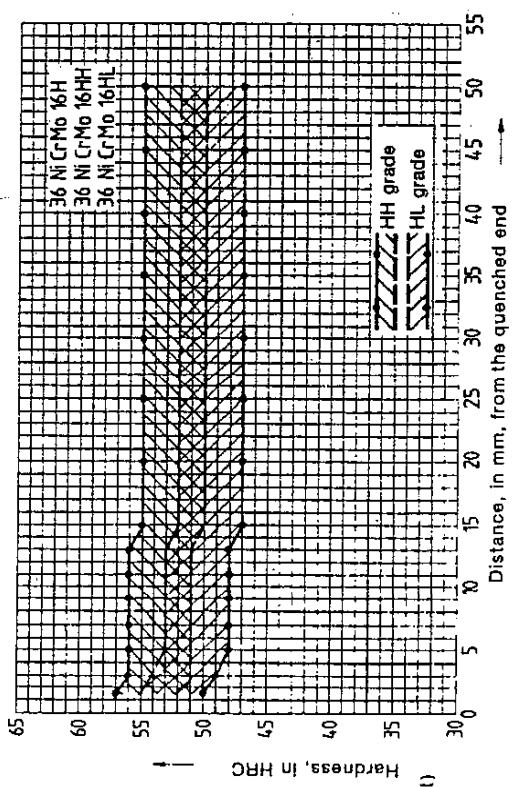
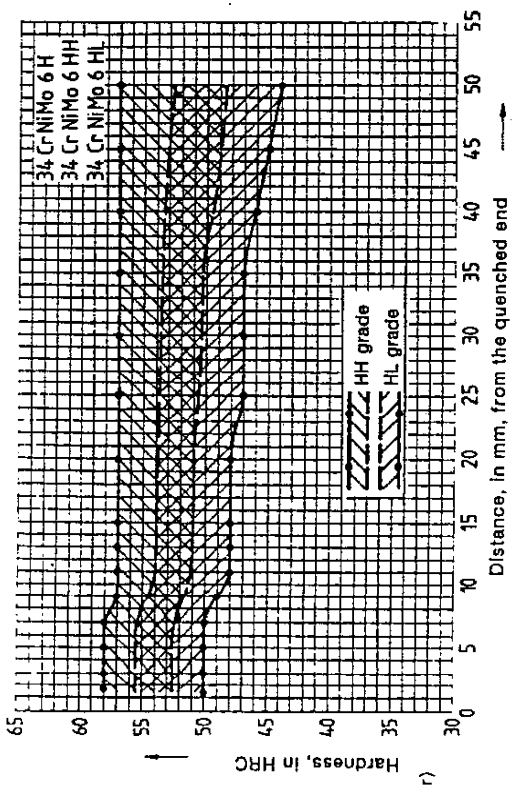
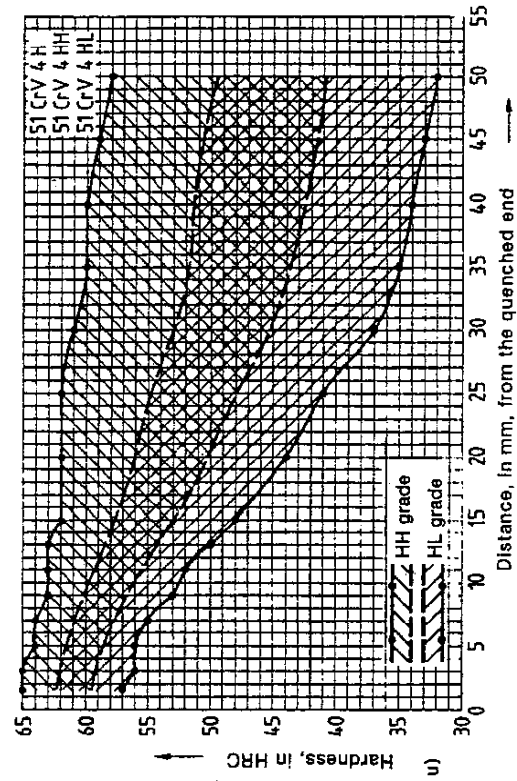
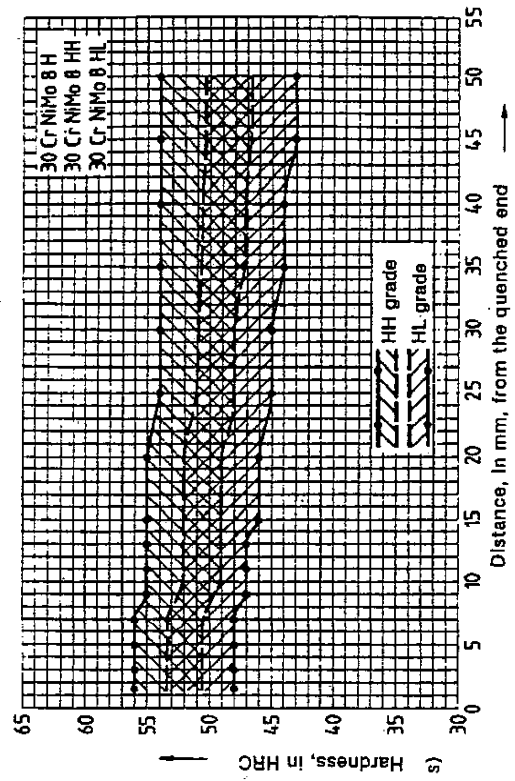
Figure 1. Scatterbands for the Rockwell C hardness in the end quench hardenability test



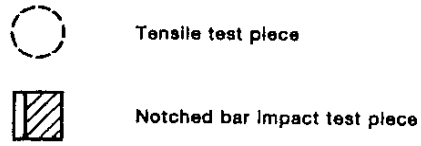




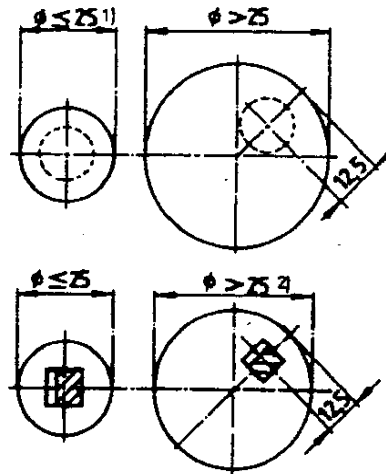




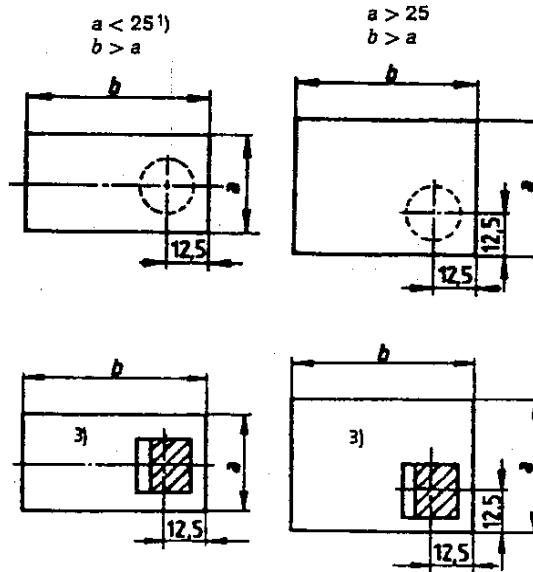
Dimensions in mm



Round and similar shaped sections

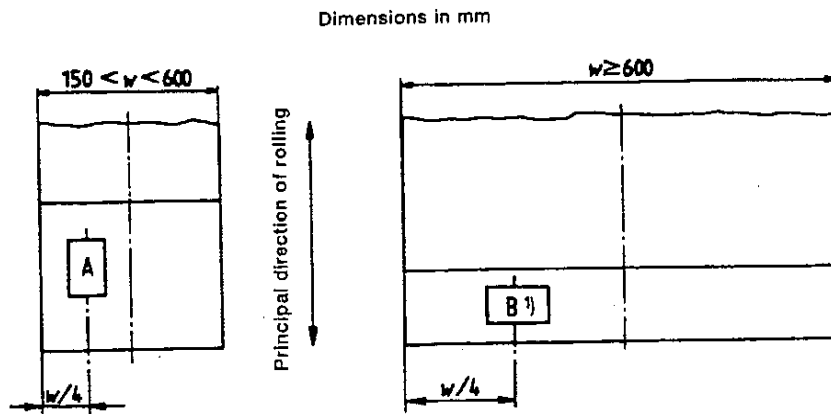


Rectangular and square sections



- 1) For small products (d or $b \leq 25$ mm), the test piece shall, if possible, consist of an unmachined part of the bar.
- 2) For round bars, the longitudinal axis of the notch shall be roughly parallel to the direction of a diameter.
- 3) For rectangular bars, the longitudinal axis of the notch shall be perpendicular to the wider rolling surface.

Figure 2. Location of the test pieces in bars and rod



1) In the case of steel grades and treatment conditions with impact energy requirements, the width of the sample shall be sufficient for longitudinal impact test pieces to be taken as specified in figure 4.

Figure 3. Location of the samples (A and B) in flat products in relation to the product width

Type of test	Product thickness	Location of the test piece ¹⁾ for a product width of		Distance of the test piece from the rolled surface
	mm	$w < 600$ mm	$w \geq 600$ mm	mm
Tensile test ²⁾	≤ 30	Longitudinal	Transverse	
	> 30			
Impact test ³⁾	> 10 ⁴⁾	Longitudinal	Longitudinal	

1) Location of the longitudinal axis of the test piece with respect to the principal rolling direction.
 2) The test piece shall comply with EN 10 002-1.
 3) The longitudinal axis of the test piece shall be perpendicular to the rolled surface.
 4) If agreed at the time of ordering, the test piece from products with a thickness exceeding 30 mm may be taken from $\frac{1}{4}$ product thickness.

Figure 4. Location of the test piece in flat products in relation to product thickness and principal direction of rolling

Annex A

(normative)

Ruling section for mechanical properties

A.1 Definition

See 3.5.

A.2 Determination of the diameter of the ruling section

A.2.1 If the test pieces are taken from products with simple cross sections and from positions with quasi two-dimensional heat flow, A.2.1.1 to A.2.1.3 shall apply.

A.2.1.1 For rounds, the nominal diameter of the product (not comprising the machining allowance) shall be taken as the diameter of the ruling section.

A.2.1.2 For hexagons and octagons, the nominal distance between two opposite sides of the cross section shall be taken as the diameter of the ruling section.

A.2.1.3 For square and rectangular bars, the diameter of the ruling section shall be determined in accordance with the example shown in figure 5.

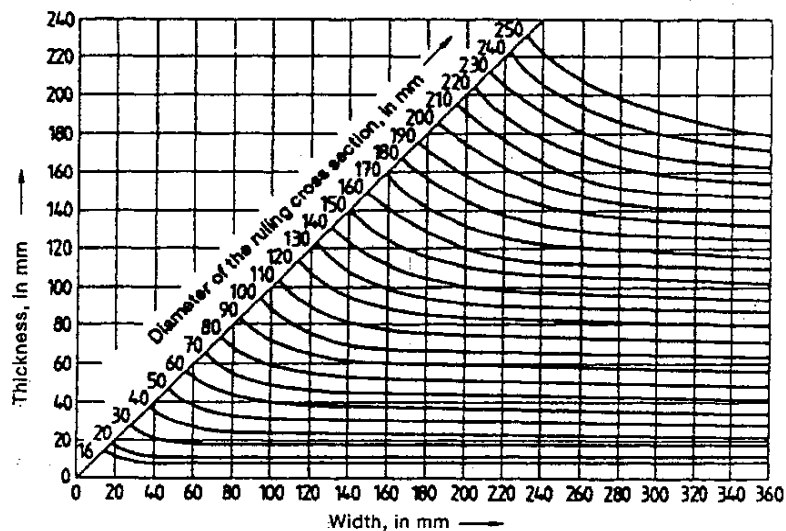
A.2.2 For other product forms, the ruling section shall be agreed at the time of ordering.

NOTE: For this purpose, the following procedure may serve as a guideline.

The product is hardened in accordance with usual practice. It is then cut so that the hardness and structure at the position of the ruling section provided for taking test pieces can be determined.

From another product of the type under consideration and of the same cast, an end quench test piece is taken from the prescribed position and tested in the usual way. Then the distance is determined at which the end quench test piece shows the same hardness and structure as the ruling section at the position provided for taking test pieces.

On the basis of this distance, the diameter of the ruling section is then estimated using figure 6.



Example:

For a rectangular bar with a section of 40 mm x 60 mm, the diameter of the ruling section is 50 mm.

Figure 5. Diameter of the ruling section for square and rectangular sections for quenching in oil or water

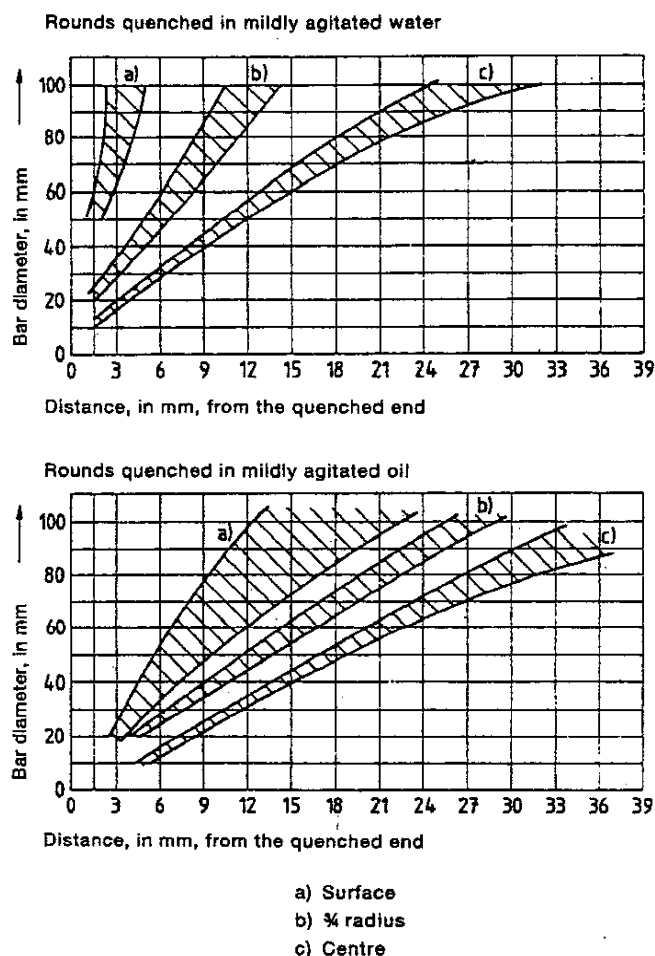


Figure 6. Relationship between the cooling rates in end quench test pieces (Jominy test pieces) and in quenched round bars

(Source: SAE J406c)

Annex B

(normative)

Supplementary or special requirements

NOTE: One or more of the following supplementary or special requirements may be applied if specified on ordering. Details of these requirements shall, where necessary, be agreed upon by the manufacturer and purchaser at the time of ordering.

B.1 Mechanical properties of reference test pieces in the quenched and tempered condition

For deliveries in a condition other than quenched and tempered or normalized, the requirements for the mechanical properties in the quenched and tempered condition shall be verified on a reference test piece.

In the case of bars and rod, the quenched and tempered sample bar shall, unless otherwise agreed, have the cross section of the product. In all other cases, the dimensions and the preparation of the sample bar shall be agreed at the time of ordering, where appropriate, taking into consideration the method for determining the ruling section given in annex A. The sample bars shall be quenched and

tempered in accordance with the conditions given in table 13 or as agreed at the time of ordering. The details of the heat treatment shall be given in the document. The test pieces shall, unless otherwise agreed, be taken in accordance with figure 2 for bars and rod and in accordance with figure 4 for flat products.

B.2 Mechanical properties of reference test pieces in the normalized condition

For deliveries of unalloyed steels in a condition other than quenched and tempered or normalized, the requirements for the mechanical properties in the normalized condition shall be verified on a reference test piece.

In the case of bars and rod, the sample bar to be normalized shall, unless otherwise agreed, have the cross section of the product. In all other cases, the dimensions and the preparation of the sample bar shall be agreed at the time of ordering.

The details of the heat treatment shall be given in the inspection document. The test pieces shall, unless otherwise agreed, be taken in accordance with figure 2 in the case of bars and rod and with figure 4 in the case of flat products.

B.3 Fine-grain steel

When tested in accordance with EURONORM 103, the steel shall have an austenitic grain size of 5 or finer. If specific testing is ordered, it shall also be agreed whether this grain size requirement is to be verified by determining the aluminium content or micrographically. In the former case, the aluminium content shall also be agreed.

In the latter case, one test piece shall be inspected per cast for the determination of the austenitic grain size. Sampling and sample preparation shall be as specified in EURONORM 103.

Unless otherwise agreed at the time of ordering, the quenched grain size shall be determined. Hardening shall be carried out under the following conditions for the purposes of determining the quenched grain size:

- for steels with a lower carbon content limit $<0,35\%$:
(880 ± 10) °C, 90 minutes/water;
- for steels with a lower carbon content limit $\geq 0,35\%$:
(850 ± 10) °C, 90 minutes/water.

In cases of dispute, pretreatment at 1150 °C for 30 minutes/air shall be carried out in order to produce a uniform starting condition.

Annex C

(informative)

Other relevant standards

EURONORMs partially covering the same or very similar steel grades as in table 3, but intended for other product forms or treatment conditions or for special applications:

EURONORM 84	Case-hardening steels; quality specifications
EURONORM 85	Nitriding steels; quality specification
EURONORM 86	Steels for flame and induction hardening; quality specifications
EURONORM 87	Free cutting steels
EURONORM 89	Alloy steels for hot-formed and heat-treated springs; quality specifications
EURONORM 119	Steels for cold heading and cold extrusion
EURONORM 132	Cold rolled steel strip for springs; technical delivery conditions

Annex D

(informative)

Dimensional standards applicable to products complying with this European Standard

For hot rolled rod:

EURONORM 17	Rod in general purpose non-alloy steel for cold drawing; dimensions and tolerances
EURONORM 108	Round steel rod for cold-stamped bolts and nuts; dimensions and tolerances

For hot rolled bars:

EURONORM 58	Hot rolled flats for general purposes
EURONORM 59	Hot rolled square bars for general purposes
EURONORM 60	Hot rolled round bars for general purposes
EURONORM 61	Hot rolled steel hexagons
EURONORM 65	Hot rolled round steel bars for screws and rivets

B.4 Non-metallic inclusions content

The microscopically determined non-metallic inclusions content shall be within agreed limits, when tested according to a procedure to be agreed at the time of ordering (see annex F).

NOTE: For steels with a specified minimum sulfur content, the agreements should only concern the oxides.

B.5 Non-destructive testing

The products shall be non-destructively tested in accordance with a method to be agreed at the time of ordering and to acceptance criteria also to be agreed at the time of ordering.

B.6 Product analysis

One product analysis shall be carried out per cast for the determination of all elements for which values are specified for the cast analysis (see table 3) of the steel grade concerned.

Sampling shall be carried out as specified in EURONORM 18. In cases of dispute, the method used shall be agreed wherever possible with reference to appropriate European Standards or EURONORMs.

B.7 Special marking

The product shall be marked in a way specially agreed at the time of ordering.

Page 36 EN 10 083 Part 1**For cold rolled flats:**

EURONORM 140 Cold rolled uncoated steel narrow strip; tolerances on dimensions, shape and mass

For hot rolled sheet strip and plate:

EN 10 029 Hot rolled steel plates 3 mm thick or above; tolerances on dimensions, shape and mass

EURONORM 48 Hot rolled narrow steel strip; tolerances on dimensions and shape

EN 10 051 Continuously hot rolled non-coated steel sheet, plate and strip of unalloyed and alloy steel with specified minimum yield strength; tolerances on dimensions and shape

EURONORM 91 Hot rolled wide flats; tolerances on dimensions, shape and mass

Annex E

(Informative)

Comparison of steel grades specified in this European Standard and ISO 683-1 : 1987 and other steel grades previously standardized nationally

EN 10 083-1	ISO 683-1:1987 ¹⁾	Germany ¹⁾		Finland	United Kingdom ¹⁾	France ¹⁾	Sweden	Spain	
		Alphanumeric name	Material number					SS steel	Name
2 C 22 3 C 22	—	(Ck 22) (Cm 22)	(1.1151) (1.1149)	—	(070M20) —	[XC 18] [XC 18 u]	—	—	—
2 C 25 3 C 25	(C 25 E4) (C 25 M2)	Ck 25 Cm 25	1.1158 1.1163	—	(070M26) —	[XC 25] [XC 25 u]	—	C25K C25K-1	F1120 F1125(1)
2 C 30 3 C 30	(C 30 E4) (C 30 M2)	Ck 30 Cm 30	1.1178 1.1179	—	(080M30) —	[XC 32] [XC 32 u]	—	—	—
2 C 35 3 C 35	(C 35 E4) (C 35 M2)	Ck 35 Cm 35	1.1181 1.1180	C 35 —	(080M36) —	[XC 38 H 1] [XC 38 H 1 u]	1572 —	C35K C35K-1	F1130 F1135(1)
2 C 40 3 C 40	(C 40 E4) (C 40 M2)	Ck 40 Cm 40	1.1186 1.1189	—	(080M40) —	[XC 42 H 1] [XC 42 H 1 u]	—	—	—
2 C 45 3 C 45	(C 45 E4) (C 45 M2)	Ck 45 Cm 45	1.1191 1.1201	C 45 —	(080M46) —	[XC 48 H 1] [XC 48 H 1 u]	1672 —	C45K C45K-1	F1140 F1145(1)
2 C 50 3 C 50	(C 50 E4) (C 50 M2)	Ck 50 Cm 50	1.1206 1.1241	—	(080M50) —	—	1674 —	—	—
2 C 55 3 C 55	(C 55 E4) (C 55 M2)	Ck 55 Cm 55	1.1203 1.1209	—	(070M55) —	[XC 55 H 1] [XC 55 H 1 u]	—	C55K C55K-1	F1150 F1155(1)
2 C 60 3 C 60	(C 60 E4) (C 60 M2)	Ck 60 Cm 60	1.1221 1.1223	—	(070M60) —	—	—	—	—
28 Mn 6	(28 Mn 6)	28 Mn 6	1.1170	—	(150M19)	—	—	—	—
38 Cr 2 38 CrS 2	—	38 Cr 2 38 CrS 2	1.7003 1.7023	—	—	(38 C 2) (38 C 2 u)	—	—	—
46 Cr 2 46 CrS 2	—	46 Cr 2 46 CrS 2	1.7006 1.7025	—	—	—	—	—	—
34 Cr 4 34 CrS 4	34 Cr 4 34 CrS 4	34 Cr 4 34 CrS 4	1.7033 1.7037	—	(530M32) —	(32 C 4) (32 C 4 u)	—	—	—
37 Cr 4 37 CrS 4	37 Cr 4 37 CrS 4	37 Cr 4 37 CrS 4	1.7034 1.7038	—	(530M36) —	(38 C 4) (38 C 4 u)	—	38Cr4 38Cr4-1	F1201 F1206(1)
41 Cr 4 41 CrS 4	41 Cr 4 41 CrS 4	41 Cr 4 41 CrS 4	1.7035 1.7039	—	(530M40) —	42 C 4 42 C 4 u	— 2245	42Cr4 42Cr4-1	F1202 F1207(1)
25 CrMo 4 25 CrMoS 4	25 CrMo 4 25 CrMoS 4	25 CrMo 4 25 CrMoS 4	1.7218 1.7213	25 CrMo 4 —	(708M25) —	25 CD 4 25 CD 4 u	2225 —	—	—
34 CrMo 4 34 CrMoS 4	34 CrMo 4 34 CrMoS 4	34 CrMo 4 34 CrMoS 4	1.7220 1.7226	34 CrMo 4 —	(708M32) —	(34 CD 4) (34 CD 3 u)	2234 —	—	—
42 CrMo 4 42 CrMoS 4	42 CrMo 4 42 CrMoS 4	42 CrMo 4 42 CrMoS 4	1.7225 1.7227	42 CrMo 4 —	(708M40) —	42 CD 4 42 CD 4 u	2244 —	40CrMo4 40CrMo4-1	F1252 F1257(1)
50 CrMo 4	50 CrMo 4	50 CrMo 4	1.7228	—	(708M50)	—	—	—	—
36 CrNiMo 4	36 CrNiMo 4	36 CrNiMo 4	1.6511	—	(817M37)	—	—	—	—
34 CrNiMo 6	(36 CrNiMo 6)	(34 CrNiMo 6)	(1.6582)	34 CrNiMo 6	(817M40)	—	2541	—	—
30 CrNiMo 8	(31 CrNiMo 8)	30 CrNiMo 8	1.6580	—	[823M30]	30 CND 8	—	—	—
36 NiCrMo 16	—	—	—	—	[835M30]	35 NCD 16	—	—	—
51 CrV 4	[51 CrV 4]	50 CrV 4	1.8159	—	[735A50]	(50 CV 4)	—	51CrV4	F1430

¹⁾ If a steel grade is given in round brackets, this means that the chemical composition differs only slightly from EN 10 083-1. If it is given in square brackets, this means that greater differences exist in the chemical composition compared with EN 10 083-1. If there are no brackets around the steel grade, this means that there are practically no differences in the chemical composition compared with EN 10 083-1.

Annex F

(normative)

Determining the non-metallic inclusions content

F.1 At the time of publication of this European Standard, no standardized test method exists in Europe for the microscopic determination of non-metallic inclusions in special steels. However, several national test methods have been standardized. Until the European Standard is published, agreement may be reached at the time of ordering on a test in accordance with one of the following national standards:

DIN 50 602 Metallographic examination; microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions

NF A 04-106 Iron and steel; methods for the determination of the non-metallic inclusion content of steel. Part 2: Microscopic methods with standard series

NOTE: ISO 4967:1979, Steel — Determination of non-metallic inclusions — Micrographic method using standard diagrams, is identical to NF A 04-106.

SS 11 11 16 Steel — Methods for determining non-metallic inclusions content — Microscopic method — Jernkontoret's inclusion table 2 for determining non-metallic inclusions

F.2 The following requirements are applicable.

F.2.1 If proof is given in accordance with DIN 50 602, the requirements specified in table 14 apply.

Table 14. Requirements for microscopic degree of purity when tested in accordance with DIN 50 602 (method K) (applicable to oxidic non-metallic inclusions)

Bar diameter, d , in mm	Total characteristic value K (oxides) for the individual cast
$140 < d \leq 200$	$K 4 \leq 50$
$100 < d \leq 140$	$K 4 \leq 45$
$70 < d \leq 100$	$K 4 \leq 40$
$35 < d \leq 70$	$K 4 \leq 35$
$17 < d \leq 35$	$K 3 \leq 40$
$8 < d \leq 17$	$K 3 \leq 30$
$d \leq 8$	$K 2 \leq 35$

F.2.2 If proof is given in accordance with NF A 04-106, the requirements specified in table 15 apply.

Table 15. Requirements of microscopic degree of purity when tested in accordance with NF A 04-106

Inclusion type	Series	Limiting value
Type B	Fine	$\leq 2,5$
	Thick	≤ 1
Type C	Fine	$\leq 0,5$
	Thick	$\leq 0,5$
Type D	Fine	$\leq 1,5$
	Thick	$\leq 0,5$

F.2.3 If proof is given in accordance with SS 11 11 16, the requirements specified in table 16 apply.

Table 16. Requirements of microscopic degree of purity when tested in accordance with SS 11 11 16

Inclusion type	Series	Limiting value
Type B	Fine	≤ 4
	Middle	≤ 3
	Thick	≤ 2
Type C	Fine	≤ 4
	Middle	≤ 3
	Thick	≤ 2
Type D	Fine	≤ 4
	Middle	≤ 2
	Thick	≤ 1