BRITISH STANDARD

BS EN 10087:1999

Incorporating Corrigenda Nos. 1 and 2

Free cutting steels — Technical delivery conditions for semi-finished products, hot-rolled bars and rods

The European Standard EN 10087:1998 has the status of a British Standard

ICS 77.140.60

National foreword

This British Standard is the English language version of EN 10087:1998. Together with BS EN 10083-1:1991, BS EN 10084:1998, BS EN 10088-1:1995, BS EN 10088-2:1995 and BS EN 10088-3:1995, it supersedes BS 970-1:1996 which is withdrawn.

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

The UK participation in its preparation was entrusted to Technical Committee ISE/31, Wrought steels, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 15 January 1999

ISBN 0 580 30635 6

Amendments issued since publication

Amd. No.	Date	Comments
10442 Corrigendum No. 1	February 1999	National annex NA added
15803 Corrigendum No. 2	23 January 2006	Revision of the supersession details

Contents

blank

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10087

September 1998

ICS 77.140.50; 77.140.60; 77.140.65

Descriptors: Iron and steel products, hot-rolled products, metal bars, wire rod, free machining steels, grades, quality, chemical position, mechanical properties, heat treatment, delivery condition, surface defects, inspection, tests

English version

Free-cutting steels — Technical delivery conditions for semi-finished products, hot-rolled bars and rods

Aciers de décolletage — Conditions techniques de livraison pour les demi-produits, barres et fils-machine laminés à chaud

Automatenstähle — Technische Lieferbedingungen für Halbzeug, warmgewalzte Stäbe und Walzdraht

This European Standard was approved by CEN on 4 September 1998.

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, Czech Republic, 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

Ref. No. EN 10087:1998 E

Foreword

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

ECISS/TC 23 met on 1st/2nd July 1997 in Düsseldorf and agreed on the text for submission of this draft European Standard to COCOR-Vote. The following countries were represented in the meeting: Finland, France, Germany, Italy and United Kingdom.

The United Kingdom issues a non-conflicting national addition which describes a steel used in the United Kingdom but not included in this European Standard. This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 1999, and conflicting national standards shall be withdrawn at the latest by March 1999.

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

Contents

1 Scope

1.1 This European Standard gives the technical delivery conditions for

— semi-finished products;

— hot-rolled bars (including peeled bars);

— rods;

manufacturerd from the free-cutting steels listed in Table 1.

This European Standard covers those groups of free-cutting steels classified as listed in Table 1.

NOTE European Standards for similar steels are listed for information in Annex C.

1.2 In special cases, variations in these technical delivery conditions or additions to them may form the subject of an agreement at the time of enquiry and order (see Annex B).

1.3 In addition to the specifications of this European Standard, the general technical delivery conditions specified in EN 10021 are applicable unless otherwise specified below.

2 Normative references

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

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test (at ambient temperature).*

EN 10003-1, *Metallic materials — Brinell hardness test — Part 1: Test method.*

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

EN 10021, *General technical delivery requirements for steel and iron products.*

EN 10027-1, *Designation systems for steel — Part 1: Steel names, principal symbols.*

EN 10027-2, *Designation systems for steel — Part 2: Numerical system.*

EN 10052, *Vocabulary of heat treatment terms for ferrous products.*

EN 10079, *Definition of steel products.*

EN 10204, *Metallic products — Types of inspection documents (includes amendment A1:1995).*

EN 10221, *Surface quality classes for hot-rolled bars and rods — Technical delivery conditions.*

CR 10260 – ECISS IC 10, *Designation systems for steel — Additional symbols.*

EN ISO 377, *Steel and steel products — Location and preparation of test pieces for mechanical testing.*

EURONORM 103, *Microscopic determination of the ferritic or austenitic grain size of steels*[1)].

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition.*

3 Definitions

For the purposes of this European Standard the following definition applies in addition to the definitions in EN 10020, EN 10021, EN 10052, EN 10079, EN ISO 377 and ISO 14284.

3.1
free-cutting steels

steels with a minimum sulfur content of at least, in general, 0,1 %, are regarded as free-cutting steels

4 Classification and designation

4.1 Classification

All steels covered by this European Standard are classified as non-alloy quality steels according to EN 10020.

4.2 Designation

4.2.1 *Steel names*

For the steel grades covered by this European Standard, the steel names, as given in Table 1, are allocated in accordance with EN 10027-1 and CR 10260.

4.2.2 *Steel numbers*

For the steel grades covered by this European Standard, the steel numbers, as given in Table 1, are allocated in accordance with EN 10027-2.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) the quantity to be delivered;

b) the designation of the product form (e.g. round or square);

c) the number of the dimensional standard (see Annex D);

[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 may be applied.

d) the dimensions and tolerances on dimensions and shape and, if applicable, letters denoting relevant special tolerances;

e) the number of this European Standard (EN 10087);

f) steel name or steel number (see **4.2**);

g) the standard designation for a test report (**2.2**) or, if required, any other type of inspection document in accordance with EN 10204 (see **8.1**).

EXAMPLE

20, rounds, EURONORM 60, 40 × 8 000;

EN 10087, 35S20;

EN 10204, 2.2; or

20 rounds, EURONORM, 60, 40 × 8 000;

EN 10087, 1.0726;

EN 10204, 2.2.

5.2 Options

A number of options are specified in this European Standard and listed below. If the purchaser does not indicate his wish to implement one of these options, the supplier shall supply in accordance with the basic specification of this European Standard (see **5.1**):

a) any special requirement on treatment condition at delivery (see **6.2**);

b) any special requirement on grain size (see **7.3** and **B.2**);

c) any requirement for internal soundness (see **7.4** and **B.3**);

d) any requirement relating to surface quality (see **7.5.3**);

e) any requirement concerning suitability of bars and for bright drawing (see **7.5.4**);

f) any requirement relating to removal of surface defects (see **7.5.5**);

g) any requirement concerning special marking of the products (see clause **9** and **B.5**);

h) any special requirement concerning verification of the mechanical properties in the quenched and tempered condition on a reference test piece (see **8.2.1.1** e) and **B.1**);

i) any verification of the product analysis (see **8.2.1.1** f), Table 8 and **B.4**).

6 Manufacturing process

6.1 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 **6.2** (see also **7.3**).

6.2 Treatment condition at delivery

Unless otherwise agreed, products shall be delivered in the untreated condition.

6.3 Cast separation

The products shall be delivered separated by cast.

7 Requirements

7.1 Chemical composition and mechanical properties

The product shall have a chemical composition and mechanical properties, i.e. tensile strength and hardness, appropriate to the product form and treatment condition as set out in Table 1 to Table 5.

7.2 Weldability

Because of their high sulfur and phosphorus contents, free-cutting steels are not normally recommended for welding.

7.3 Structure

Unless otherwise agreed at the time of enquiry and order, the grain size shall be left to the discretion of the manufacturer. If, for case-hardening or direct-hardening steels, a fine grain structure is required in accordance with a reference treatment, this must be agreed at the time of enquiry and order (see **B.2**).

7.4 Internal soundness

Requirements for internal soundness may be agreed upon at the time of enquiry and order, e.g. on the basis of non-destructive tests (see **B.3**).

7.5 Surface quality

7.5.1 All products shall have a surface finish appropriate to the forming processes applied.

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

7.5.3 Where appropriate, requirements relating to the surface quality of the products shall be agreed on at the time of enquiry and order with reference to EN 10221.

NOTE It is more difficult to detect and eliminate surface discontinuities from coiled products than from cut lengths. This should be taken into account when agreements are made on surface quality.

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

7.5.5 The repair of surface defects by welding is not permitted.

The method and permissible depth of defect removal, where appropriate, shall be agreed at the time of enquiry and order.

7.6 Dimensions, tolerances on dimensions and shape

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

8 Inspection and testing

8.1 Types and contents of inspection documents

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

8.1.2 If, in accordance with **8.1.1**, a test report is to be issued, it shall contain the following information:

a) the confirmation that the material complies with the requirements of the order;

b) the results of the cast analysis for all the elements specified in Table 1 for the steel grade concerned.

8.1.3 If, in accordance with the agreements at the time of enquiry and order, an inspection certificate or inspection report is to be issued, the specific inspection described in **8.2** shall be carried out and the results shall be confirmed in the inspection document.

In addition, the inspection document shall contain the following information:

a) the manufacturer's results for the cast analysis of all elements specified in Table 1 for the steel grade concerned;

b) the results of inspections and tests ordered as a result of supplementary or special requirements (see Annex B);

c) the symbol letters or numbers relating the inspection documents, test pieces and products to each other.

8.2 Specific inspection and testing

8.2.1 *Chemical composition and mechanical properties*

8.2.1.1 Where specific inspection and testing is specified (see **8.1.3**) the properties of the product in the untreated or quenched and tempered condition shall be verified as follows:

a) for steels not intended for heat treatment, tensile strength in accordance with Table 3;

b) for steels intended for case hardening, tensile strength in accordance with Table 4;

c) for steels intended for quenching and tempering, tensile strength in the untreated condition in accordance with Table 5;

d) for steels according to Table 5 delivered in the quenched and tempered condition, the mechanical properties in accordance with Table 5;

e) where specified at the time of enquiry and order, the mechanical properties of steels intended for quenching and tempering shall be verified by the testing of a reference test piece in accordance with **B.1**;

f) where specified at the time of enquiry and order, the product analysis shall be verified in accordance with **B.4**.

8.2.1.2 The frequency of testing, sampling conditions and the test methods to be applied for verification of the requirements shall be as given in Table 8.

8.2.2 *Visual and dimensional inspection*

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

8.2.3 *Retests*

See EN 10021.

9 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 **B.5**).

Table 1 — Types of steel, chemical composition (applicable to cast analysis)[a]

Steel designation		Chemical composition (% by mass)					
Name	Number	C	Si max.	Mn	P max.	S	Pb
Steels not intended for heat treatment							
11SMn30	1.0715	≤ 0,14	0,05[b]	0,90 to 1,30	0,11	0,27 to 0,33	—
11SMnPb30	1.0718	≤ 0,14	0,05	0,90 to 1,30	0,11	0,27 to 0,33	0,20 to 0,35
11SMn37	1.0736	≤ 0,14	0,05[b]	1,00 to 1,50	0,11	0,34 to 0,40	—
11SMnPb37	1.0737	≤ 0,14	0,05	1,00 to 1,50	0,11	0,34 to 0,40	0,20 to 0,35
Case-hardening steels							
10S20	1.0721	0,07 to 0,13	0,40	0,70 to 1,10	0,06	0,15 to 0,25	—
10SPb20	1.0722	0,07 to 0,13	0,40	0,70 to 1,10	0,06	0,15 to 0,25	0,20 to 0,35
15SMn13	1.0725	0,12 to 0,18	0,40	0,90 to 1,30	0,06	0,08 to 0,18	—
Direct-hardening steels							
35S20	1.0726	0,32 to 0,39	0,40	0,70 to 1,10	0,06	0,15 to 0,25	—
35SPb20	1.0756	0,32 to 0,39	0,40	0,70 to 1,10	0,06	0,15 to 0,25	0,15 to 0,35
36SMn14	1.0764	0,32 to 0,39	0,40	1,30 to 1,70	0,06	0,10 to 0,18	—
36SMnPb14	1.0765	0,32 to 0,39	0,40	1,30 to 1,70	0,06	0,10 to 0,18	0,15 to 0,35
38SMn28	1.0760	0,35 to 0,40	0,40	1,20 to 1,50	0,06	0,24 to 0,33	—
38SMnPb28	1.0761	0,35 to 0,40	0,40	1,20 to 1,50	0,06	0,24 to 0,33	0,15 to 0,35
44SMn28	1.0762	0,40 to 0,48	0,40	1,30 to 1,70	0,06	0,24 to 0,33	—
44SMnPb28	1.0763	0,40 to 0,48	0,40	1,30 to 1,70	0,06	0,24 to 0,33	0,15 to 0,35
46S20	1.0727	0,42 to 0,50	0,40	0,70 to 1,10	0,06	0,15 to 0,25	—
46SPb20	1.0757	0,42 to 0,50	0,40	0,70 to 1,10	0,06	0,15 to 0,25	0,15 to 0,35

[a] Elements not quoted in this Table shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. However, elements such as Te, Bi, etc. may only be added by the manufacturer for improving the machinability, if this has been agreed at the time of enquiry and order.

[b] If, by metallurgical techniques, the formation of special oxides is guaranteed, a Si-content of 0,10 % to 0,40 % can be agreed.

Table 2 — Permissible deviations between specified analysis and product analysis

Element	Permissible maximum content according to cast analysis % by mass	Permissible deviations[a] % by mass
C	≤ 0,30	± 0,02
	> 0,30 ≤ 0,50	± 0,03
Si	≤ 0,05	+ 0,01
	> 0,05 ≤ 0,40	+ 0,03
Mn	≤ 1,00	± 0,04
	> 1,00 ≤ 1,70	± 0,06
P	≤ 0,06	+ 0,008
	> 0,06 ≤ 0,11	+ 0,02
S	≤ 0,33	± 0,03
	> 0,33 ≤ 0,40	± 0,04
Pb	≤ 0,35	+ 0,03 – 0,02

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

Table 3 — Hardness and tensile strength in the untreated condition of free-cutting steels not intended for heat-treatment

Steel designation		Diameter d	Hardness[ab]	Tensile strength[ac]
Name	Number	mm	HB	N/mm^2
11SMn30	1.0715	$5 \leq d \leq 10$	—	380 to 570
		$10 < d \leq 16$	—	380 to 570
11SMnPb30	1.0718	$16 < d \leq 40$	112 to 169	380 to 570
11SMn37	1.0736	$40 < d \leq 63$	109 to 169	370 to 570
11SMnPb37	1.0737	$63 < d \leq 100$	107 to 154	360 to 520

[a] In cases of dispute, the tensile strength values are deciding.
[b] The hardness values are given for information only.
[c] For flats, a minimum tensile strength of 340 N/mm^2 applies.

Table 4 — Hardness and tensile strength of case hardening free-cutting steels in the untreated condition

Steel designation		Diameter d	Hardness[ab]	Tensile strength[a]
Name	Number	mm	HB	N/mm^2
10S20 10SPb20	1.0721 1.0722	$5 \leq d \leq 10$	—	360 to 530
		$10 < d \leq 16$	—	360 to 530
		$16 < d \leq 40$	107 to 156	360 to 530
		$40 < d \leq 63$	107 to 156	360 to 530
15SMn13	1.0725	$63 < d \leq 100$	105 to 146	350 to 490
		$5 \leq d \leq 10$	—	430 to 610
		$10 < d \leq 16$	—	430 to 600
		$16 < d \leq 40$	128 to 178	430 to 600
		$40 < d \leq 63$	128 to 172	430 to 580
		$63 < d \leq 100$	125 to 160	420 to 540

[a] In cases of dispute, the tensile strength values are deciding.
[b] The hardness values are given for information only.

Table 5 — Mechanical properties of direct-hardening free-cutting steels[a]

Steel designation		Diameter d	Untreated		Quenched and tempered		
Name	Number		Hardness[bc]	Tensile strength[b]	R_e	R_m	A
		mm	HB	N/mm^2	N/mm^2 min.	N/mm	% min.
35S20 35SPb20	1.0726 1.0756	$5 \leq d \leq 10$	—	550 to 720	430	630 to 780	15
		$10 < d \leq 16$	—	550 to 700	430	630 to 780	15
		$16 < d \leq 40$	154 to 201	520 to 680	380	600 to 750	16
		$40 < d \leq 63$	154 to 198	520 to 670	320	550 to 700	17
		$63 < d \leq 100$	149 to 193	500 to 650	320	550 to 700	17
36SMn14 36SMnPb14	1.0764 1.0765	$5 \leq d \leq 10$	—	580 to 770	480	700 to 850	14
		$10 < d \leq 16$	—	580 to 770	460	700 to 850	14
		$16 < d \leq 40$	166 to 222	560 to 750	420	670 to 820	15
		$40 < d \leq 63$	166 to 219	560 to 740	400	640 to 790	16
		$63 < d \leq 100$	163 to 219	550 to 740	360	570 to 720	17
38SMn28 38SMnPb28	1.0760 1.0761	$5 \leq d \leq 10$	—	580 to 780	480	700 to 850	15
		$10 < d \leq 16$	—	580 to 750	460	700 to 850	15
		$16 < d \leq 40$	166 to 216	560 to 730	420	700 to 850	15
		$40 < d \leq 63$	166 to 216	560 to 730	400	700 to 850	16
		$63 < d \leq 100$	163 to 207	550 to 700	380	630 to 800	16
44SMn28 44SMnPb28	1.0762 1.0763	$5 \leq d \leq 10$	—	630 to 900	520	700 to 850	16
		$10 < d \leq 16$	—	630 to 850	480	700 to 850	16
		$16 < d \leq 40$	187 to 242	630 to 820	420	700 to 850	16
		$40 < d \leq 63$	184 to 235	620 to 790	410	700 to 850	16
		$63 < d \leq 100$	181 to 231	610 to 780	400	700 to 850	16
46S20 46SPb20	1.0727 1.0757	$5 \leq d \leq 10$	—	590 to 800	490	700 to 850	12
		$10 < d \leq 16$	—	590 to 780	490	700 to 850	12
		$16 < d \leq 40$	175 to 225	590 to 760	430	650 to 800	13
		$40 < d \leq 63$	172 to 216	580 to 730	370	630 to 780	14
		$63 < d \leq 100$	166 to 211	560 to 710	370	630 to 780	14

[a] R_e = yield strength (0,2 % proof stress);
R_m = tensile strength;
A = percentage elongation after fracture ($L_o = 5d_o$).

[b] In cases of dispute, the tensile strength values are deciding.

[c] The hardness values are given for information only.

Table 6 — Conditions for heat treatment of case-hardening free-cutting steels[a]

Steel designation		Carburizing temperature[b]	Core-hardening temperature[c]	Case-hardening temperature[c]	Quenching agent	Tempering[e]
Name	Number	°C	°C	°C		°C
10S20	1.0721	880 to 980	880 to 920	780 to 820	Water, oil, emulsion[d]	150 to 200
10SPb20	1.0722					
15SMn13	1.0725					

[a] The temperatures given for carburizing, core-hardening, case hardening and tempering are for guidance; the actual temperatures chosen should be those that will give the properties required.
[b] The carburizing temperature will depend on the chemical composition of the steel, the mass of the product, and the carburizing medium. If the steels are direct hardened, in general, a temperature of 950 °C is not exceeded. For special procedures, for example under vacuum, higher temperatures (for example 1 020 to 1 050 °C) are not unusual.
[c] When applying the single quench method, the steel is to be quenched from the carburizing temperature or a lower temperature. The lower hardening temperatures are in each case to be preferred, in particular when there is risk of distortion.
[d] The kind of quenching agent depends on, for example, the shape of the products, the cooling conditions and the amount of furnace filling.
[e] Time for tempering as a guide: 1 h minimum.

Table 7 — Conditions for heat treating of direct-hardening free-cutting steels[a]

Steel designation		Quenching[b]		Tempering[c]
Name	Number	°C	agent	°C
35S20 35SPb20	1.0726 1.0756	860 to 890	Water or oil	540 to 680
36SMn14 36SMnPb14	1.0764 1.0765	850 to 880	Water or oil	540 to 680
38SMn28 38SMnPb28	1.0760 1.0761	850 to 880	Water or oil	540 to 680
44SMn28 44SMnPb28	1.0762 1.0763	840 to 870	Oil or water	540 to 680
46S20 46SPb20	1.0727 1.0757	840 to 870	Oil or water	540 to 680

[a] The temperatures are for guidance, but the actual temperatures chosen shall be those that will give the properties required.
[b] Time for austenitizing as a guide: 0,5 h minimum.
[c] Time for tempering as a guide: 1 h minimum.

Table 8 — Test conditions for verification of compliance with the various requirements

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 **8.2.1.1**.

1	2		3	4	5	6	7
	Requirements		**Amount of testing**				
No.		**See table**	**Test unit**[a]	**Number of**		**Sampling**[b]	**Test method**
				Sample products per test unit	**Tests per sample product**		
1	Chemical composition	1 + 2	C	(The cast analysis is given by the manufacturer; for product analysis, see **B.4**)			
2	Hardness in the untreated condition (as-rolled or as-peeled)	3 + 4 + 5	C + D	1	1	The hardness shall, where possible, be determined at the following point on the surface: — at a distance of 1 × diameter from the end of the bar in the case of round bars; — at a distance of 1 × thickness from one end and 0,25 × thickness from one longitudinal edge of the product in the case of bars with square or rectangular cross-section.	According to EN 10003-1
3	Mechanical properties of products in the untreated or quenched and tempered delivery condition	3 + 4 + 5	C + D + T	1[c]	1	The test pieces for the tensile test shall be taken in accordance with EN ISO 377	The tensile test shall be carried out in accordance with EN 10002-1 on proportional test pieces having a gauge length of $L_o = 5{,}65\sqrt{S_o}$ (S_o = area of the cross-section of the test piece.)

[a] The tests shall be carried out separately for each cast as indicated by "C", each dimension as indicated by "D" and each heat treatment batch as indicated by "T".

Products with different thicknesses may be grouped if the thicknesses lie in the same dimensional range for mechanical properties and if the differences in thickness do not affect the properties. In cases of doubt, the thinnest and the thickest product shall be tested.

[b] The general conditions for selection and preparation of test samples and test pieces shall be in accordance with EN ISO 377 and ISO 14284.

[c] If the products are 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.

Annex A (normative) Ruling section for the mechanical properties

A.1 Definition

The ruling section of a product is the section for which the mechanical properties have been specified.

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.

A.2 Determination of the diameter of the ruling section

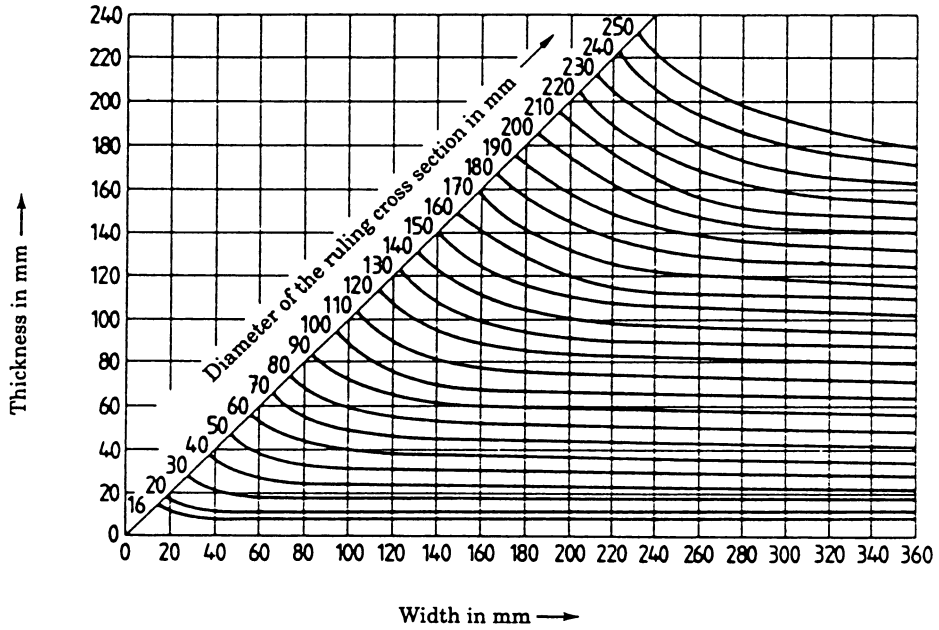
A.2.1 If the test pieces are taken from products with simple cross-sections and from positions with quasi two-dimensional heat flow, **A.2.1.1** to **A.2.1.3** shall apply.

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 A.1.

A.2.2 For other product forms the ruling section shall be agreed at the time of enquiry and order.



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

Figure A.1 — 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 agreed upon at the time of enquiry and order. The details of these requirements may be agreed upon between the manufacturer and the purchaser at the time of enquiry and order if necessary.

B.1 Mechanical properties of reference test piece in the quenched and tempered condition (direct-hardening steels only)

For deliveries in a condition other than quenched and tempered 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 rods, 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 enquiry and order, 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 7 or as agreed at the time of enquiry and order. The details of the heat treatment shall be given in the document. The test pieces shall, unless otherwise agreed, be taken in accordance with EN ISO 377.

B.2 Fine grain steels

Unless otherwise agreed, the steel when tested in accordance with one of the methods described in EURONORM 103 shall show an austenitic grain size of 5 to 8. The grain structure shall be considered satisfactory if 70 % of the area is within the specified size limits.

B.3 Non-destructive testing

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

B.4 Product analysis

One product analysis shall be carried out per cast for the determination of elements for which values are specified for the cast analysis (see Table 1) of the steel grade concerned.

Sampling shall be carried out as specified in ISO 14284. In cases of dispute, the method used shall be agreed if possible with reference to the corresponding European Standards or EURONORMS.

B.5 Special marking

The product shall be marked in a way specially agreed at the time of enquiry and order.

Annex C (informative) Bibliography

European Standards for similar steel grades as in Table 1 which are intended for other product forms, treatment conditions or special applications are:

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

EN 10083-2, *Quenched and tempered steels — Part 2: Technical delivery conditions for unalloyed quality steels.*

EN 10083-3, *Quenched and tempered steels — Part 3: Technical delivery conditions for boron steels.*

EN 10084, *Case-hardening steels — Technical delivery conditions.*

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

prEN 10277-3, *Bright steel products — Technical delivery conditions — Part 3: Free-cutting steels.*

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.*

National annex NA (informative)
Non-conflicting national additions

In the United Kingdom the steels in this annex are widely used but they have not been included in the European Standard. This annex gives chemical composition and mechanical property requirements for these steels.

Table NA1 — Chemical composition (% by mass)

Steel	C	Mn	Si	P max.	S	Mo
214M15	0,12 to 0,18	1,20 to 1,60	0,40 max.	0,050	0,10 to 0,18	—
606M36	0,37 to 0,44	1,30 to 1,70	0,10 to 0,40	0,035	0,25 to 0,30	0,25 to 0,35

Table NA2 — Mechanical properties in the normalized condition

Steel	Diameter d mm	Tensile strength R_m N/mm^2 min.	Yield strength R_e N/mm^2 min.	A % min.	Hardness HB min.	Impact Izod ft. lb min.	Impact KV J min.
214M15	$5 \le d \le 10$	525	280	20	156	30	35
	$10 \le d \le 16$	525	280	20	156	30	35
	$16 \le d \le 40$	500	275	18	147	30	35
	$40 \le d \le 63$	500	275	18	147	30	35
	$63 \le d \le 100$	500	275	18	147	30	35

Table NA3 — Mechanical properties in the quenched and tempered condition

Steel	Diameter d mm	Tensile strength R_m N/mm^2	Yield strength R_e N/mm^2 min.	A % min.	Hardness HB min.	Impact Izod ft. lb min.	Impact KV J min.
606M36	$5 \le d \le 10$	850 to 1 000	680	11	248 to 302	30	35
	$10 \le d \le 16$	850 to 1 000	680	11	248 to 302	30	35
	$16 \le d \le 40$	775 to 925	585	13	223 to 277	35	42
	$40 \le d \le 63$	775 to 925	585	13	223 to 277	35	42
	$63 \le d \le 100$	700 to 850	525	15	201 to 255	40	50

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL