

Steels for quenching and tempering —

Part 1: General technical delivery conditions

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National foreword

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Foreword

This document (EN 10083-1:2006) 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of an identical text or by endorsement, at the latest by February 2007, and conflicting national standards shall be withdrawn at the latest by February 2007.

Together with Part 2 and Part 3 of this standard, this Part 1 is a revision of the following European Standards:

EN 10083-1:1991 + A1:1996, *Quenched and tempered steels — Part 1: Technical delivery conditions for special steels*

EN 10083-2:1991 + A1:1996, *Quenched and tempered steels — Part 2: Technical delivery conditions for unalloyed quality steels*

EN 10083-3:1995, *Quenched and tempered steels — Part 3: Technical delivery conditions for boron steels*

and of

EURONORM 86:1970, *Steels for flame and induction hardening — Quality specifications*

The specific requirements for steels for quenching and tempering are given in the following parts:

Part 2: Technical delivery conditions for non alloy steels

Part 3: Technical delivery conditions for alloy steels

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

1 Scope

This part of EN 10083 specifies the general technical delivery requirements for

- semi-finished products, hot formed, e.g. blooms, billets, slabs (see NOTES 2 and 3),
- bars (see NOTE 2),
- rod,
- wide flats,
- hot-rolled strip and sheet/plate,
- forgings (see NOTE 2)

manufactured from the direct hardening non alloy steels for quenching and tempering (see EN 10083-2), the direct hardening alloy steels for quenching and tempering (see EN 10083-3), the non alloy flame and induction hardening steels (see EN 10083-2) and the alloy flame and induction hardening steels (see EN 10083-3), and supplied in one of the heat treatment conditions given for the different types of products in the relevant tables of EN 10083-2 and EN 10083-3 and in one of the surface conditions given in the relevant tables of EN 10083-2 and EN 10083-3.

The steels are generally intended for the manufacture of quenched and tempered, flame or induction hardened machine parts, but can also be used in the normalized condition (see EN 10083-2).

Where applicable, the requirements for mechanical properties given in EN 10083-2 and EN 10083-3 are restricted to the relevant tables in these documents.

NOTE 1 European Standards on similar grades are listed in Annex C.

NOTE 2 Hammer forged semi-finished products (blooms, billets, slabs etc.), seamless rolled rings and hammer forged bars are in the following covered under semi-finished products or bars and not under the term "forgings".

NOTE 3 Special agreements should be made when ordering un-worked continuously cast semi-finished products.

NOTE 4 In accordance with EN 10020, the steels covered by EN 10083-2:2006 are quality and special steels, the steels covered by EN 10083-3:2006 are special steels. The differences between quality and special steels are characterized by the following requirements, which are valid for special steels only:

- the minimum impact values in the quenched and tempered condition (for non alloy special steels in the case of mean percentages by mass of carbon < 0,50 % only);
- limiting hardenability values in the Jominy test (for non alloy steels in the case of percentages by mass of carbon > 0,30 % only);
- limited oxide inclusion content;
- lower maximum contents for phosphorus and sulphur.

NOTE 5 This European Standard does not apply for bright steel products. For bright steel products EN 10277-1 and EN 10277-5 apply.

In special cases, variations in these technical delivery requirements or additions to them may be agreed at the time of enquiry and order (see Annex B).

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

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*
- EN 10020:2000, *Definition and classification of grades of steel*
- EN 10021, *General technical delivery requirements for steel and iron products*
- EN 10027-1, *Designation systems for steels — Part 1: Steel names*
- EN 10027-2, *Designation systems for steels — Part 2: Numerical system*
- EN 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method*
- EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products*
- EN 10079:1992, *Definition of steel products*
- EN 10083-2:2006, *Steels for quenching and tempering — Part 2: Technical delivery conditions for non alloy steels*
- EN 10083-3:2006, *Steels for quenching and tempering — Part 3: Technical delivery conditions for alloy steels*
- EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*
- 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*
- EN 10221, *Surface quality classes for hot-rolled bars and rods — Technical delivery conditions*
- CR 10261, *ECISS Information Circular 11 — Iron and steel — Review of available methods of chemical analysis*
- EN 10308, *Non destructive testing — Ultrasonic testing of steel bars*
- EN ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*
- EN ISO 642, *Steel — Hardenability test by end quenching (Jominy test) (ISO 642:1999)*
- EN ISO 643, *Steels — Micrographic determination of the apparent grain size (ISO 643:2003)*
- EN ISO 3887, *Steels — Determination of depth of decarburization (ISO 3887:2003)*
- EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*
- EN ISO 6508-1:2005, *Metallic materials — Rockwell hardness test— Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1:2005)*
- EN ISO 14284:2002, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10052:1993, EN 10079:1992, EN ISO 377:1997, EN ISO 14284:2002 and the following apply.

3.1

flame and induction hardening steels

flame and induction hardening steels are characterized by the fact that, when in the usual quenched and tempered condition, they are capable of being surface hardened by local heating and quenching without any appreciable impairment of the strength and toughness properties of the core

3.2

quenched and tempered steels

quenched and tempered steels are engineering steels which because of their chemical composition are suitable for hardening and in the quenched and tempered condition have good toughness at a given tensile strength

3.3

ruling section

section for which the specified mechanical properties apply (see Annex A). 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

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades according to EN 10020 is indicated in EN 10083-2 and EN 10083-3.

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 of EN 10083-2 and EN 10083-3 shall be allocated in accordance with EN 10027-1.

4.2.2 Steel numbers

For the steel grades covered by this European Standard, the steel numbers as given in the relevant tables of EN 10083-2 and EN 10083-3 shall be allocated in accordance with EN 10027-2.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The manufacturer shall obtain the following information from 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 bar, rod, sheet or forging);
- c) the number of the dimensional standard (e.g. EN 10060);
- d) the dimensions and tolerances on dimensions and shape and, if applicable, letters denoting relevant special tolerances;
- e) the number of this European Standard including the number of the relevant part;
- f) steel name or steel number (see 4.2, EN 10083-2 and EN 10083-3);
- g) the type of inspection document in accordance with EN 10204 (see 8.1).

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 any of these options, the supplier shall act in accordance with the basic specification of this European Standard (see 5.1):

- a) any particular heat treatment condition (see 6.3.2);
- b) any particular surface condition (see 6.3.3);
- c) any verification of the product analysis (see 7.1.1.2 and B.6);
- d) any requirement to the hardenability (+H, +HH, +HL) for special steels (see 7.1.2) and if agreed the information about calculation of the hardenability (see 10.3.2);
- e) any verification of mechanical properties of reference test pieces in the quenched and tempered (+QT) or normalized (+N) condition (see B.1 and B.2);
- f) any fine grain requirements or verification of fine grain size (see 7.4 and B.3);
- g) any requirements for the verification of non-metallic inclusion content of special steels (see 7.4 and B.4);
- h) any requirement for internal soundness (see 7.5 and B.5);
- i) any requirement relating to surface quality (see 7.6.3);
- j) any requirement regarding the permissible depth of decarburization (see 7.6.4);
- k) suitability of bars and rod for bright drawing (see 7.6.5);
- l) any requirement relating to removal of surface defects (see 7.6.6);
- m) inspection of surface condition and dimensions shall be carried out by the purchaser at the manufacturer's works (see 8.1.4);

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n) any requirement concerning special marking of the products (see Clause 11 and B.7).

EXAMPLE

20 round bars with the nominal diameter 20 mm and the nominal length of 8000 mm according to EN 10060 made of steel grade 25CrMo4 (1.7218) according to EN 10083-3 in the heat treatment condition +A, inspection certificate 3.1 as specified in EN 10204.

20 round bars EN 10060 - 20x8000
EN 10083-3 – 25CrMo4+A
EN 10204 - 3.1

or

20 round bars EN 10060 - 20x8000
EN 10083-3 – 1.7218+A
EN 10204 - 3.1

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 to 6.4.

6.2 De-oxidation

All steels shall be killed.

6.3 Heat treatment and surface condition at delivery

6.3.1 Untreated condition

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

NOTE Depending on product shape and dimensions, not all steel grades can be delivered in the hot worked untreated condition.

6.3.2 Particular heat treatment condition

If so agreed at the time of enquiry and order, the products shall be delivered with one of the particular heat-treatment conditions given in Table 1, lines 3 to 7, of EN 10083-2:2006 or Table 1, lines 3 to 6, of EN 10083-3:2006.

6.3.3 Particular surface condition

If so agreed at the time of enquiry and order, the products shall be delivered with one of the particular surface conditions given in Table 2, lines 3 to 7, of EN 10083-2:2006 or EN 10083-3:2006.

6.4 Cast separation

The products shall be delivered separated by cast.

7 Requirements

7.1 Chemical composition, hardenability and mechanical properties

7.1.1 Chemical composition

7.1.1.1 The chemical composition determined by cast analysis shall comply with the values in Table 3 of EN 10083-2:2006 or EN 10083-3:2006 respectively.

7.1.1.2 Permissible deviations between the limiting values for cast analysis and the values for product analysis are given in Tables 4 of EN 10083-2:2006 and EN 10083-3:2006 respectively.

The product analysis shall be carried out when specified at the time of the order (see B.6).

7.1.2 Hardenability

Where the steel is ordered by using the symbols for normal (+H) or restricted (+HL, +HH) hardenability requirements, the hardenability values given in the relevant tables of EN 10083-2 and EN 10083-3 shall apply.

7.1.3 Mechanical properties

Where the steel is ordered without hardenability requirements, the requirements for mechanical properties specified in EN 10083-2 and EN 10083-3 apply as appropriate for the particular heat treatment condition.

The mechanical property values given in EN 10083-2 and EN 10083-3 apply to test pieces in the quenched and tempered or normalized condition which have been taken and prepared in accordance with Figure 1 or Figures 2 and 3.

7.2 Machinability

All steels delivered in the soft annealed (+A) condition are machinable. Where improved machinability is required, the grades with a specified sulphur range should be ordered and/or with a specific treatment to improve machinability (e.g. Ca treatment).

7.3 Shearability of semi-finished products and bars

The relevant specifications in EN 10083-2 and EN 10083-3 shall apply.

7.4 Structure

The requirements specified in the relevant clauses of EN 10083-2 and EN 10083-3 shall apply.

Regarding fine grain requirements and/or verification of fine grain size see B.3.

Regarding the verification of non-metallic inclusion content of special steels see B.4.

NOTE Segregation is the result of a natural phenomenon. Segregations can be found in ingots as well as in slabs, blooms and billets from the continuous casting process. The positive segregation is a concentration of various elements at different locations in the ingot, slab, bloom and billet. In case of flat products customers should note, that these segregations can occur parallel to the surface of the product. Especially for medium and high carbon contents segregations lead to a higher hardness and should be taken into consideration during further heat treatments.

7.5 Internal soundness

Where appropriate, requirements relating to the internal soundness of products shall be agreed at the time of enquiry and order, if possible with reference to European Standards. EN 10160 specifies requirements of ultrasonic testing of flat products of thickness equal to or greater than 6 mm and EN 10308 specifies requirements of ultrasonic testing of steel bars (see B.5).

7.6 Surface quality

7.6.1 All products shall have a smooth finish appropriate to the manufacturing processes applied, see also 6.3.3

7.6.2 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.

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

Sheet/plate and wide flats shall be delivered with surface class A, subclass 1 according to EN 10163-2 unless otherwise agreed at the time of enquiry and order.

Bars and rods shall be delivered with surface class A according to EN 10221 unless otherwise agreed at the time of enquiry and order.

NOTE 1 Bars and rods for cold heading and cold extrusion and subsequent quenching and tempering are contained in EN 10263-4 (together with EN 10263-1).

NOTE 2 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.

7.6.4 Requirements relating to the permissible depth of decarburization may be agreed at the time of enquiry and order for special steels.

The depth of decarburization shall be determined in accordance with the micrographic method specified in EN ISO 3887.

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

7.6.6 The removal of surface defects by welding shall only be permitted with the approval of the customer or his representative.

If surface discontinuities are repaired, the method and maximum depth of removal shall be agreed at the time of enquiry and order.

7.7 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

8.1 Testing procedures and types of documents

8.1.1 Products complying with the individual parts of 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 2.2 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 Tables 3 of EN 10083-2:2006 and EN 10083-3:2006 for the steel grade concerned.

8.1.3 If, in accordance with the order agreements, an inspection certificate 3.1 or 3.2 is to be issued, the specific inspection described in 8.3, Clauses 9 and 10 shall be carried out and the results shall be confirmed in the inspection certificate.

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

- a) the manufacturer's results for the cast analysis of all elements specified in the Tables 3 of EN 10083-2:2006 and EN 10083-3:2006 for the steel grade concerned;
- b) the results of inspections and tests ordered as a result of supplementary requirements (see Annex B);
- c) the symbol letters or numbers relating the inspection certificate, test pieces and products to each other.

8.1.4 Unless otherwise agreed at the time of the order, inspection of surface quality and dimensions shall be carried out by the manufacturer (see also 6.3.3).

8.2 Frequency of testing

8.2.1 Sampling

The verification of mechanical properties and hardenability shall be as specified in EN 10083-2 and EN 10083-3.

8.2.2 Test units

The test units shall be as specified in EN 10083-2 and EN 10083-3.

8.3 Tests to be carried out for specific inspection

The tests to be carried out for specific inspection shall be as specified in EN 10083-2 and EN 10083-3.

9 Preparation of samples and test pieces

9.1 Selection and preparation of samples for chemical analysis

The preparation of samples for product analysis shall be in accordance with EN ISO 14284.

9.2 Location and orientation of samples and test pieces for mechanical tests

9.2.1 Preparation of samples

9.2.1.1 The following samples shall be taken from one sample product of each test unit:

- for normalized (+N) or quenched and tempered (+QT) products one sample for tensile testing;
- for quenched and tempered (+QT) products one sample for one set of six impact test pieces (see 10.2.2).

9.2.1.2 From bars, rods and flat products the samples shall be taken in accordance with Figures 1 to 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.

9.2.2 Preparation of test pieces

9.2.2.1 General

The requirements of EN ISO 377 shall apply.

9.2.2.2 Tensile test pieces

The requirements of EN 10002-1 as appropriate shall apply.

Test pieces may be non-proportional but in cases of dispute proportional test pieces having a gauge length $L_0 = 5,65 \sqrt{S_0}$ shall be used.

For flat products with a nominal thickness < 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.

9.2.2.3 Impact test pieces

The test pieces shall be machined and prepared in accordance with EN 10045-1.

In addition the following requirements apply for flat products: For nominal thicknesses > 12 mm, standard 10 mm x 10 mm test pieces shall be machined in such a way that one side is not further away than 2 mm from a rolled surface (see Figure 3).

9.3 Location and preparation of samples for hardness and hardenability tests

The specifications given in EN 10083-2 and EN 10083-3 shall apply.

9.4 Identification of samples and test pieces

Samples and test pieces shall be marked so that the original products and their location and orientation in the product are known.

10 Test methods

10.1 Chemical analysis

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer. In cases of dispute, the method for product analysis used shall be agreed taking into account the relevant existing European Standards.

NOTE The list of available ENs on chemical analysis is given in CR 10261.

10.2 Mechanical tests

10.2.1 Tensile test

The tensile test shall be carried out in accordance with EN 10002-1.

For the specified yield strength in the tables on mechanical properties in EN 10083-2 and EN 10083-3 the upper yield strength (R_{eH}) shall be determined.

If a yield phenomenon is not present, the 0,2 % proof strength ($R_{p0,2}$) shall be determined.

10.2.2 Impact test

The impact test shall be carried out in accordance with EN 10045-1.

The average values of a set of three test pieces shall be equal to or greater than the specified value. One individual value may be below the specified value, provided that it is not less than 70% of that value.

If the above conditions are not satisfied then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample and tested. To consider the test unit as conforming, after testing the second set, the following conditions shall be satisfied simultaneously:

- The average value of six test pieces shall be equal to or greater than the specified value;
- Not more than two of six individual values may be lower than the specified value;
- Not more than one of the six individual values may be lower than 70 % of the specified value.

If these conditions are not satisfied the sample product is rejected and retests may be carried out on the remainder of the test unit.

10.3 Hardness and hardenability tests

10.3.1 Hardness in treatment conditions +A and +S

For products in treatment conditions +A (soft annealed) and +S (treated to improve shearability), the hardness shall be measured in accordance with EN ISO 6506-1.

10.3.2 Verification of hardenability

As far as available the manufacturer has the option to verify the hardenability by calculation. The calculation method is left to the discretion of the manufacturer. If agreed at the time of enquiry and order the manufacturer shall give sufficient information about the calculation for the customer to confirm the result.

If a calculation formula is not available or in the case of dispute an end quench hardenability test shall be carried out in accordance with EN ISO 642. The temperature for quenching shall comply with the relevant

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tables in EN 10083-2 and EN 10083-3. The hardness values shall be determined in accordance with EN ISO 6508-1:2005, method C.

10.3.3 Surface hardness

The surface hardness of steels after flame or induction hardening shall be determined in accordance with EN ISO 6508-1:2005, method C.

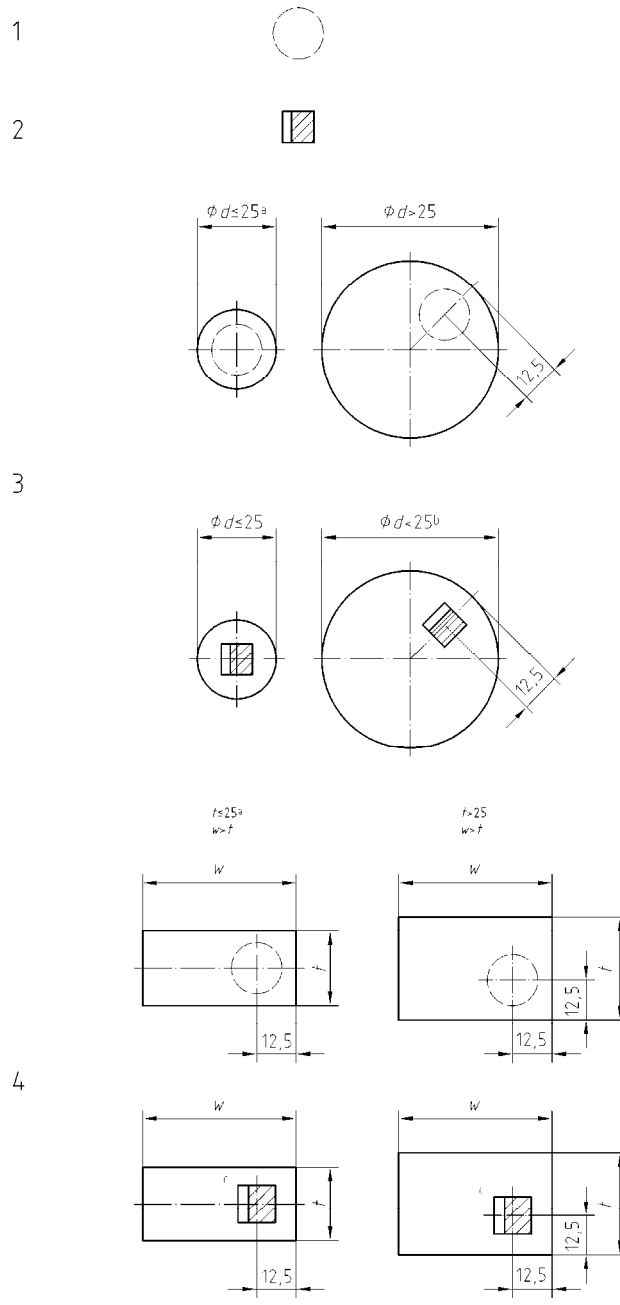
10.4 Retests

For retests, EN 10021 shall apply.

11 Marking, labelling, packaging

The manufacturer shall mark the products or the bundles or boxes in a suitable way so that it is possible to determine the cast, the steel grade and the origin of the delivery (see B.7).

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

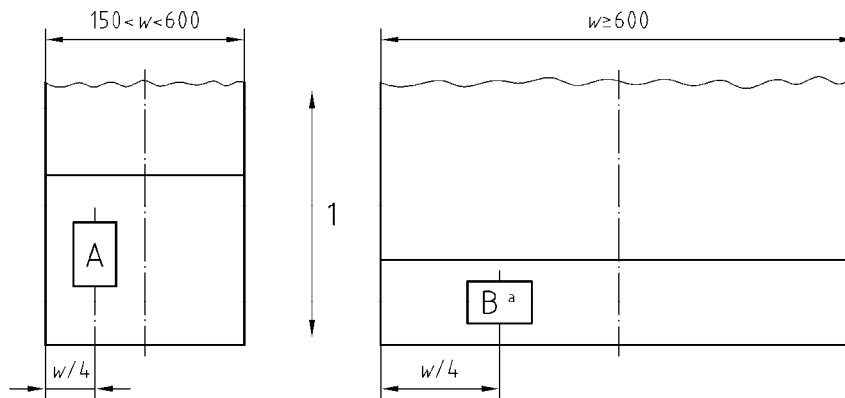
^a For small products (d or $w \leq 25$ mm), the test piece shall, if possible, consist of an un-machined part of the bar.

^b For round bars the longitudinal axis of the notch shall be about parallel to the direction of a diameter.

^c 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, seamless rolled rings and rods

Dimensions in millimetres



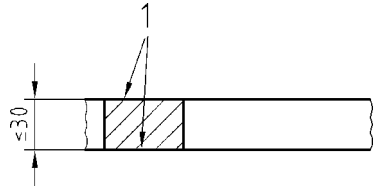
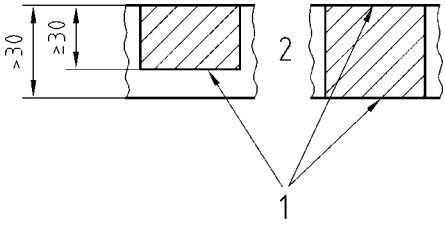
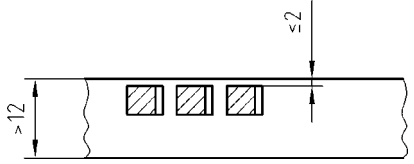
Key

1 principal direction of rolling

^a 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

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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	
	> 30			
Impact test ^c	> 12 ^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 notch shall be perpendicular to the rolled surface. ^d If agreed at the time of ordering, the test piece from products with a thickness exceeding 40 mm may be taken from 1/4 product thickness.				

Key

1 rolled surface 2 (alternatives)

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 3.3.

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

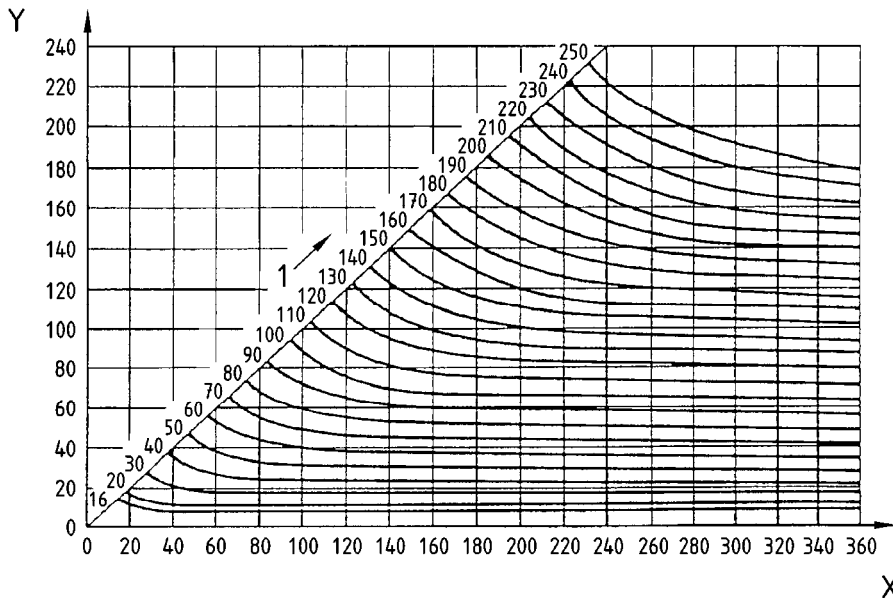
A.2.1 If the test pieces are taken from products with simple cross sections and from positions with quasi two-dimensional heat flow, A.2.1.1 to A.2.1.3 shall apply.

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.

Dimensions in millimetres



Key

- X width
- Y thickness
- 1 diameter of the ruling cross section

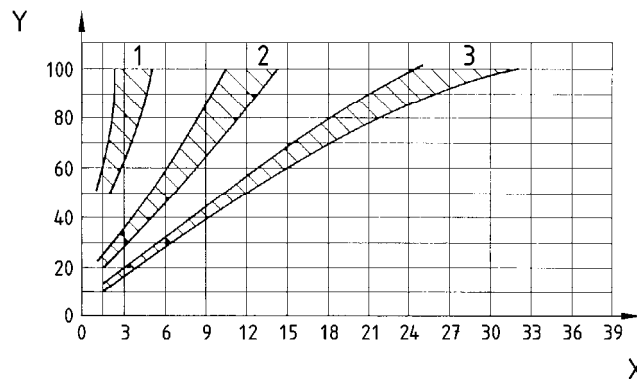
EXAMPLE For a rectangular bar with a section of 40 mm × 60 mm, the diameter of the ruling section is 50 mm.

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

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

NOTE For this purpose, the following procedure may serve as a guideline. The product is hardened in accordance with usual practice. It is then cut so that the hardness and structure at the position of the ruling section provided for taking test pieces can be determined. From another product of the type under consideration and of the same cast, an end quench piece is taken from the prescribed position and tested in the usual way. Then the distance is determined at which the end quench test piece shows the same hardness and structure as the ruling section at the position provided for taking test pieces. On the basis of this distance, the diameter of the ruling section is then estimated using Figure A.2 and Figure A.3.

Dimensions in millimetres

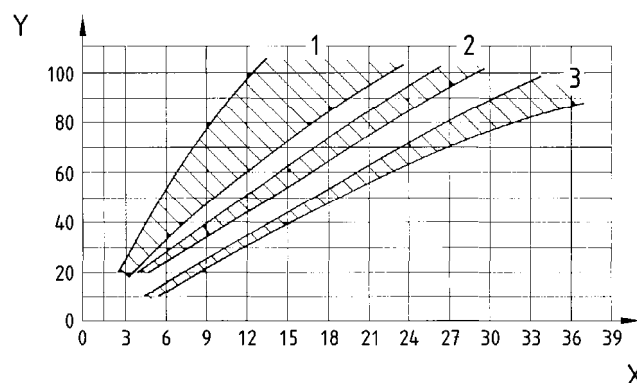


Key

- X distance from the quenched end
- Y bar diameter
- 1 surface
- 2 3/4 radius
- 3 centre

Figure A.2 — Relationship between the cooling rates in end quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated water (source: SAE J406c)

Dimensions in millimetres



Key

- X distance from the quenched end
- Y bar diameter
- 1 surface
- 2 3/4 radius
- 3 centre

Figure A.3 — Relationship between the cooling rates in end quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated oil (source: SAE J406c)

Annex B (normative)

Options

NOTE One or more of the following options 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 or normalized, the requirements for the mechanical properties in the quenched and tempered condition shall be verified on a reference test piece.

In the case of bars and 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 tables for the heat-treatment conditions in EN 10083-2 or EN 10083-3 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 Figure 1 for bars and rods and in accordance with Figure 3 for flat products.

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

For deliveries of non-alloy steels in a condition other than quenched and tempered or normalized, the requirements for the mechanical properties in the normalized condition shall be verified on a reference test piece.

In the case of bars and rods, the sample to be normalized shall, unless otherwise agreed, have the cross-section of the product. In all other cases the dimensions and the preparation of the sample shall be 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 Figure 1 in the case of bars and rods and with Figure 3 in the case of flat products.

B.3 Fine grain steel

When tested in accordance with EN ISO 643, the steel shall have an austenite grain size of 5 or finer. If specific testing is ordered, it shall also be agreed whether this grain size requirement is to be verified by determining the aluminium content or micrographically. In the first case, the aluminium content shall also be agreed.

In the second case, one test piece shall be inspected per cast for the determination of the austenitic grain size. Sampling and sample preparation shall be as specified in EN ISO 643.

For further details see EN 10083-2:2006, A.3 and EN 10083-3:2006, A.3.

B.4 Non-metallic inclusion content

This requirement is applicable to special steels. The microscopically determined non-metallic inclusion content shall be within agreed limits when tested according to a procedure to be agreed at the time of enquiry and order (see Annex E).

NOTE 1 The requirements for non metallic inclusion content apply in every case, however, verification requires a special agreement.

NOTE 2 For steels with a specified minimum sulphur content the agreements should only concern the oxides.

B.5 Non-destructive testing

Steel flat products of thickness equal to or greater than 6 mm shall be tested ultrasonically in accordance with EN 10160 and steel bars shall be tested ultrasonically in accordance with EN 10308. Other products shall be non-destructively tested in accordance with a method to be agreed at the time of enquiry and order and to acceptance criteria also to be agreed at the time of enquiry and order.

B.6 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 EN 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 CR 10261.

B.7 Special agreements for marking

The products shall be specially marked (e.g. by bar coding in accordance with EN 606) in a way agreed upon at the time of enquiry and order.

Annex C (informative)

Other relevant standards

European Standards partially covering the same or very similar steel grades as in EN 10083-2 and EN 10083-3, but intended for other product forms or treatment conditions or for special applications:

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

EN 10085, *Nitriding steels — Technical delivery conditions*

EN 10087, *Free-cutting steels — Technical delivery conditions for semi-finished products, hot-rolled bars and rods*

EN 10089, *Hot-rolled steels for quenched and tempered springs — Technical delivery conditions*

EN 10132-1, *Cold-rolled narrow steel strip for heat-treatment — Technical delivery conditions — Part 1: General*

EN 10132-3, *Cold-rolled narrow steel strip for heat-treatment — Technical delivery conditions — Part 3: Steels for quenching and tempering*

EN 10132-4, *Cold-rolled narrow steel strip for heat-treatment — Technical delivery conditions — Part 4: Spring steels and other applications*

EN 10250-1, *Open die steel forgings for general engineering purposes — Part 1: General requirements*

EN 10250-2, *Open die steel forgings for general engineering purposes — Part 2: Non-alloy quality and special steels*

EN 10250-3, *Open die steel forgings for general engineering purposes — Part 3: Alloy special steels*

EN 10263-1, *Steel rod, bars and wire for cold heading and cold extrusion — Part 1: General technical delivery conditions*

EN 10263-4, *Steel rod, bars and wire for cold heading and cold extrusion — Part 4: Technical delivery conditions for steels for quenching and tempering*

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

EN 10277-5, *Bright steel products — Technical delivery conditions — Part 5: Steels for quenching and tempering*

Annex D (informative)

Dimensional standards applicable to products complying with this European Standard

For rod:

EN 10017, *Steel rod for drawing and/or cold rolling — Dimensions and tolerances*

EN 10108, *Round steel rod for cold heading and cold extrusion — Dimensions and tolerances*

For hot rolled bars:

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

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

EN 10060, *Hot rolled round steel bars for general purposes — Dimensions and tolerances on shape and dimensions*

EN 10061, *Hot rolled hexagon steel bars for general purposes — Dimensions and tolerances on shape and dimensions*

For hot rolled strip and sheet/plate:

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*

Annex E (informative)

Determining the non-metallic inclusion content

E.1 For the microscopic determination of the non-metallic inclusions in special steels, agreement may be reached at the time of enquiry and order on a test in accordance with one of the following standards:

prEN 10247, *Micrographic examination of the non-metallic inclusion content of steels using standard pictures*

DIN 50602, *Metallographic examination; microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions*

NF A 04-106, *Iron and steel — Methods for the determination of the non-metallic inclusion content of steel — Part 2: Microscopic methods with standard series*

SS 111116, *Steel — Methods for estimation of the content of non-metallic inclusions — Microscopic methods — Jernkontoret's inclusion chart II for the assessment of non-metallic inclusions*

NOTE ISO 4967:1998 "Steel — Determination of content of non-metallic inclusions — Microscopic method using standard diagrams" is identical to NF A 04-106.

E.2 The following requirements are applicable:

If evidence is provided in accordance with DIN 50602, the requirements specified in Table E.1 apply.

Table E.1 — Requirements of microscopic degree of purity when tested in accordance with DIN 50602 (method K) (applicable to oxidic non-metallic inclusions)

Bars diameter d mm	Total characteristic value K (oxides) for the individual cast
$140 < d \leq 200$	$K4 \leq 50$
$100 < d \leq 140$	$K4 \leq 45$
$70 < d \leq 100$	$K4 \leq 40$
$35 < d \leq 70$	$K4 \leq 35$
$17 < d \leq 35$	$K3 \leq 40$
$8 < d \leq 17$	$K3 \leq 30$
$d \leq 8$	$K2 \leq 35$

If evidence is provided in accordance with NF A 04-106, the requirements specified in Table E.2 apply.

Table E.2 — Requirements of microscopic degree of purity when tested in accordance with NF A 04-106

Inclusion type	Series	Limiting value
Type B	fine	$\leq 2,5$
	thick	$\leq 1,0$
Type C	fine	$\leq 2,5$
	thick	$\leq 1,5$
Type D	fine	$\leq 1,5$
	thick	$\leq 1,0$

If evidence is provided in accordance with SS 111116, the requirements specified in Table E.3 apply.

Table E.3 — Requirements of microscopic degree of purity when tested in accordance with SS 111116

Inclusion type	Series	Limiting value
Type B	fine	≤ 4
	middle	≤ 3
	thick	≤ 2
Type C	fine	≤ 4
	middle	≤ 3
	thick	≤ 2
Type D	fine	≤ 4
	middle	≤ 3
	thick	≤ 2

In case where prEN 10247 is used for testing the non-metallic inclusion content the method of assessment and the requirements shall be defined at the time of enquiry and order.

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