European Standard EN 10085: 2001 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword
This standard has been prepared by ECISSTC 23 'Steels for heat treatment, alloy steels and free-cutting steels - Qualities' (Secretariat: Germany). The responsible German body involved in its preparation was the Normenausschuss Eisen und Stahl (Steel and Iron Standards Committee).

The DIN Standards corresponding to the documents referred to in clause 2 of the EN are as follows:

- CR 10260 DIN V 17006-100
- Euronorm 103 DIN 50601
- Euronorm 104 DIN 50192

Amendments
DIN 17211, April 1987 edition, has been superseded by the specifications of EN 10085.

Previous editions

National Annex NA
Standards referred to
(and not included in Normative references)

- DIN 50192 Determination of depth of decarburization of steel
- DIN 50601 Metallographic examination - Determination of the ferritic or austenitic grain size of steel and ferrous materials
- DIN V 17006-100 Designation systems for steel – Additional symbols for steel names

EN comprises 26 pages.
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 2001-01-19.
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 Management Centre or to any CEN member.
The European Standards exist 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 Management Centre has the same status as the official versions.
CEN members are the national standards bodies of Austria, Belgium, the 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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Bibliography
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


EURONORM 103\textsuperscript{1}, Microscopic determination of the ferritic or austenitic grain size of steels

EURONORM 104\textsuperscript{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.

\textsuperscript{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 relating to 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 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 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>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heat-treatment condition at delivery</td>
<td>Symbol</td>
<td>x = indicates applicable for</td>
<td>Requirements</td>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Semi-products</td>
<td>Bars</td>
<td>Rod</td>
<td>Flat products</td>
<td>Forgings</td>
<td>1.</td>
<td>2.</td>
</tr>
<tr>
<td>2</td>
<td>Soft annealed</td>
<td>+A</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Quenched and tempered</td>
<td>+QT</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Others</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> 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

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Surface condition at delivery</td>
<td>Symbol</td>
<td>x = indicates in general applicable for</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>Semi-finished products</td>
<td>Bars</td>
<td>Rod</td>
<td>Flat products</td>
<td>Forgings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Unless otherwise agreed</td>
<td>As rolled or forged</td>
<td>None</td>
<td>x^a</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>+pickled</td>
<td>+Pl</td>
<td>--</td>
<td>--</td>
<td>x</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>+blast cleaned</td>
<td>+BC</td>
<td>x</td>
<td>x</td>
<td>--</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>+rough machined</td>
<td>--^b</td>
<td>--</td>
<td>x</td>
<td>x</td>
<td>--</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

^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)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Steel name</th>
<th>Steel number</th>
<th>C</th>
<th>Si max.</th>
<th>Mn</th>
<th>P max.</th>
<th>S max.</th>
<th>% by mass&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Al</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24CrMo13-6</td>
<td>1.8516</td>
<td>0.20 to 0.27</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>3.00 to 3.50</td>
<td>0.50 to 0.70</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>31CrMo12</td>
<td>1.8515</td>
<td>0.28 to 0.35</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>2.80 to 3.30</td>
<td>0.30 to 0.50</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32CrAlMo7-10</td>
<td>1.8505</td>
<td>0.28 to 0.35</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>0.80 to 1.20</td>
<td>1.50 to 1.80</td>
<td>0.20 to 0.40</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>31CrMoV9</td>
<td>1.8519</td>
<td>0.27 to 0.34</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>2.30 to 2.70</td>
<td>0.15 to 0.25</td>
<td>-</td>
<td>0.10 to 0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>33CrMoV12-9</td>
<td>1.8522</td>
<td>0.29 to 0.36</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>2.80 to 3.30</td>
<td>0.70 to 1.00</td>
<td>0.15 to 0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>34CrAlNi7-10</td>
<td>1.8550</td>
<td>0.30 to 0.37</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>0.80 to 1.20</td>
<td>1.50 to 1.80</td>
<td>0.15 to 0.25</td>
<td>0.85 to 1.15</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41CrAlMo7-10</td>
<td>1.8509</td>
<td>0.38 to 0.45</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>0.80 to 1.20</td>
<td>1.50 to 1.80</td>
<td>0.20 to 0.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40CrMoV13-9</td>
<td>1.8523</td>
<td>0.36 to 0.43</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>3.00 to 3.50</td>
<td>0.80 to 1.10</td>
<td>-</td>
<td>0.15 to 0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>34CrAlMo5-10</td>
<td>1.8507</td>
<td>0.30 to 0.37</td>
<td>0.40</td>
<td>0.40 to 0.70</td>
<td>0.025</td>
<td>0.035</td>
<td>0.80 to 1.20</td>
<td>1.00 to 1.30</td>
<td>0.15 to 0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> 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.

<sup>b</sup> 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

<table>
<thead>
<tr>
<th>Element</th>
<th>Permissible maximum content according to cast analysis</th>
<th>Permissible deviation a</th>
<th>% by mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>≤ 0.45</td>
<td>± 0.02</td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>≤ 0.40</td>
<td>+ 0.03</td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>≤ 0.80</td>
<td>± 0.04</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>≤ 0.025</td>
<td>+ 0.005</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>≤ 0.035</td>
<td>+ 0.005</td>
<td></td>
</tr>
<tr>
<td>Al</td>
<td>≥ 0.80, ≤ 1.20</td>
<td>± 0.10</td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td>≥ 1.00, ≤ 2.00</td>
<td>± 0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 2.00, ≤ 3.50</td>
<td>± 0.10</td>
<td></td>
</tr>
<tr>
<td>Mo</td>
<td>≥ 0.30, ≤ 1.00</td>
<td>± 0.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 0.30</td>
<td>± 0.04</td>
<td></td>
</tr>
<tr>
<td>Ni</td>
<td>≥ 1.15</td>
<td>± 0.05</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>≤ 0.25</td>
<td>± 0.02</td>
<td></td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Hardness HR max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel name</td>
<td>Steel number</td>
</tr>
<tr>
<td>24CrMo13-6</td>
<td>1.8516</td>
</tr>
<tr>
<td>31CrMo12</td>
<td>1.8515</td>
</tr>
<tr>
<td>32CrAlMo7-10</td>
<td>1.8505</td>
</tr>
<tr>
<td>31CrMoV9</td>
<td>1.8519</td>
</tr>
<tr>
<td>33CrMoV12-9</td>
<td>1.8522</td>
</tr>
<tr>
<td>34CrAlNi7-10</td>
<td>1.8550</td>
</tr>
<tr>
<td>41CrAlMo7-10</td>
<td>1.8509</td>
</tr>
<tr>
<td>40CrMoV13-9</td>
<td>1.8523</td>
</tr>
<tr>
<td>34CrAlMo5-10</td>
<td>1.8507</td>
</tr>
</tbody>
</table>
Table 6 - Mechanical properties in the quenched and tempered condition (+QT)\(^a\)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Steel number</th>
<th>16 ≤ d ≤ 40 mm</th>
<th>40 &lt; d ≤ 100 mm</th>
<th>100 &lt; d ≤ 160 mm</th>
<th>160 &lt; d ≤ 250 mm</th>
<th>HV 1 (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Re MPa (^a)</td>
<td>A % min.</td>
<td>KV J min.</td>
<td>Re MPa (^a)</td>
<td>A % min.</td>
</tr>
<tr>
<td>24CrMo13-6</td>
<td>1.8516</td>
<td>1000 to 1200</td>
<td>800</td>
<td>10</td>
<td>25</td>
<td>950 to 1150</td>
</tr>
<tr>
<td>31CrMo12</td>
<td>1.8515</td>
<td>1030 to 1230</td>
<td>835</td>
<td>10</td>
<td>25</td>
<td>980 to 1180</td>
</tr>
<tr>
<td>32CrAlMo7-10</td>
<td>1.8505</td>
<td>1070 to 1230</td>
<td>835</td>
<td>10</td>
<td>25</td>
<td>980 to 1180</td>
</tr>
<tr>
<td>31CrMoV9</td>
<td>1.8519</td>
<td>1100 to 1300</td>
<td>900</td>
<td>9</td>
<td>25</td>
<td>1000 to 1200</td>
</tr>
<tr>
<td>33CrMoV12-9</td>
<td>1.8522</td>
<td>1150 to 1350</td>
<td>950</td>
<td>11</td>
<td>30</td>
<td>1050 to 1250</td>
</tr>
<tr>
<td>34CrAlNi7-10</td>
<td>1.8550</td>
<td>900 to 1100</td>
<td>680</td>
<td>10</td>
<td>30</td>
<td>850 to 1050</td>
</tr>
<tr>
<td>41CrAlMo7-10</td>
<td>1.8509</td>
<td>950 to 1150</td>
<td>750</td>
<td>11</td>
<td>25</td>
<td>900 to 1100</td>
</tr>
<tr>
<td>40CrMoV13-9</td>
<td>1.8523</td>
<td>950 to 1150</td>
<td>750</td>
<td>11</td>
<td>25</td>
<td>900 to 1100</td>
</tr>
<tr>
<td>34CrAlMo5-10(^c)</td>
<td>1.8507</td>
<td>800 to 1000</td>
<td>600</td>
<td>14</td>
<td>35</td>
<td>800 to 1000</td>
</tr>
</tbody>
</table>

\(^a\) R\(_t\) = 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/mm\(^2\)
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.

<table>
<thead>
<tr>
<th>No.</th>
<th>Requirements</th>
<th>Test Unit</th>
<th>Amount of testing</th>
<th>Line</th>
<th>6a</th>
<th>7a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>Number of sample products per test unit</td>
<td>Number of tests per sample product</td>
<td>Sampling</td>
<td>Test method</td>
</tr>
<tr>
<td>1</td>
<td>Chemical composition</td>
<td>3.4</td>
<td>C</td>
<td>(The cast analysis is given by the manufacturer; for product analysis, see B.4)</td>
<td>T1</td>
<td>General conditions</td>
</tr>
<tr>
<td>2</td>
<td>Hardness in the soft annealed condition (+A)</td>
<td>5</td>
<td>C + D + T</td>
<td>1</td>
<td>T2</td>
<td>T2</td>
</tr>
</tbody>
</table>
| 3   | Mechanical properties of quenched and tempered products (+QT) | 6 | C + D + T | 1 | T3 | T3 | Tensile and impact tests | The tensile test shall be carried out in accordance with EN 10002-1 on proportional test pieces having a gauge length of 

\[ l_a = 5.65 \sqrt{S_s} \]

where \( S_s \) 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 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 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 treated.
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

For small products \((d \text{ or } b \leq 25 \text{ mm})\), 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.

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**
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
<table>
<thead>
<tr>
<th>Type of test</th>
<th>Product thickness</th>
<th>Location of the test piece&lt;sup&gt;a&lt;/sup&gt; for a product width of</th>
<th>Distance of the test piece from the rolled surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>w &lt; 600 mm</td>
<td>w ≥ 600 mm</td>
</tr>
<tr>
<td>Tensile test&lt;sup&gt;b&lt;/sup&gt;</td>
<td>≤ 30 mm</td>
<td>longitudinal</td>
<td>transverse</td>
</tr>
<tr>
<td></td>
<td>&gt; 30 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact test&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&gt; 10&lt;sup&gt;d&lt;/sup&gt; mm</td>
<td>longitudinal</td>
<td>longitudinal</td>
</tr>
</tbody>
</table>

<sup>a</sup> Location of the longitudinal axis of the test piece with respect to the principal rolling direction.

<sup>b</sup> The test piece shall comply with EN 10002-1.

<sup>c</sup> The longitudinal axis of the test piece shall be perpendicular to the rolled surface.

<sup>d</sup> 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.

---

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

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.
**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 agreed, 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

<table>
<thead>
<tr>
<th>Designation</th>
<th>Steel name</th>
<th>Steel number</th>
<th>Soft annealing Temperature °C</th>
<th>Hardening Temperature&lt;sup&gt;a&lt;/sup&gt; °C</th>
<th>Agent</th>
<th>Tempering Temperature&lt;sup&gt;b,c&lt;/sup&gt; °C</th>
<th>Nitriding Temperature&lt;sup&gt;d&lt;/sup&gt; °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>24CrMo13-6</td>
<td>1.8516</td>
<td>650 to 700</td>
<td>870 to 970</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>31CrMo12</td>
<td>1.8515</td>
<td>650 to 700</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>32CrAlMo7-10</td>
<td>1.8505</td>
<td>650 to 750</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>31CrMoV9</td>
<td>1.8519</td>
<td>680 to 720</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>33CrMoV12-9</td>
<td>1.8522</td>
<td>680 to 720</td>
<td>870 to 970</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>34CrAlNi7-10</td>
<td>1.8550</td>
<td>650 to 700</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>41CrAlMo7-10</td>
<td>1.8509</td>
<td>650 to 750</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>40CrMoV13-9</td>
<td>1.8523</td>
<td>680 to 720</td>
<td>870 to 970</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
<tr>
<td>34CrAlMo5-10</td>
<td>1.8507</td>
<td>650 to 750</td>
<td>870 to 930</td>
<td>Oil or water</td>
<td>580 to 700</td>
<td>480 to 570</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Time for austenitizing as a guide: 0.5 h minimum.

<sup>b</sup> Time for tempering as a guide: 1 h minimum.

<sup>c</sup> With very large sizes, the tempering temperature may be agreed at the time of enquiry and order.

<sup>d</sup> 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