

Case hardening steels — Technical delivery conditions

The European Standard EN 10084:1998 has the status of a
British Standard

ICS 77.140.10

National foreword

This British Standard is the English language version of EN 10084:1998. Together with BS EN 10083-1:1991, BS EN 10087:1999, BS EN 10088-1:1995, BS EN 10088-2:1995 and BS EN 10088-3:1995, it supersedes BS 970-1:1996 which is withdrawn.

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

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 UK interests informed;
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English version

Case hardening steels — Technical delivery conditons

Aciers pour cémentation —
Conditions techniques de livraison

Einsatzstähle —
Technische Lieferbedingungen

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CEN

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 23, Steels for heat treatment, alloy steels and free-cutting steels — Qualities, 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of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.
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.
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.

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1 Scope

1.1 This European Standard gives the technical delivery requirements for:

- semi-finished products, hot formed, for example blooms, billets, slabs (see notes 2 and 3);
- bars (see note 2);
- rod;
- wide flats;
- hot-rolled sheet/plate and strip;
- hammer and drop forgings (see note 2).

manufactured from the case hardening unalloyed or alloyed 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 case-hardened (see clause 3) machine parts.

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

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 undeformed continuously cast semi-finished products.

NOTE 4 In accordance with EN 10020, the steels covered by this European Standard are special steels.

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 A).

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

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate 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 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 10109-1, *Metallic materials — Hardness test — Part 1: Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T).*

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, *ECISS IC 10 — Designation systems for steel — Additional symbols for steel names.*

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

EURONORM 23, *End quench hardenability test for steel (Jominy test).*¹⁾

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.*

DIN 50602:1985, *Metallographic examination — Microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions.*

NF A 04-106:1984, *Iron and steel — Methods of determination of non metallic inclusions in wrought steel — Part II: Micrographic method using standard diagrams.*

SS 11116:1987, *Steel — Methods for assessment of the content of non-metallic inclusions — Microscopic methods — Jernkontoret's inclusion chart II for the assessment of non-metallic inclusions.*

3 Definitions

For the purpose 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

case-hardening steels

steels with a relatively low carbon content which are intended for carburizing or carbonitriding and subsequent hardening; such steels, after treatment, are characterized by a high hardness surface layer and a tough core

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.

4 Classification and designation

4.1 Classification

All steels covered by this European Standard are classified according to EN 10020. Steel grades C10E, C10R, C15E, C15R, C16E and C16R are non-alloy special steels. All other steels covered by this European Standard are alloy special steels.

4.2 Designation

4.2.1 Steel names

For the steel grades covered by this European Standard, the steel names as given in Tables 3, 5 and 6 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 Tables 3, 5 and 6 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 10084);
- f) steel name or steel number (see 4.2);
- g) if appropriate, the symbol for the heat-treatment condition at delivery (see 6.4.2 and Table 1);
- h) if appropriate, the symbol for the surface condition at delivery (see 6.4.3 and Table 2);
- i) 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 × 8000

EN 10084 - 20MnCr5+A+BC

EN 10204 - 2.2

or:

20 rounds EURONORM 60 - 40 × 8000

EN 10084 - 1.7147+A+BC

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 basis specification of this European Standard (see 5.1).

- a) any requirement concerning minimum reduction ratio of rolled and forged products (see 6.3 and A.4);
- b) any special requirement on grain size (see 7.3.1 and 8.2.2);
- c) any requirement concerning determination of non-metallic inclusion content (see 7.3.2, Tables 8 to 10, A.1 and annex D);
- d) any requirement for internal soundness (see 7.4 and A.2);
- e) any requirement relating to surface quality (see 7.5.3);
- f) any requirement concerning suitability of bars and rod for bright drawing (see 7.5.4);
- g) any requirement relating to removal of surface defects (see 7.5.5);
- h) any requirement concerning special marking of the products (see clause 9 and A.5);
- i) any verification of the product analysis (see Table 12 and A.3).

6 Manufacturing process

6.1 Melting process

The type of melting process is left to the discretion of the manufacturer.

6.2 Deoxidation

All steels shall be killed.

6.3 Manufacture of the product

The manufacturing process route of the product shall be at the manufacturer's discretion.

For minimum reduction ratio of rolled and forged products see A.4.

6.4 Heat-treatment condition and surface finish at the time of delivery

6.4.1 Normal condition at delivery

Unless otherwise agreed at the time of enquiry and order, the products shall be delivered in the untreated, i.e. hot formed, condition.

6.4.2 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 3 to 7.

6.4.3 Particular surface condition

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

6.5 Cast separation

The products shall be delivered separated by cast.

7 Requirements

7.1 Chemical composition, hardness and hardenability

7.1.1 Table 1 gives a survey on combinations of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 7 (chemical composition, hardenability, maximum hardness, hardness range).

7.1.2 Where the steel is ordered according to Table 3 (designation without hardenability index) the requirements for chemical composition and hardness cited in Table 1, column 9, apply as appropriate for the particular heat-treatment condition. In this case the values of hardenability given in Table 5 are for guidance purposes only.

7.2 Technological properties

7.2.1 Machinability

All steels are machinable in the conditions “annealed to maximum hardness requirements”, “treated to hardness range” and “treated to ferrite/pearlite structure and hardness range”.

Where improved machinability is required, the grades with a specified sulfur range should be ordered. (see also Table 3, footnote 3.)

7.2.2 Shearability of semi-finished products and bars

7.2.2.1 Under suitable shearing conditions (preheating, application of blades with a profile adapted to that of the product, etc.) all steels are shearable in the condition “annealed to maximum hardness requirements”.

7.2.2.2 The steel types 28Cr4, 28CrS4, 20MnCr5, 20MnCrS5, 22CrMoS3-5, 20MoCr3, 20MoCrS3, 20MoCr4, 20MoCrS4, 16NiCr4, 16NiCrS4, 18NiCr5-4, 17CrNi6-6, 15NiCr13, 17NiCrMo6-4, 17NiCrMoS6-4, 20NiCrMoS6-4 and 18CrNiMo7-6 and the corresponding grades with requirements on hardenability (see Tables 5 and 6), are, under suitable conditions, also shearable when supplied in the “treated to improve shearability” condition with the hardness requirements given in Table 7.

7.2.2.3 The unalloyed steels and the steels 17Cr3, 17CrS3, 16MnCr5, 16MnCrS5, 16MnCrB5, 18CrMo4, 18CrMoS4, 10NiCr5-4, 20NiCrMo2-2, 20NiCrMoS2-2 and the corresponding grades with requirements on hardenability (see Tables 5 and 6) are shearable in the untreated condition under suitable conditions.

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 to 8. The grain structure shall be considered satisfactory if 70 % of the area is within the specified size limits.

7.3.2 The steels shall have a degree of cleanliness corresponding to the special steel quality (see A.1, annex D and Tables 8 to 10).

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 A.2).

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; in the case of hot-rolled bars and rods with reference to EN 10221, in the case of flat products with reference to EN 10163-2.

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 on surface quality are made.

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

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

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 C).

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 the agreements made at the time of enquiry and order, 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 3 for the steel grade concerned.

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

In addition, the inspection 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 inspections and tests ordered as a result of supplementary requirements (see annex A);
- 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 Verifications of the hardenability and hardness

8.2.1.1 For steels being ordered without hardenability requirements, i.e. without the symbol +H, +HH or +HL in the designation, the hardness requirements given for the relevant heat-treatment condition in Table 1, column 9, subheading 2, shall be verified.

For steels being ordered with the symbol +H, +HH or +HL in the designation (see Tables 5 and 6), unless otherwise agreed, only the hardenability requirements according to Table 5 or 6 shall be verified. If so agreed at the time of enquiry and order, verification of hardenability may be provided by calculation. The calculation method shall also be agreed upon in this case.

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 in Table 12.

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

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 **A.5**).

Table 1 — Combinations of usual heat-treatment conditions at delivery, product forms and requirements according to Tables 3 to 7

1	2	3	4	5	6	7	8	9	10	11			
1	Heat-treatment condition at delivery	Symbol	× = Applicable for					Applicable requirements if the steel is ordered with the designation given in					Remarks
			semi-finished products	bars	rod	flat products	hammer and drop forgings	Table 3		Table 5 or 6			
								1	2	1	2	3	
2	Untreated	None or + U	×	×	×	×	×	Chemical composition according to Tables 3 and 4	—		As in column 9 (see footnote 2 to Table 3)	Hardenability values according to Table 5 or 6	Observe also supplementary requirements given in annex A
3	Treated to improve shearability	+ S	×	×	—	—	—		Brinell hardness according to Table 7	Column + S			
4	Annealed to maximum hardness requirements	+ A	×	×	×	×	×			Column + A			
5	Treated to hardness range	+ TH	—	×	×	×	×			Column + TH			
6	Treated to ferrite-pearlite structure and hardness range	+ FP	—	×	—	—	×			Column + FP			
7	Others	Other treatment conditions, for example certain annealing conditions to achieve a certain structure, may be agreed at the time of enquiry and order. The condition “annealed to achieve a spheroidization of the carbides”, as required for cold heading and cold extrusion, is covered in EURONORM 119.											

Table 2 — Surface condition at delivery

1	2	3	4	5	6	7	8	9	10
1	Surface condition at delivery		Symbol	× = in general applicable for					Notes
				semi-finished products such as blooms billets	bars	rods	flat products	products and drop forgings (see 1.1, note 2)	
2	Unless otherwise agreed	As hot worked	None or + HW	× ¹⁾	×	×	×		
3	Particular conditions supplied by agreement	HW +pickled	+ PI	—	—	×	×	—	3)
4		HW + blast cleaned	+ BC	×	×	×	×	×	
5		HW + rough machined	²⁾	—	×	×	—	×	

¹⁾ The term “hot worked” includes in the case of semi-finished products also the continuously cast condition.

²⁾ Until the term “rough machined” is defined by, for example, machining allowances etc., the details are to be agreed at the time of enquiry and order.

³⁾ In addition certain surface treatments like oiled or limed or phosphated may be agreed.

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

Steel designation		% by mass ¹⁾²⁾³⁾								
name	number	C	Si max.	Mn	P max	S	Cr	Mo	Ni	B
C10E	1.1121	0,07 to 0,13	0,40	0,30 to 0,60	0,035	≤ 0,035				
C10R	1.1207	0,07 to 0,13	0,40	0,30 to 0,60	0,035	0,020 to 0,040				
C15E	1.1141	0,12 to 0,18	0,40	0,30 to 0,60	0,035	≤ 0,035				
C15R	1.1140	0,12 to 0,18	0,40	0,30 to 0,60	0,035	0,020 to 0,040				
C16E	1.1148	0,12 to 0,18	0,40	0,60 to 0,90	0,035	≤ 0,035				
C16R	1.1208	0,12 to 0,18	0,40	0,60 to 0,90	0,035	0,020 to 0,040				
17Cr3	1.7016	0,14 to 0,20	0,40	0,60 to 0,90	0,035	≤ 0,035	0,70 to 1,00			
17CrS3	1.7014					0,020 to 0,040				
28Cr4	1.7030	0,24 to 0,31	0,40	0,60 to 0,90	0,035	≤ 0,035	0,90 to 1,20			
28CrS4	1.7036					0,020 to 0,040				
16MnCr5	1.7131	0,14 to 0,19	0,40	1,00 to 1,30	0,035	≤ 0,035	0,80 to 1,10			
16MnCrS5	1.7139					0,020 to 0,040				
16MnCrB5	1.7160	0,14 to 0,19	0,40	1,00 to 1,30	0,035	≤ 0,035	0,80 to 1,10			0,0008 to 0,0050 ⁴⁾

Table 3 — Steel grades and chemical composition (cast analysis) (continued)

Steel designation		% by mass ¹⁾²⁾³⁾								
name	number	C	Si max.	Mn	P max.	S	Cr	Mo	Ni	B
20MnCr5	1.7147	0,17 to 0,22	0,40	1,10 to 1,40	0,035	≤ 0,035	1,00 to 1,30			
20MnCrS5	1.7149					0,020 to 0,040				
18CrMo4	1.7243	0,15 to 0,21	0,40	0,60 to 0,90	0,035	≤ 0,035	0,90 to 1,20	0,15 to 0,25		
18CrMoS4	1.7244					0,020 to 0,040				
22CrMoS3-5	1.7333	0,19 to 0,24	0,40	0,70 to 1,00	0,035	0,020 to 0,040	0,70 to 1,00	0,40 to 0,50		
20MoCr3	1.7320	0,17 to 0,23	0,40	0,60 to 0,90	0,035	≤ 0,035	0,40 to 0,70	0,30 to 0,40		
20MoCrS3	1.7319					0,020 to 0,040				
20MoCr4	1.7321	0,17 to 0,23	0,40	0,70 to 1,00	0,035	≤ 0,035	0,30 to 0,60	0,40 to 0,50		
20MoCrS4	1.7323					0,020 to 0,040				
16NiCr4	1.5714	0,13 to 0,19	0,40	0,70 to 1,00	0,035	≤ 0,035	0,60 to 1,00		0,80 to 1,10	
16NiCrS4	1.5715					0,020 to 0,040				
10NiCr5-4	1.5805	0,07 to 0,12	0,40	0,60 to 0,90	0,035	≤ 0,035	0,90 to 1,20		1,20 to 1,50	
18NiCr5-4	1.5810	0,16 to 0,21	0,40	0,60 to 0,90	0,035	≤ 0,035	0,90 to 1,20		1,20 to 1,50	
17CrNi6-6	1.5918	0,14 to 0,20	0,40	0,50 to 0,90	0,035	≤ 0,035	1,40 to 1,70		1,40 to 1,70	
15NiCr13	1.5752	0,14 to 0,20	0,40	0,40 to 0,70	0,035	≤ 0,035	0,60 to 0,90		3,00 to 3,50	
20NiCrMo2-2	1.6523	0,17 to 0,23	0,40	0,65 to 0,95	0,035	≤ 0,035	0,35 to 0,70	0,15 to 0,25	0,40 to 0,70	
20NiCrMoS2-2	1.6526					0,020 to 0,040				
17NiCrMo6-4	1.6566	0,14 to 0,20	0,40	0,60 to 0,90	0,035	≤ 0,035	0,80 to 1,10	0,15 to 0,25	1,20 to 1,50	
17NiCrMoS6-4	1.6569					0,020 to 0,040				
20NiCrMoS6-4	1.6571	0,16 to 0,23	0,40	0,50 to 0,90	0,035	0,020 to 0,040	0,60 to 0,90	0,25 to 0,35	1,40 to 1,70	
18CrNiMo7-6	1.6587	0,15 to 0,21	0,40	0,50 to 0,90	0,035	≤ 0,035	1,50 to 1,80	0,25 to 0,35	1,40 to 1,70	
14NiCrMo13-4	1.6657	0,11 to 0,17	0,40	0,30 to 0,60	0,035	≤ 0,035	0,80 to 1,10	0,10 to 0,25	3,00 to 3,50	

¹⁾ 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. All reasonable precautions should be taken to prevent the addition from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

²⁾ Where requirements are made on hardenability (see Tables 5 and 6), slight deviations from the limits for the cast analysis are permitted, except for phosphorus and sulfur; these deviations shall, however, not exceed in the case of carbon $\pm 0,01$ % and in all other cases the values acc. to Table 4.

³⁾ Steels with improved machinability as a result of the addition of lead or higher sulfur contents, depending on the manufacturing process up to around 0,100 % S (including controlled sulfide and oxide formation, e.g. calcium treatment), may be supplied on request. In this case, the upper limit of the manganese content may be increased by 0,15 %.

⁴⁾ Boron is in this case added not for increase of hardenability but to improve the toughness of the case hardened zone.