UDC 669.14.018.298.3 : 620.1

October 1991

Quenched and tempered steels

Technical delivery conditions for unalloyed quality steels

English version of DIN EN 10 083 Part 2

DIN
EN 10083
Part 2

Vergütungsstähle; technische Lieferbedingungen für unlegierte Qualitätsstähle

This standard, together with DIN EN 10 083 Part 1, October 1991 edition, supersedes DIN 17 200, March 1987 edition.

European Standard EN 10 083-2 : 1991 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 23.

The responsible German body involved in the preparation of this standard was the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee), Technical Committee 05 *Maschinenbaustähle*.

Besides the principle amendments made to that draft, as listed on page 2, the following should be noted.

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.

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.

Note. Part 2 of EN 10 027 will cover material designations and numbers.

c) The DIN Standards corresponding to the European Standards (or EURONORMs) referred to in clause 2 of the EN are as follows:

European Standard/ EURONORM	DIN Standard
EN 10 002-1	DIN EN 10 002 Part 1
EN 10 020	DIN EN 10 020
EN 10 083-1	DIN EN 10 083 Part 1
EN 10 204	DIN 50 049
EURONORM 3	DIN 50 351
EURONORM 21	DIN EN 10 021 (at present at the stage of draft)
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 163	DIN EN 10 163 Parts 1 und 2

Continued on pages 2 and 3.
EN comprises 16 pages.

Standards referred to

(and not included in **Normative references**)

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 50 351	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) The specifications relating to the chemical composition have been amended in some cases.

c) 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.

d) Some specifications for maximum hardness in the soft annealed condition have been amended.

e) Some specifications for mechanical properties of steel in the quenched and tempered condition have been amended.

f) Details of test piece location and the ruling section have been amended.

g) Table 13 showing minimum yield strength values of steels in their quenched and tempered condition is no longer included.

h) 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.

i) The specimen designation (cf. subclause 4.1) has been changed.

j) The specifications relating to surface quality have been amended.

k) The specifications relating to surface finish are now given in tabular form.

l) Besides a number of other editorial changes, 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 38/18

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 10 083-2 as issued by CEN. In its preparation for publication as DIN EN 10 083 Part 2 (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 *To complete the sense of note 4 to clause 1, 'Jominy test' is to be substituted for 'Jominy'.*

2 *Re note 1 to subclause 5.6.3: EN 10 163 Parts 1 and 2 are now available.*

3 *'Shape tolerances' has been used throughout instead of the common technical term 'form tolerances' (cf. ISO 1101).*

4 *The heading of clause 6 should preferably read 'Inspection and testing for conformity...'.*

5 *In subclause 6.1.1, third sentence, 'test report' should be substituted for 'works test certificate' (cf. EN 10 204).*

6 *In subclause 6.1.3, first sentence, 'inspection certificate' should be substituted for 'inspection document'.*

7 *In note 1 to table 5, 'deformed' should preferably read 'worked'.*

8 *In table 9, column 1, '3a' has been substituted here for '34' and '3b' for '35'.*

9 *In table 9, line T2, column 6a, the 3rd paragraph differs in substance from the German version (cf. DIN EN 10 083-1, p.22).*

10 *To complete the sense of note 1 to table 9, 'differences' in the last line must be substituted for 'thicknesses'.*

11 *In table 10, 'quenching agent' should be substituted for 'hardening medium' (cf. EN 10 083-1).*

12 *In note 1 to the table following figure 2, 'axis' is to be substituted for 'access'.*

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10083-1

February 1991

UDC 669.14.018.298.3 : 260.1

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

English version

Quenched and tempered steels

Part 2: Technical delivery conditions for unalloyed quality steels

Aciers pour trempe et revenu; Partie 2: Conditions techniques de livraison des aciers de qualité non alliés

Vergütungsstähle; Teil 2: Technische Lieferbedingungen für unlegierte Qualitätsstähle

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.

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CEN

European Committee for Standardization

Comité Européen de Normalisation

Europäisches Komitee für Normung

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

Ref. No. EN 10 083-2 : 1991 E

Contents

Foreword

This European Standard has been prepared by ECISS/TC 23 '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, with a European Standard.

The discussions within ECISS/TC 23 were based on International Standard ISO 683-1 : 1987, Heat-treatable steels, alloy steels and free-cutting steels. 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 2 and 3),

— bars (see note 2),

— rod,

— wide flats,

— hot or cold rolled sheet/plate and strip,

— hammer and drop forgings (see note 2),

manufactured from the direct hardening unalloyed steels (see note 4) 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 machine parts, but are partly (see table 7) also used in the normalized condition.

The requirements for mechanical properties given in this European Standard are restricted to the sizes given in tables 6 and 7.

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: 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 3: Special agreements shall be made when ordering unworked+) continuously cast semi-finished products.

NOTE 4: In accordance with EN 10 020, the steels covered by this European Standard are unalloyed quality steels. Unalloyed and alloy special steels are standardized in EN 10 083-1. The differences between quality steels and special steels are

— no minimum impact values are specified;

— no hardenability requirements in the Jominy+);

— the oxidic inclusions content is not limited;

— the maximum phosphorus and sulfur contents are higher.

NOTE 5: A standard on boron steels for quenching and tempering is being prepared as Part 3 of EN 10 083.

1.2 In special cases, deviations from or supplements to these technical delivery conditions may be agreed 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 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 52[1)]	Vocabulary of heat treatment terms for ferrous products
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 163[1)]	Delivery conditions for the surface finish of hot rolled plates and wide flats
EN 10 002-1	Metallic materials; Tensile testing. Part 1: Method of test at ambient temperature
EN 10 020	Definition and classification of grades of steel
EN 10 083-1	Quenched and tempered steels. Part 1: Technical delivery conditions for special steels
EN 10 204	Metallic materials; types of inspection documents

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 the 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 designation of the heat treatment condition (see table 1).

EXAMPLE:

Steel EN 10 083 — 1 C 45 — TN

NOTE: European Standards are being prepared on the formation of alphanumeric and numbering systems for the designation of steels. Until the publication of these European Standards, the previous national designations listed in annex E may be used instead of the symbols used in EN 10 083-2; if these previous national designations are used, the corresponding grade specified in EN 10 083-2 will automatically be supplied. After publication of the European Standards on the formation of symbols and designations, EN 10 083-2 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.

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 and mechanical properties

5.2.1 The requirements given in table 1, column 9, shall apply for each heat treatment.

5.2.2 The mechanical property values given in tables 6 and 7 shall apply to specimens in the 'quenched and tempered' and 'normalized' heat treatment conditions, which have been taken and prepared in accordance with figures 1 or 2 and 3 in table 9 (see also footnote 1 to table 1).

5.3 Technological properties

5.3.1 Machinability

All steels are machinable in the 'soft-annealed' condition (see also table 1, line 7, and table 3, footnote 2).

[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.

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 in the normalized condition.

5.3.2.2 Steel grades 1 C 45 to 1 C 60 are also shearable under suitable conditions if they are supplied in the 'treated for shearability' condition with the hardness requirements as specified in table 5.

5.3.2.3 Steel grades 1 C 22 to 1 C 40 are, under suitable conditions, shearable in the untreated condition.

Shearability may also be assumed for steel grade 1 C 45 with dimensions greater than 80 mm and in the untreated condition.

5.4 Structure

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.

5.5 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.4).

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 upon 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 is to be transformed into an European Standard and will then also contain requirements for the surface quality of sectional products.+)

NOTE 2: 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 If suitability of bars and rod for bright drawing is required, this shall be agreed at the time of ordering.

5.6.5 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 test certificate shall be agreed at the time of ordering. If the order does not contain any specification of this type, a test certificate+) 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 document+), or an inspection report is to be provided, the specific inspection described in 6.2 shall be carried out and its 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 hardness and mechanical properties

6.2.1.1 With the following exception, the hardness requirements or mechanical properties given for the relevant heat treatment condition in table 1, column 9.2, shall be verified. The requirement given in footnote 1 to table 1 (mechanical properties of reference test pieces) shall only 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 8 up to maximum thickness given in table 8, the hardness in the hardened condition shall be verified.

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 9.

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.6.)

Table 1. **Combinations of usual heat treatment conditions at delivery, product forms and requirements as specified in tables 3 to 8**

1	2	3	4	5	6	7	8	9		
1	Heat treatment condition at delivery	Symbol *)	x indicates applicable for					Applicable requirements		
			semi-finished products	bars	rod	flat products	hammer and drop forgings	9.1	9.2	
2	Untreated	None or TU	x	x	x	x	x	Chemical composition according to tables 3 and 4	– [1),2)]	
3	Treated to improve shearability	TS	x	x	–	–	–		Maximum hardness according to	table 5, column TS [1)]
4	Soft annealed	TA	x	x	x	x [3)]	x			table 5, column TA [1), 2)]
5	Normalized [4)]	TN [4)]	–	x	–	x [3)]	x		Mechanical properties according to	table 7
6	Quenched and tempered [5)]	TQ + T	–	x	x	x [3)]	x			table 6
7	Others	Other treatment conditions, e.g. certain annealing conditions to achieve a certain structure, may be agreed at the time of ordering.								

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

1) For deliveries in the untreated condition and in the 'treated to improve shearability' and 'soft annealed' conditions, the mechanical properties specified in tables 6 and 7 shall be achievable for the ruling end cross section after appropriate treatment (for information on reference test pieces, see annex B, clauses B.1 and B.2).

2) For deliveries of strip made of steel grades listed in table 8 up to the maximum thicknesses given in table 8, the hardness shall also be verified in the hardened condition.

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

4) Normalizing may be replaced by normalizing forming.

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 2 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	Unworked, 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]								
	C[3]	Si max.	Mn	P max.	S max.	Cr max.	Mo max.	Ni max.	Cr + Mo + Ni max.[3]
1 C 22	0,17 to 0,24	0,40	0,40 to 0,70	0,045	0,045	0,40	0,10	0,40	0,63
(1 C 25)[4]	0,22 to 0,29	0,40	0,40 to 0,70	0,045	0,045	0,40	0,10	0,40	0,63
(1 C 30)[4]	0,27 to 0,34	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63
1 C 35	0,32 to 0,39	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63
(1 C 40)[4]	0,37 to 0,44	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63
1 C 45	0,42 to 0,50	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63
(1 C 50)[4]	0,47 to 0,55	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63
(1 C 55)[4]	0,52 to 0,60	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63
1 C 60	0,57 to 0,65	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63

1) Elements not quoted in this table 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 measures 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) Steels with improved machinability as a result of the addition of lead or higher sulfur contents up to around 0,100 % S (including controlled sulfide and oxide formation, e.g. Ca treatment), may be supplied on request.

3) If the steels are ordered without mechanical property requirements in the quenched and tempered or normalized condition, a restriction in the carbon range to 0,05 % and/or of the total sum of the elements Cr, Mo and Ni to ≤0,45 % may be agreed at the time of ordering.

4) 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 he 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	≤0,55 >0,55 ≤0,65	±0,02 ±0,03
Si	≤0,40	+0,03
Mn	≤0,90	±0,04
P	≤0,045	+0,005
S	≤0,045	+0,005
Cr	≤0,40	+0,05
Mo	≤0,10	+0,03
Ni	≤0,40	+0,05

1) ± means that, in one cast, the deviation may occur over the upper value or under the lower value of the specified range in table 3, but not both at the same time.

Table 5. **Maximum hardness for products to be supplied in the 'treated to improve shearability' (TS) or 'soft annealed' (TA) conditions**

Steel grade symbol	HB max. in condition[1]	
	TS	TA
1 C 22	–[2]	–
1 C 25	–[2]	–
1 C 30	–[2]	–
1 C 35	–[2]	–
1 C 40	–[2]	–
1 C 45	255[2]	207
1 C 50	255	217
1 C 55	255[3]	229
1 C 60	255[3]	241

1) The values are not applicable to slabs which have been continuously cast and not further deformed+).

2) See 5.3.2.3.

3) Soft annealing may be necessary as a function of the chemical composition of the cast and of the dimension.

Table 6. **Mechanical properties[1],[2] in the quenched and tempered condition**

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											
	$d \leq 16$ mm or $t \leq 8$ mm				16 mm $< d \leq$ 40 mm or 8 mm $< t \leq$ 20 mm				40 mm $< d \leq$ 100 mm or 20 mm $< t \leq$ 60 mm			
	R_e min.	R_m	A min.	Z min.	R_e min.	R_m	A min.	Z min.	R_e min.	R_m	A min.	Z min.
	N/mm²		%	%	N/mm²		%	%	N/mm²		%	%
1 C 22	340	500 to 650	20	50	290	470 to 620	22	50	–	–	–	–
1 C 25	370	550 to 700	19	45	320	500 to 650	21	50	–	–	–	–
1 C 30	400	600 to 750	18	40	350	550 to 700	20	45	300[3]	500 to 650[3]	21[3]	50[3]
1 C 35	430	630 to 780	17	40	380	600 to 750	19	45	320	550 to 700	20	50
1 C 40	460	650 to 800	16	35	400	630 to 780	18	40	350	600 to 750	19	45
1 C 45	490	700 to 850	14	35	430	650 to 800	16	40	370	630 to 780	17	45
1 C 50	520	750 to 900	13	30	460	700 to 850	15	35	400	650 to 800	16	40
1 C 55	550	800 to 950	12	30	490	750 to 900	14	35	420	700 to 850	15	40
1 C 60	580	850 to 1000	11	25	520	800 to 950	13	30	450	750 to 900	14	35

[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 9, column 7a, line T3).
Z: Reduction in cross section on fracture.

[2] Specifying the dimensional limits does not mean that quenching and tempering can produce a martensitic structure through to the specified sample taking point.

[3] Applicable to diameters up to 63 mm or thicknesses up to 35 mm.

Table 7. **Mechanical properties [1] in the normalized condition**

Steel grade symbol	For products with a diameter (d) or for flat products with a thickness (t) of								
	$d \leq 16$ mm $t \leq 16$ mm			16 mm $< d \leq$ 100 mm 16 mm $< t \leq$ 100 mm			100 mm $< d \leq$ 250 mm 100 mm $< t \leq$ 250 mm		
	R_e min. N/mm²	R_m min. N/mm²	A min. %	R_e min. N/mm²	R_m min. N/mm²	A min. %	R_e min. N/mm²	R_m min. N/mm²	A min. %
1 C 22	240	430	24	210	410	25	–	–	–
1 C 25	260	470	22	230	440	23	–	–	–
1 C 30	280	510	20	250	480	21	230	460	21
1 C 35	300	550	18	270	520	19	245	500	19
1 C 40	320	580	16	290	550	17	260	530	17
1 C 45	340	620	14	305	580	16	275	560	16
1 C 50	355	650	12	320	610	14	290	590	14
1 C 55	370	680	11	330	640	12	300	620	12
1 C 60	380	710	10	340	670	11	310	650	11

[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 9, column 7a, line T3).

Table 8. **Minimum hardness of strip in the hardened condition[1]**

Steel grade symbol	Minimum hardness HV	Max. strip thickness mm
1 C 40	510	2
1 C 45	560	2
1 C 50	600	2
1 C 55	650	2
1 C 60	670	2

[1] The values apply for the hardening temperatures given in table 10 and quenching in oil (see also footnote 2 to table 10).

Table 9. **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.

(Supplement to table 9, columns 6 and 7)

1	2		3	4	5	6	7	Line	6a Sampling and sample preparation	7a Test method to be applied
No.	Requirement	See table	Test unit [1]	Extent of testing: Number of products per test unit	Extent of testing: Number of tests per product	Sampling and sample preparation	Test method to be applied	T1	General conditions The general conditions for selection and preparation of test samples and test pieces shall be in accordance with EURONORM 18.	
						(See line T1 and line ... in the supplement to this table)				
1	Chemical composition	3 and 4	C	The cast analysis is given by the manufacturer; for a possible product analysis, see clause B.5 in annex B.						
2	Hardness in condition TS or TA and for strip in the hardened condition	5 8	C +D +T	1	1	T2		T2	Hardness tests In cases of dispute, the hardness shall, where possible, be determined at the following point on the surface: — at a distance of 1 × diameter from one end of the bar in the case of round bars; — at a distance of 1 × 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. 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. Sample preparation shall be in accordance with EURONORM 3.	In accordance with EURONORM 3

[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 together if the thicknesses lie in the same dimensional range for mechanical properties and if the thicknesses+) do not affect the properties.

Table 9 (concluded).

1	2		3	4	5	6	7	Line	6a	7a
No.	Requirement	See table	Test unit [1]	Extent of testing: Number of products per test unit	Extent of testing: Number of tests per product	Sampling and sample preparation (See line T1 and line ... in the supplement to this table)	Test method to be applied		Sampling and sample preparation	Test method to be applied
3	Mechanical properties of							T3	Tensile test	
3a+)	quenched and tempered products	6	C + D + T	1	1 tensile test	T3a		T3a and T3b	The sample shall be taken as follows: — in the case of bars and rod, in accordance with figure 1; — in the case of flat products, in accordance with figures 2 and 3; — in the case of hammer and drop forgings (see note 2 of 1.1), the samples shall be taken from a position agreed at the time of ordering in such a way that their longitudinal axis lies in the direction of principal grain flow. The sample shall be prepared in accordance with EN 10 002-1.	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). If this is not possible, i.e. in the case of flat products with a thickness of <3 mm, a test piece with a constant gauge length as specified in EN 10 002-1 shall be agreed upon at the time of ordering. In this case, the minimum elongation value to be obtained for these test pieces shall also be agreed.
3b+)	normalized products	7	C + D + T	1 [2]	1 tensile test	T3b				

For [1]), see page 10.

[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 10. **Heat treatment**[1]

Steel grade symbol	Hardening [2],[3] °C	Hardening medium+), [4]	Tempering [5] °C	Normalizing [3] °C
1 C 22	860 to 900	Water	550 to 660	880 to 920
1 C 25	860 to 900			880 to 920
1 C 30	850 to 890			870 to 910
1 C 35	840 to 880	Water or oil		860 to 900
1 C 40	830 to 870			850 to 890
1 C 45	820 to 860			840 to 880
1 C 50	810 to 850	Oil or water		830 to 870
1 C 55	805 to 845			825 to 865
1 C 60	800 to 840			820 to 860

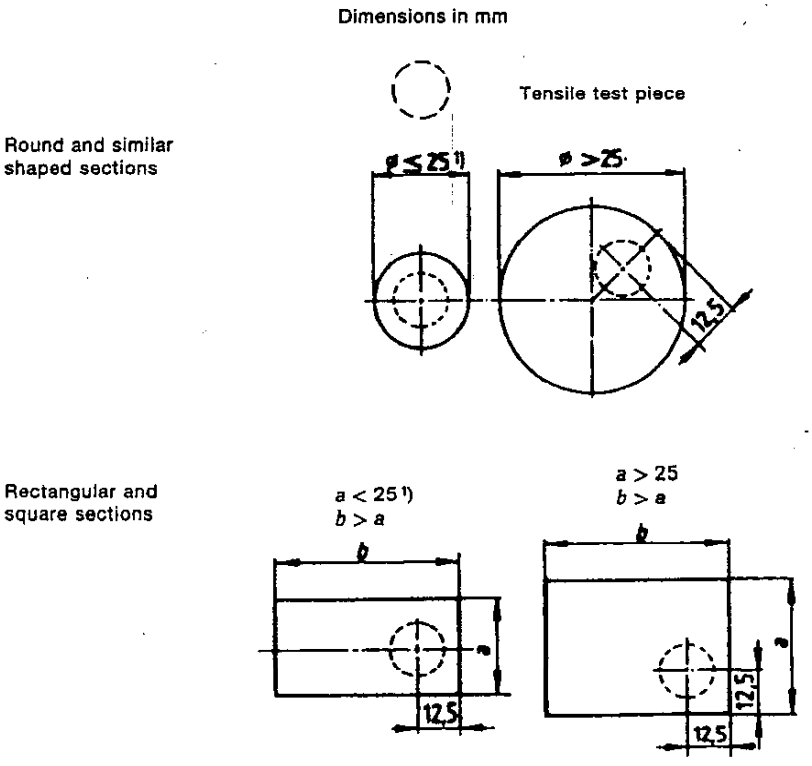
[1] The conditions given in this table are for guidance.

[2] 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.

[3] Austenitizing period: at least 30 min (guideline value).

[4] When choosing the hardening medium+), 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.

[5] Tempering period: at least 60 min (guideline value).



[1] For small products (d or $b \leq 25$ mm), the test piece shall, if possible, consist of an unmachined part of the bar.

Figure 1. Location of the test pieces in bars and rod

Dimensions in mm

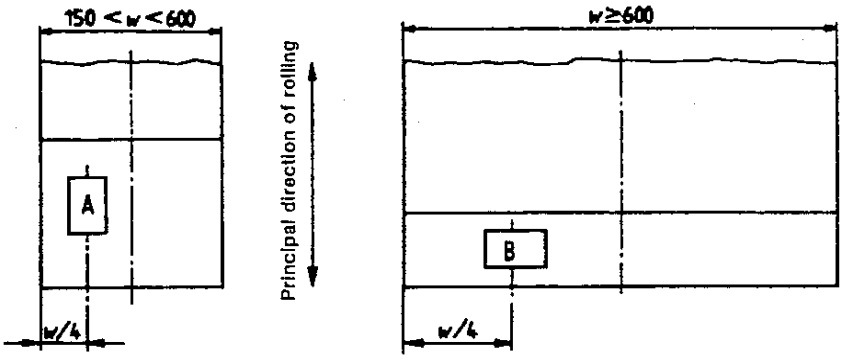
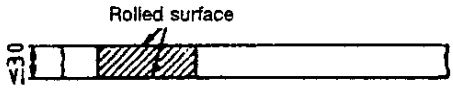
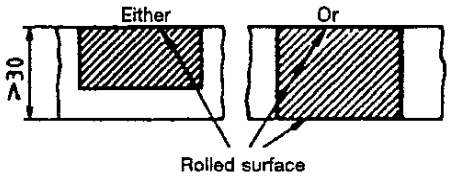


Figure 2. Location of the samples (A and B) in flat products in relation to the product width

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

[1] Location of the longitudinal access+) of the test piece with respect to the principal rolling direction.
[2] The test piece shall comply with EN 10 002-1.

Figure 3. 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

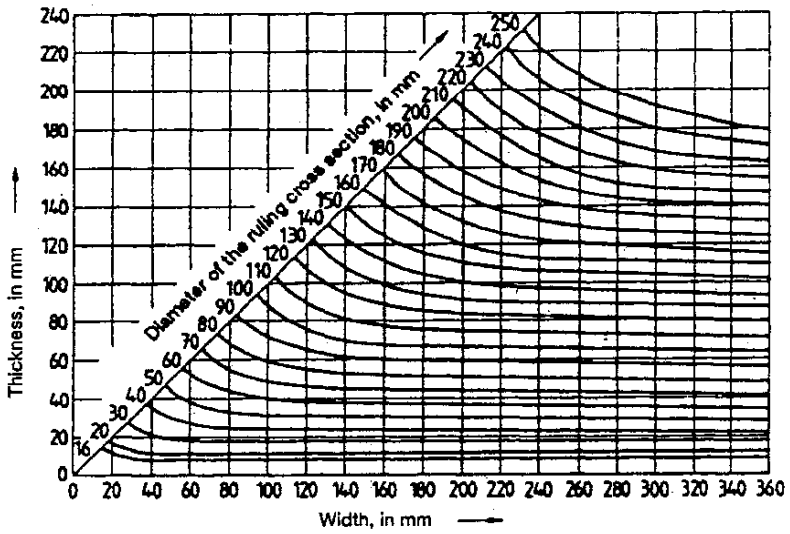
A.2.1 If the test pieces are taken from products with simple cross section and from positions with quasi two-dimensional heat flow, A.2.1.1 to A.2.1.3 shall apply.

A.2.1.1 For rounds, the nominal diameter of the product (not including 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 4.

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



Example:

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

Figure 4. Diameter of the ruling section for square and rectangular sections for quenching in oil or water

Annex B

(normative)

Supplementary or special requirements

NOTE: One or more of the following supplementary or special requirements may be applied if specified in the order. 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 10 or as 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 1 for bars and rod and in accordance with figure 3 for flat products.

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

For deliveries 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 1 in the case of bars and rod and with figure 3 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 an inspection test 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 ≥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.

B.4 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.5 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.6 Special marking

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

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 87	Free cutting steels
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

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 10 083-2	ISO 683-1 : 1987 [1]	Germany[1]		
		Symbol	Material number	
1 C 22	–	(C 22)	(1.0402)	
1 C 25	(C 25)	C 25	1.0406	
1 C 30	(C 30)	C 30	1.0528	
1 C 35	(C 35)	C 35	1.0501	
1 C 40	(C 40)	C 40	1.0511	
1 C 45	(C 45)	C 45	1.0503	
1 C 50	(C 50)	C 50	1.0540	
1 C 55	(C 55)	C 55	1.0535	
1 C 60	(C 60)	C 60	1.0601	

[1] If a steel grade is given in round brackets, this means that the chemical composition differs only slightly from EN 10 083-2. If there are no brackets round the steel grade, there are practically no differences in the chemical composition compared with EN 10 083-2.