BRITISH STANDARD

BS EN
10085:2001

Nitriding steel — Technical delivery conditions

The European Standard EN 10085:2001 has the status of a British Standard

ICS 77.140.10

National foreword

This British Standard is the official English language version of EN 10085:2001. It supersedes table 6 of BS 970-1:1996. BS 970-1:1996 is currently under revision.

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.

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This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 May 2001

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EN 10085

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English version

Nitriding steels - Technical delivery conditions

Aciers pour nitruration - Conditions techniques de livraison

Nitrierstähle - Technische Lieferbedingungen

This European Standard was approved by CEN on 19 January 2001.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

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

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2001, and conflicting national standards shall be withdrawn at the latest by September 2001.

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.

1 Scope

1.1 This European Standard specifies the technical delivery requirements for

— semi-finished products, e. g. blooms, billets, slabs (see NOTE 3);

— bars (see NOTE 3);

— rod;

— wide flats;

— hot- or cold-rolled strip and sheet/plate;

— forgings (see NOTE 3)

manufactured from the nitriding steels listed in Table 3 and supplied in one of the heat-treatment conditions given for the different types of products in Table 1, line 2 to 4 and in one of the surface conditions given in Table 2.

The steels are, in general, intended for the fabrication of quenched and tempered and generally machined and subsequently nitrided parts.

NOTE 1 Some grades from EN 10083-1 are also used for nitriding treatment.

NOTE 2 Related European Standards are given in Bibliography.

NOTE 3 Hammer-forged semi-finished products (blooms, billets, slabs etc.) and hammer-forged bars are in the following covered under semi-finished products or bars and not under the term "forgings".

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

1.3 In addition to the specifications of this European Standard, the general technical delivery requirements of EN 10021 are applicable.

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 (including amendments).

EN 10002-1, *Metallic materials - Tensile testing - Part 1: Test method (at ambient temperature) "including Addendum AC1:1990"*

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 10045-1, *Metallic materials - Charpy impact test - Part 1: Test method*

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

EN 10079, *Definition of steel products*

EN 10163-2, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections - Part 2: Plates and wide flats*

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, *Designation systems for steels - Additional symbols*

CR 10261, *ECISS IC 11 - Iron and steel - Review of available methods of chemical analysis*

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

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:1999)*

EURONORM 103[1)], *Microscopic 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*

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

3 Terms and definitions

For the purpose of this European Standard, the following terms and definitions apply in addition to the terms and definitions given in EN 10020, EN 10052, EN 10079, EN ISO 377 and ISO 14284.

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1) It may be agreed at the time of ordering, until these EURONORMS have been adopted as European Standards, that these EURONORMS or the corresponding national standards should be applied.

3.1
ruling section
that section for which the specified mechanical properties apply

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

3.2
nitriding steels
heat-treatable steels containing controlled amounts of two or more of the nitride forming elements aluminium, chromium, molybdenum, vanadium, making them particularly suitable for nitriding

4 Classification and designation

4.1 Classification

All steels covered by this European Standard are classified as alloy special 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 the relevant tables 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 the relevant tables 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;

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 10085);

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

g) if appropriate, the symbol for the heat treatment condition at delivery (see 6.2.1, 6.2.2 and Table 1);

h) if appropriate, the symbol for the surface condition at delivery (see 6.2.3 and Table 2);

i) if required, the type of inspection document in accordance with EN 10204 (see 8.1).

EXAMPLE

20 rounds EURONORM 60 - 20x8000
EN 10085 - 34CrAlNi7-10+A
EN 10204 - 3.1.B

or

20 rounds EURONORM 60 - 20x8000
EN 10085 - 1.8550+A
EN 10204 - 3.1.B

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 basis specification of this European Standard (see 5.1).

a) any special requirement on grain size (see 7.3.1 and 8.2.2);

b) any requirement concerning the admissible ferrite content in the core (see 7.3.2);

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 regarding the permissible depth of decarburization (see 7.5.4);

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

g) any verification of the mechanical properties of reference test pieces in the quenched and tempered condition (see 8.2.1.1 and B.1);

h) any requirement concerning special marking of the product (see clause 9 and B.5);

i) any verification of the product analysis (see Table 8 and B.4);

j) any requirement concerning non-metallic inclusion content (see B.2).

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 and 6.3.

6.2 Heat-treatment and surface condition at delivery

6.2.1 Normal condition at delivery

Unless otherwise agreed at the time of enquiry and order, the products shall be delivered in the untreated, i. e. as rolled condition (see Table 2, NOTE a).

6.2.2 Particular heat-treatment condition

If so agreed at the time of enquiry and order, the products shall be delivered in one of the heat-treatment conditions given in Table 1, lines 2 to 4.

6.2.3 Particular surface condition

If so agreed at the time of enquiry and order, the products shall be delivered in one of the particular surface conditions given in Table 2, lines 3 to 6.

6.3 Cast separation

The steels shall be delivered separated by casts.

7 Requirements

7.1 Chemical composition, hardness and mechanical properties

The requirements for chemical composition, hardness and mechanical properties cited in Table 1, column 9, apply as appropriate for the particular heat-treatment condition.

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

7.2 Shearability

Under suitable shearing conditions (avoiding local stress peaks, preheating, application of blades with a profile adapted to that of the product etc.) all steels are shearable in the condition "soft annealed".

7.3 Structure

7.3.1 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 or finer.

7.3.2 Requirements for the ferrite content in the core may be agreed at the time of enquiry and order.

7.4 Internal soundness

The steel shall be free from internal defects likely to have an adverse effect (see B.3).

7.5 Surface quality and decarburization

7.5.1 All products shall have a workmanlike finish.

7.5.2 Minor surface imperfections, which may 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.

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

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

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

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

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

7.5.5 Repair of surface discontinuities by welding is not permitted.

If surface discontinuities are to be repaired, the method and permissible maximum depth of removal should 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 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 For each delivery, the issue of any inspection document according to EN 10204 may be agreed upon at the time of enquiry and order.

8.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report is to be provided, this shall cover:

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

b) the results of the cast analysis for all elements specified for the type of steel supplied;

c) the actual tempering temperature for the steel grades delivered in the quenched and tempered condition.

8.1.3 If, in accordance with the agreements in the order, an inspection certificate 3.1.A, 3.1.B or 3.1.C or an inspection report 3.2 (see EN 10204) is to be provided, the specific inspections and tests described in 8.2 shall be carried out and their results shall be certified in the document.

In addition the document shall cover

a) for all elements specified for the steel type concerned, the results of the cast analysis given by the manufacturer;

b) the actual tempering temperature for the steel grades delivered in the quenched and tempered condition;

c) the result of all inspections and tests ordered by supplementary requirements (see annex B);

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

8.2 Specific inspection and testing

8.2.1 Verification of the hardness and mechanical properties

8.2.1.1 The hardness requirements or mechanical properties given for the relevant heat-treatment condition in Table 1, column 9, sub-clause 2, shall, with the following exception, be verified. The requirement given in Table 1, footnote a (mechanical properties of reference test pieces), is only to be verified if the supplementary requirement specified in B.1 is ordered.

8.2.1.2 The amount of testing, the sampling conditions and the test methods to be applied for the verification of the requirements shall be in accordance with the prescriptions of Table 7.

8.2.2 Verification of the grain size

In case the verification of the fine grain structure is specified, the method for determination of grain size according to EURONORM 103, the amount of testing and the testing conditions shall be agreed at the time of enquiry and order.

8.2.3 Visual and dimensional inspection

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

8.2.4 Retests

For retests, EN 10021 shall apply.

9 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that the identification of the cast, the steel type and the origin of the delivery is possible (see B.5).

Table 1 - Combinations of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 6

1	2	3	4	5	6	7	8	9		10
1	Heat-treatment condition at delivery	Symbol	x = indicates applicable for					Requirements		Remarks
			Semi-products	Bars	Rod	Flat products	Forgings	1.	2.	
2	Soft annealed	+A	x	x	x	x	x	Chemical composition according to Tables 3 and 4	Maximum Brinell hardness according to Table 5[a]	Observe also the supplementary requirements given in annex B
3	Quenched and tempered	+QT	-	x	-	x	x		Mechanical properties according to Table 6	
4	Others	Other treatment conditions, for example the quenched and tempered and stress relieved condition or special heat treatments for improving the machinability may be agreed at the time of enquiry and order.								

[a] For deliveries in the condition "soft annealed", the values given in Table 6 for the quenched and tempered condition shall be achievable after appropriate heat treatment if so agreed at the time of enquiry and order (see B.1).

Table 2 - Surface condition at delivery

1	2	3	4	5	6	7	8	9	10
1	Surface condition at delivery			x = indicates in general applicable for					Notes
			Symbol	Semi-finished products	Bars	Rod	Flat products	Forgings	
2	Unless otherwise agreed	As rolled or forged	None	x[a]	x	x	x	x	
3	Particular conditions supplied by agreement	+pickled	+PI	--	--	x	--	--	--[c]
4		+blast cleaned	+BC	x	x	--	x	x	
5		+rough machined	--[b]	--	x	x	--	x	
6		Others							

[a] The term "as rolled" includes in the case of the semi-finished products also the continuously cast condition.
[b] Until the term "rough machined" is defined by, for example, machining allowances, the details shall be agreed at the time of enquiry and order.
[c] In addition it may be agreed that the products are oiled or, where appropriate, limed or phosphated.

Table 3 - Types of steel and specified chemical composition (applicable to cast analysis)

Designation		% by mass[a]									
Steel name	Steel number	C	Si max.	Mn	P max.	S[b] max.	Al	Cr	Mo	Ni	V
24CrMo13-6	1.8516	0,20 to 0,27	0,40	0,40 to 0,70	0,025	0,035	-	3,00 to 3,50	0,50 to 0,70	-	-
31CrMo12	1.8515	0,28 to 0,35	0,40	0,40 to 0,70	0,025	0,035	-	2,80 to 3,30	0,30 to 0,50	-	-
32CrAlMo7-10	1.8505	0,28 to 0,35	0,40	0,40 to 0,70	0,025	0,035	0,80 to 1,20	1,50 to 1,80	0,20 to 0,40	-	-
31CrMoV9	1.8519	0,27 to 0,34	0,40	0,40 to 0,70	0,025	0,035	-	2,30 to 2,70	0,15 to 0,25	-	0,10 to 0,20
33CrMoV12-9	1.8522	0,29 to 0,36	0,40	0,40 to 0,70	0,025	0,035	-	2,80 to 3,30	0,70 to 1,00	-	0,15 to 0,25
34CrAlNi7-10	1.8550	0,30 to 0,37	0,40	0,40 to 0,70	0,025	0,035	0,80 to 1,20	1,50 to 1,80	0,15 to 0,25	0,85 to 1,15	-
41CrAlMo7-10	1.8509	0,38 to 0,45	0,40	0,40 to 0,70	0,025	0,035	0,80 to 1,20	1,50 to 1,80	0,20 to 0,35	-	-
40CrMoV13-9	1.8523	0,36 to 0,43	0,40	0,40 to 0,70	0,025	0,035	-	3,00 to 3,50	0,80 to 1,10	-	0,15 to 0,25
34CrAlMo5-10	1.8507	0,30 to 0,37	0,40	0,40 to 0,70	0,025	0,035	0,80 to 1,20	1,00 to 1,30	0,15 to 0,25	-	-

[a] Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition, from scrap or other materials used in manufacture, of such elements which affect the mechanical properties and applicability.

[b] By agreement between the purchaser and manufacturer, the steel may be ordered with an upper limit of sulfur less than 0,035 %.

Table 4 - Permissible deviations between specified analysis and product analysis

Element	Permissible maximum content according to cast analysis % by mass	Permissible deviation [a] % by mass
C	≤ 0,45	± 0,02
Si	≤ 0,40	+ 0,03
Mn	≤ 0,80	± 0,04
P	≤0,025	+ 0,005
S	≤0,035	+ 0,005
Al	≥ 0,80 ≤ 1,20	± 0,10
Cr	≥ 1,00 ≤ 2,00 > 2,00 ≤ 3,50	± 0,05 ± 0,10
Mo	≤ 0,30 > 0,30 ≤ 1,00	± 0,03 ± 0,04
Ni	≤ 1,15	± 0,05
V	≤ 0,25	± 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 3, but not both at the same time.

Table 5 - Hardness in the soft annealed condition (+A)

Designation		Hardness HB max.
Steel name	Steel number	
24CrMo13-6	1.8516	248
31CrMo12	1.8515	
32CrAlMo7-10	1.8505	
31CrMoV9	1.8519	
33CrMoV12-9	1.8522	
34CrAlNi7-10	1.8550	
41CrAlMo7-10	1.8509	
40CrMoV13-9	1.8523	
34CrAlMo5-10	1.8507	

Table 6 - Mechanical properties in the quenched and tempered condition (+QT)[a]

Designation		16 ≤ d ≤ 40 mm				40 < d ≤ 100 mm				100 < d ≤ 160 mm				160 < d ≤250 mm				HV1 [b]
Steel name	Steel number	R_m MPa *)	Re MPa *) min.	A % min.	KV J min.	R_m MPa *)	Re MPa *) min.	A % min.	KV J min.	R_m MPa *)	Re MPa *) min.	A % min.	KV J min.	R_m MPa *)	Re MPa *) min.	A % min.	KV J min.	
24CrMo13-6	1.8516	1000 to 1200	800	10	25	950 to 1150	750	11	30	900 to 1100	700	12	30	850 to 1050	650	13	30	-
31CrMo12	1.8515	1030 to 1230	835	10	25	980 to 1180	785	11	30	930 to 1130	735	12	30	880 to 1080	675	12	30	800
32CrAlMo7-10	1.8505	1030 to 1230	835	10	25	980 to 1180	835	10	25	930 to 1130	735	12	30	880 to 1080	675	12	30	-
31CrMoV9	1.8519	1100 to 1300	900	9	25	1000 to 1200	800	10	30	900 to 1100	700	11	35	850 to 1050	650	12	40	800
33CrMoV12-9	1.8522	1150 to 1350	950	11	30	1050 to 1250	850	12	35	950 to 1150	750	12	40	900 to 1100	700	13	45	-
34CrAlNi7-10	1.8550	900 to 1100	680	10	30	850 to 1050	650	12	30	800 to 1000	600	13	35	800 to 1000	600	13	35	950
41CrAlMo7-10	1.8509	950 to 1150	750	11	25	900 to 1100	720	13	25	850 to 1050	670	14	30	800 to 1000	625	15	30	950
40CrMoV13-9	1.8523	950 to 1150	750	11	25	900 to 1100	720	13	25	870 to 1070	700	14	30	800 to 1000	625	15	30	-
34CrAlMo5-10[c]	1.8507	800 to 1000	600	14	35	800 to 1000	600	14	35	-	-	-	-	-	-	-	-	950

[a] R_m = Tensile strength; Re = Yield strength (0,2 % proof stress); A = Elongation after fracture; KV = Impact strength for V-notch test pieces.
[b] HV = Hardness for nitrided surface. Values for information/guidance only. Actual surface hardness may vary with nitriding treatment and initial quenched and tempered condition.
[c] Available for thicknesses d ≤ 70 mm.
*) 1 MPa = 1 N/mm²

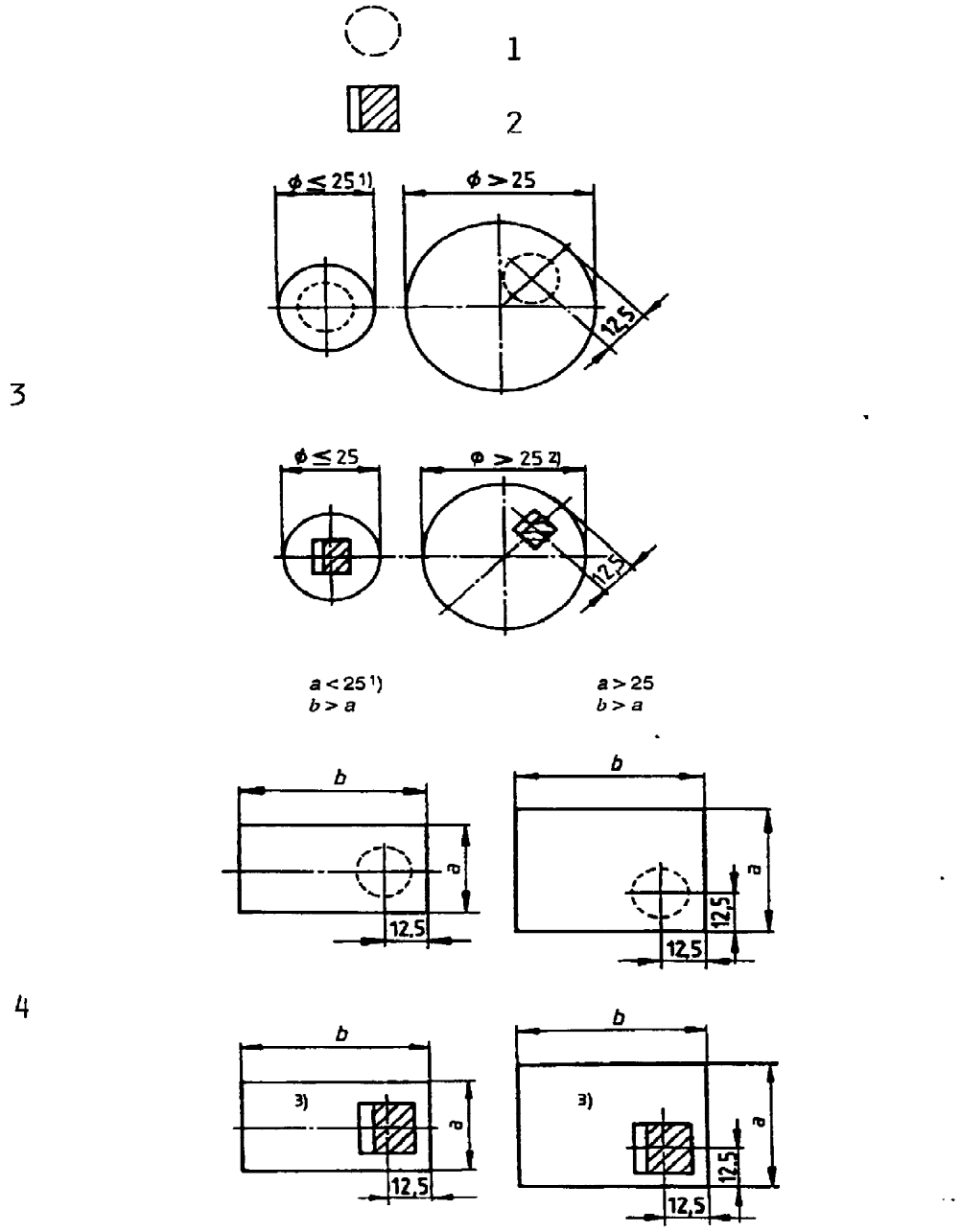
Table 7 - Test conditions for the verification of the requirements given in column 2

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.

1	2		3	4	5	6	7	Line	6a	7a
No.	Requirements	See Table	Test Unit[a]	Amount of testing: Number of sample products per test unit	Amount of testing: Number of tests per sample product	Sampling (See in the supplement to this table, line T1 and line ...)	Test method (See in the supplement to this table, line T1 and line ...)		Sampling and sample preparation	Test method to be applied
1	Chemical composition	3,4	C	(The cast analysis is given by the manufacturer; for product analysis, see B.4)				T1	**General conditions** The general conditions for selection and preparation of test samples and test pieces for steel should be in accordance with EN ISO 377 and ISO 14284.	
2	Hardness in the soft annealed condition (+A)	5	C + D + T	1	1	T2		T2	**Hardness tests** In cases of dispute, the hardness shall be measured, if possible, at the circumference of the product in a distance of 1 x thickness from one end and in cases of products with square or rectangular cross-section in a distance of 0,25 x w, where w is the width of the product, from one longitudinal edge. If for example for hammer and drop forgings the above prescriptions prove unrealistic, a more appropriate position of the hardness identations shall be agreed at the time of enquiry and order.	According to EN ISO 6506-1
3	Mechanical properties of quenched and tempered products (+QT)	6	C+ D + T	1	1 tensile and 3 Charpy-V-notch impact tests	T3		T3	**Tensile and impact tests** The test pieces for tensile tests and, the test pieces for the Charpy-V-notch impact tests shall be taken - for bars and rod in accordance with figure 1 - for plates in accordance with figures 2 and 3. For hammer and drop forgings the test pieces shall be taken with their longitudinal axis parallel to the direction of principal grain flow from a position to be agreed at the time of enquiry and order.	The tensile test shall in cases of dispute be carried out in accordance with EN 10002-1 on proportional test pieces having a gauge length of $L_o = 5{,}65\sqrt{S_o}$ where S_o is the area of the cross-section of the test piece. Where this is not possible - that means for flat products with thicknesses of about < 3 mm, a test piece with constant gauge length in accordance with EN 10002-1 shall be agreed at the time of enquiry and order. In this case also the minimum elongation value to be obtained for these test pieces shall be agreed. The impact test, where required, shall be made in accordance with EN 10045-1.

[a] The tests are to be carried out separately for each cast as indicated by "C", each dimensions as indicated by "D" and each heat treatment batch as indicatd by "T". Products with different thickness may be grouped if the thicknesses lie in the same dimension 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.

Dimensions in millimetres



Key

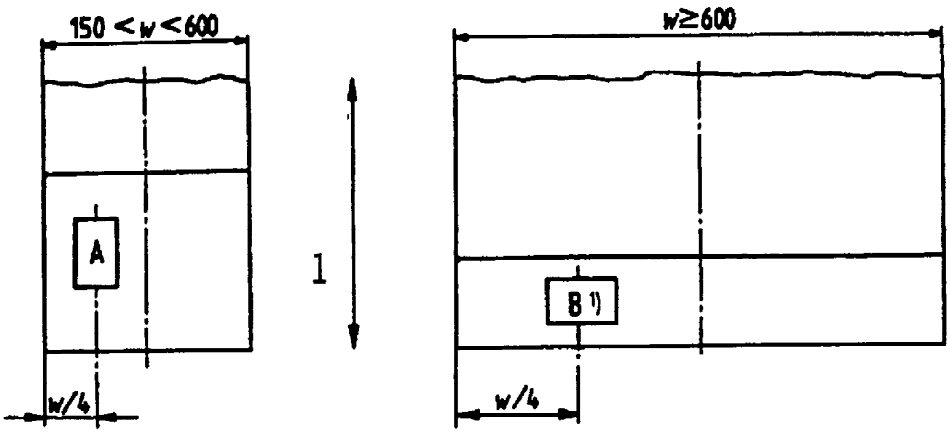
1 Tensile test piece
2 Notched bar impact test piece
3 Round and similar shaped sections
4 Rectangular and square sections

1) For small products (*d or b* ≤ 25 mm), the test piece shall, if possible, consist of an unmachined part of the bar. For round bars the longitudinal axis of the notch shall be about parallel to the direction of a diameter.

2) For rectangular bars, the longitudinal axis of the notch shall be perpendicular to the wider rolling surface.

Figure 1 - Location of the test pieces in bars and rods

Dimensions in millimetres

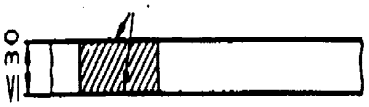
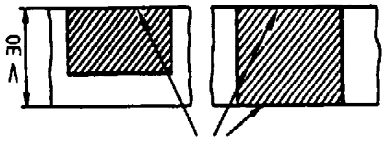
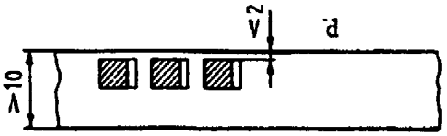


Key

1 Principal direction of rolling

1) In the case of steel grades in the quenched and tempered condition with requirements for the impact energy, the width of the sample shall be sufficient for longitudinal impact test pieces to be taken as specified in figure 3.

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[a] for a product width of		Distance of the test piece from the rolled surface
	mm	w < 600 mm	w ≥ 600 mm	mm
Tensile test[b]	≤ 30	longitudinal	transverse	Rolled surface 
	> 30			either or  Rolled surface
Impact test[c]	> 10[d]	longitudinal	longitudinal	

[a] Location of the longitudinal axis of the test piece with respect to the principal rolling direction.
[b] The test piece shall comply with EN 10002-1.
[c] The longitudinal axis of the test piece shall be perpendicular to the rolled surface.
[d] If agreed at the time of ordering, the test piece from products with a thickness exceeding 30 mm may be taken from 1/4 product thickness.

Figure 3 - Location of the test piece from flat products in relation to product thickness and principal direction of rolling

Annex A
(normative)

Ruling sections for the mechanical properties

A.1 Definition

See 3.1.

A.2 Determination of the diameter of the equivalent ruling section

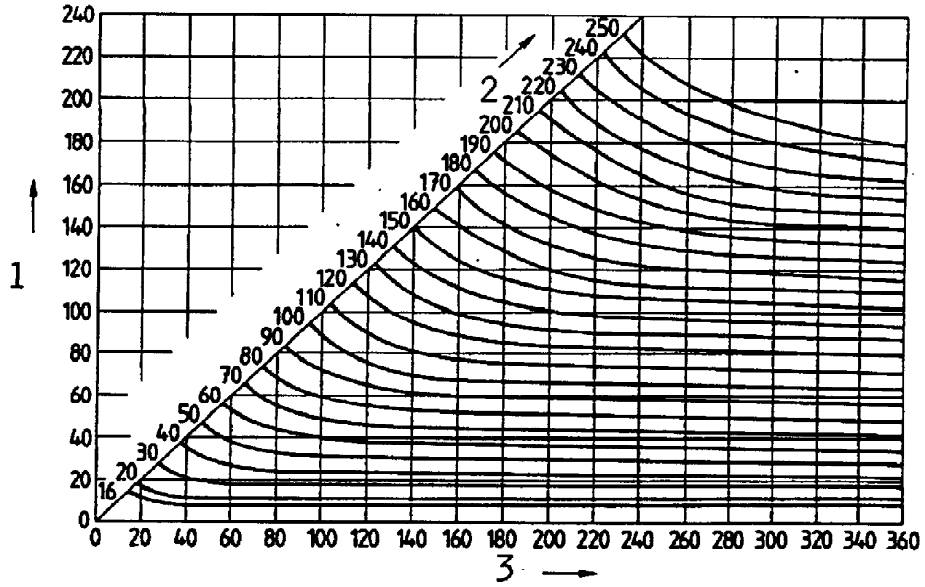
A.2.1 If the test pieces are taken from products with simple cross sections and from positions with quasi two-dimensional heat flow, **A.2.1.1** to **A.2.1.3** shall apply.

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.

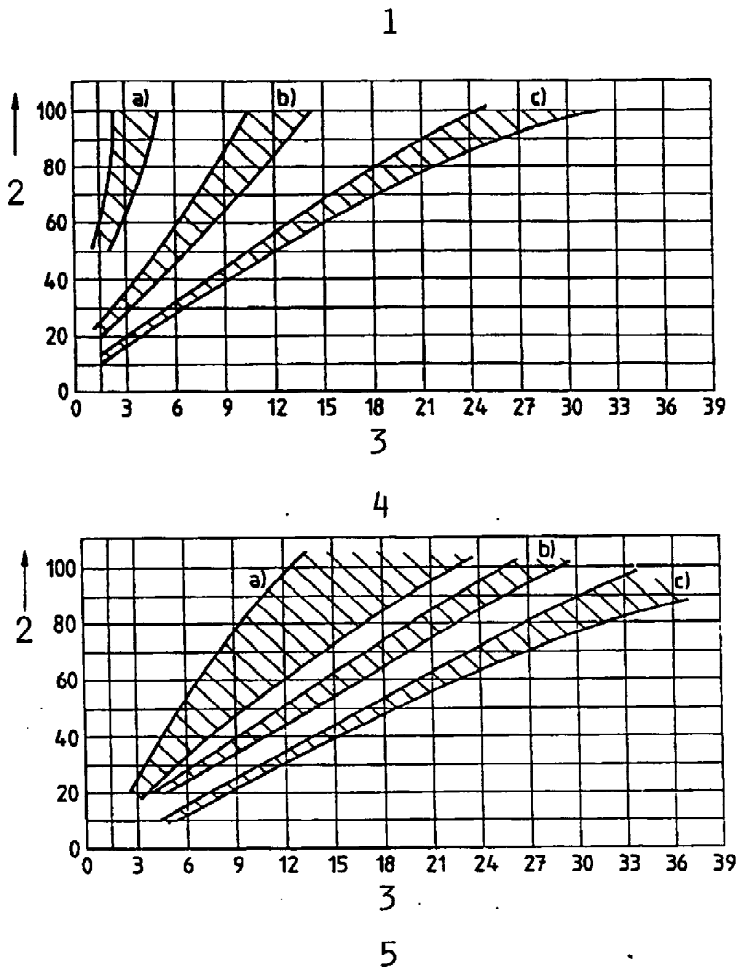
A.2.2 For other product forms the ruling section shall be agreed at the time of enquiry and order.



Key
1 Thickness in mm
2 Diameter of the ruling cross section in mm
3 Width in mm

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

Figure A.1 - Diameter of the equivalent ruling section for square and rectangular sections for quenching in oil or water



Key

1 Rounds quenched in mildly agitated water
2 Bar diameter in mm
3 Distance in mm from the quenched end
4 Rounds quenched in mildly agitated oil
5 a) Surface
b) 3/4 radius
c) Centre

Figure A.2 - 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 agreed upon at the time of enquiry and order. The details of these requirements may be agreed upon between the manufacturer and purchaser at the time of enquiry and order if necessary.

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

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 sample to be quenched and tempered shall, unless otherwise agreeed, have the cross-section of the product. In all other cases the dimensions and the manufacture of the sample shall be agreed at the time of enquiry and order, where appropriate, while taking into consideration the indications for the determination of the ruling section given in annex A. The samples shall be quenched and tempered in accordance with the conditions given in the table for the heat-treatment conditions or as agreed at the time of enquiry and order. 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 the relevant specifications of the standard.

B.2 Content of non-metallic inclusions

The content of non-metallic inclusions shall be within limits which have been agreed upon, when microscopically determined according to an agreed procedure (for example see ENV 10247).

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 elements for which values are specified for the cast analysis of the steel type concerned.

The conditions for sampling shall be in accordance with ISO 14284. In the case of dispute about the analytical method, the chemical composition shall be determined in accordance with a reference method taken from one of the European Standards in ECISS IC 11 (CR 10261).

B.5 Special agreements for marking

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

Annex C
(informative)

Heat treatment

Guidance for heat treatment is given in Table C.1 for information.

Table C.1 - Conditions for heat treatment

Designation		Soft annealing	Hardening		Tempering	Nitriding
Steel name	Steel number	Temperature °C	Temperature[a] °C	Agent	Temperature[b, c] °C	Temperature[d] °C
24CrMo13-6	1.8516	650 to 700	870 to 970	Oil or water	580 to 700	480 to 570
31CrMo12	1.8515	650 to 700	870 to 930	Oil or water	580 to 700	480 to 570
32CrAlMo7-10	1.8505	650 to 750	870 to 930	Oil or water	580 to 700	480 to 570
31CrMoV9	1.8519	680 to 720	870 to 930	Oil or water	580 to 700	480 to 570
33CrMoV12-9	1.8522	680 to 720	870 to 970	Oil or water	580 to 700	480 to 570
34CrAlNi7-10	1.8550	650 to 700	870 to 930	Oil or water	580 to 700	480 to 570
41CrAlMo7-10	1.8509	650 to 750	870 to 930	Oil or water	580 to 700	480 to 570
40CrMoV13-9	1.8523	680 to 720	870 to 970	Oil or water	580 to 700	480 to 570
34CrAlMo5-10	1.8507	650 to 750	870 to 930	Oil or water	580 to 700	480 to 570

[a] Time for austenitizing as a guide: 0,5 h minimum.
[b] Time for tempering as a guide: 1 h minimum.
[c] With very large sizes, the tempering temperature may be agreed at the time of enquiry and order.
[d] Time for nitriding depends on the desired depth of the nitrided case.

NOTE The base composition and the heat treatment (quenching and tempering) prior to nitriding both have an influence on the results of nitriding treatment. The tempering temperature should not be less than 50°C higher than the nitriding temperature. A difference of less than 50°C should be subject of a special agreement.

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:

prEN 10058, *Hot rolled flat steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

prEN 10059, *Hot rolled square steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

prEN 10060, *Hot rolled round steel bars - Dimensions and tolerances on shape and dimensions*

prEN 10061, *Hot rolled hexagon steel bars - Dimensions and tolerances on shape and dimensions*

For hot rolled strip, sheet/plate and wide flats:

EN 10029, *Hot rolled steel plates 3 mm thick or above - Tolerances on dimensions, shape and mass*

EN 10048, *Hot rolled narrow steel strip - Tolerances on dimensions and shape*

EN 10051, *Continuously hot rolled uncoated plate, sheet and strip of non-alloy and alloy steels - Tolerances on dimensions and shape*

For cold rolled strip and sheet/plate:

EN 10140, *Cold rolled narrow steel strip - Tolerances on dimensions and shape*

Bibliography

European Standards for similar steel grades as in Table 3 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 10084, *Case hardening steels - Technical delivery conditions*

BS EN 10085:2001

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