

Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties

The European Standard EN 10273:2000 has the status of a
British Standard

ICS 77.140.30; 77.140.60

National foreword

This British Standard is the official English language version of EN 10273:2000. It partially supersedes BS 1502:1982 which will be withdrawn on the publication of BS EN 10272.

The UK participation in its preparation was entrusted by Technical Committee ISE/73, Steels for pressure purposes, to Subcommittee ISE/73/2, Steel plates and bars for pressure purposes, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

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Summary of pages

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EUROPEAN STANDARD

EN 10273

NORME EUROPÉENNE

EUROPÄISCHE NORM

January 2000

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English version

**Hot rolled weldable steel bars for pressure purposes
with specified elevated temperature properties**

Barres laminées à chaud en aciers soudables pour
appareils à pression, avec des caractéristiques spécifiées
aux températures élevées

Warmgewalzte Schweißgeeignete Stäbe für Druckbehälter
mit festgelegten Eigenschaften bei erhöhten Temperaturen

This European Standard was approved by CEN on 29 October 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 22, Steels for pressure purposes - 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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

Annex D contains national A-deviations specifying the restrictions for the application of this European Standard in Sweden.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this 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.

NOTE: The clauses marked with a point (●) contain information relating to agreements which are to be made at the time of ordering. The clauses marked with two points (●●) contain information relating to agreements which may be made at the time of enquiry and order.

1 Scope

This European Standard specifies the technical delivery conditions for hot rolled weldable steel bars for the construction of pressure equipments for use at elevated temperatures.

The general technical delivery conditions in EN 10021 also apply to products supplied in accordance with this European Standard.

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 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.

CR 10260	Designation systems for steel - Additional symbols for steel names
prEN 1011-2	Welding - Recommendations for welding of metallic materials - Part 2: Arc welding of ferritic steels
EN 10002-1	Metallic materials - Tensile testing - Part 1: Method of test (at ambient temperature) (including Corrigendum AC1:1990)
EN 10002-5	Metallic materials - Tensile testing - Part 5: Method of test at elevated temperatures
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 10168 ¹⁾	Iron and steel products - Inspection and delivery documents contents - List of information and description
EN 10204	Metallic products - Types of inspection documents (including amendment A1:1995)
EN 10221	Surface quality classes for hot-rolled bars and rods - Technical delivery conditions

¹⁾ In preparation; until this document is published as European Standard a corresponding national standard should be agreed at the time of enquiry and order.

EN ISO 377	Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)
ISO 14284	Steel and iron - Sampling and preparation of samples for the determination of chemical composition

3 Definitions

For the purposes of this standard the definitions of standards:

- EN 10020 for classification of steels;
- EN 10052 for the types of heat treatment; and
- EN 10079 for the various product forms.

apply.

Deviating from (see 3.1) or additional to (see 3.2) EN 10052, are the following defined.

3.1 Normalizing rolling is a rolling process in which the final deformation process is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing. The symbol for this delivery condition is N.

3.2 Additionally to the definitions for quenching and tempering the following should be noted:

NOTE: Quenching and tempering (symbol QT) also includes direct hardening plus tempering.

3.3 Purchaser: The person or organization that orders products in accordance with this standard. The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA. Where a purchaser has responsibilities under this EU Directive, this standard will provide a presumption of conformity with the essential requirements of the Directive so identified in Annex ZA.

4 • Dimensions and tolerances on dimensions

The nominal dimensions and tolerances on dimensions for the products shall be agreed at the time of enquiry and order with reference to one of the dimensional standards listed below for:

- rectangular section to EURONORM 58;
- square section to EURONORM 59;
- round section to EURONORM 60;
- hexagonal section to EURONORM 61.

5 Calculation of mass

A density of 7,85 kg/dm³ shall be used as the basis for the calculation of the nominal mass from the nominal dimensions of all steels.

6 Classification and designation

6.1 Classification

This European Standard covers the steel grades given in table 1.

According to EN 10020 the steels P235GH, P250GH, P265GH, P295GH, P355GH, P275NH and P355NH are non-alloy quality steels. All other steel grades covered by this European Standard are alloy special steels.

6.2 Designation

The steel grades specified in this European Standard are designated with steel names and steel numbers in accordance with EN 10027-1 and CR 10260. The corresponding steel numbers have been established in accordance with EN 10027-2.

7 Information to be supplied by the purchaser

7.1 Mandatory information

The complete order of a product as specified in this European Standard shall include the following information:

- a) the quantity required;
- b) the shape of bars;
- c) the tolerances on dimensions, shape and mass (see clause 4);
- d) the nominal dimensions of the product;
- e) the number of this European Standard;
- f) the steel name or number;
- g) the delivery condition (see 8.2);
- h) type of inspection document (see 9.2.1).

7.2 Options

A number of options are specified in this European Standard and these are listed below. If the purchaser does not indicate his wish to implement any of these options the products shall be supplied in accordance with the basic specification (see 7.1).

- 1) Specification of the steelmaking process (see 8.1).
- 2) Deviating delivery condition (see 8.2.1 and 8.2.3).
- 3) Specification of a lower maximum copper content and a maximum tin content (see table 1, footnote 2).
- 4) Specification of a higher minimum chromium content (see table 1, footnote 9).
- 5) Specification of a maximum carbon equivalent value (see 8.3.3 and table 3).
- 6) Mechanical properties for diameters or thicknesses > 150 mm (see table 4, footnote 2).
- 7) Special surface condition (see 8.5).
- 8) Requirements for and verification of internal soundness (see 8.6).

- 9) Specific tests for verification of general delivery requirements (see 8.6 and 9.1).
- 10) Delivery of data on suitable welding conditions (see 8.7.2).
- 11) Product analysis (see 9.3.2, 10.1.1 and 11.1).
- 12) Verification of 0,2 % proof strength at elevated temperature (see 9.3.2 and 11.3).
- 13) Special marking requirements (see 12.2).

8 Requirements

8.1 ●● Steelmaking process

Unless a special steelmaking process is agreed at the time of enquiry and order, the steelmaking process for steels in accordance with this European Standard shall be at the discretion of the manufacturer.

8.2 ● Delivery condition

8.2.1 ●● Unless otherwise agreed at the time of enquiry and order, the products covered by this European Standard shall be supplied in the conditions given in table 4.

8.2.2 Normalizing may be replaced by normalizing rolling for steel grades P235GH, P250GH, P265GH, P295GH, P355GH, P275NH, P355NH and P460NH. This means that the requirements have to be met again even after subsequent normalizing.

In the case of the grade P460NH delayed cooling or additional tempering may be necessary for small sections and in special cases.

8.2.3 ●● Products made of steel grades P235GH, P250GH, P265GH, P295GH, P355GH, P275NH, P355NH, P460NH and 16Mo3 may also be delivered in the untreated condition if so agreed (Annex B contains for the grades P...GH as well as for 16Mo3, 13CrMo4-5, 10CrMo9-10 and 11CrMo9-10 heat treatment information for the purchaser).

In these cases, the test pieces shall be tested in the delivery condition as indicated in table 4.

NOTE: The testing of the test pieces in a simulated heat treated condition does not discharge the processor who carries out the heat treatment from the obligation of providing proof of the specified properties in the finished product.

8.3 Chemical composition

8.3.1 The requirements of table 1 shall apply for the chemical composition determined from the cast analysis.

8.3.2 The product analysis shall not deviate from the specified values for the cast analysis as specified in table 1 by more than the values given in table 2.

8.3.3 ●● A maximum value for the carbon equivalent may be agreed upon at the time of enquiry and order for steel grades P235GH, P265GH, P295GH, P355GH, P275NH and P355NH. In this case, for the grades P275NH and P355NH the values given in table 3 shall apply.

8.4 Mechanical properties

The values given in tables 4 to 6 shall apply for the specified heat treatment conditions and dimensions.

If by agreement (see 8.2.3) the products are supplied in a non-heat treated condition the mechanical properties shall be obtainable from reference test pieces which have received the appropriate heat treatment (simulated heat treatment).

Annex A gives preliminary data for the purchaser about creep strain and creep rupture properties of some steel grades covered by this European Standard.

8.5 ●● Surface condition

Slight surface imperfections, inherent in the production process, are permitted.

If more exact requirement for the surface condition are necessary, these shall be agreed at the time of enquiry and order, where appropriate on the basis of EN 10221.

8.6 ● Internal soundness

For the internal soundness, where appropriate, requirements together with the conditions for their verification may be agreed at the time of enquiry and order.

8.7 Weldability

8.7.1 The steels specified in this European Standard shall be suitable for welding processes in current use (see notes 1 to 3 to 8.7.2).

8.7.2 ●● The manufacturer shall, if so agreed at the time of enquiry and order, provide the purchaser with data on suitable welding conditions determined on the basis of weld procedure tests.

NOTE 1: With increasing product section and strength level cold cracking can occur. Cold cracking is caused by the following factors in combination:

- the amount of diffusible hydrogen in the weld metal;
- microstructure of the heat affected zone;
- tensile stress concentrations in the welded joint.

NOTE 2: When using recommendations as laid down, for example in prEN 1011-2, the recommended welding conditions of the steel grades can be determined depending on the product diameter or thickness, the applied welding energy, the design requirements, the electrode efficiency, the welding process and the weld metal properties.

NOTE 3: Inappropriate post weld heat treatment (PWHT) conditions may decrease the mechanical properties.

It is therefore recommended that the purchaser seeks, at the time of enquiry and order, the advice of the manufacturer and considers, where appropriate, the verification of the mechanical properties on simulated post weld heat treated samples.

9 Inspection

9.1 ●● General

The manufacturer shall carry out appropriate process control, inspection and testing to assure himself that the delivery complies with the requirements of the order.

This includes the following:

- a suitable frequency of verification of the dimensions of the products;
- an adequate intensity of visual examination of the surface quality of the products;
- an appropriate frequency and type of test to ensure that the correct grade of steel is used.

The nature and frequency of these verifications, examinations and tests are determined by the manufacturer, in the light of the degree of consistency that has been determined. In view of this, verification by specific tests for these requirements are not necessary unless otherwise agreed.

9.2 Types of inspection and inspection documents

9.2.1 ● All products in accordance with this European Standard shall be delivered with specific inspection.

The purchaser shall state the required type of inspection documents (3.1.A, 3.1.B, 3.1.C or 3.2) in accordance with EN 10204.

If an inspection document 3.1.A, 3.1.C or 3.2 is ordered, the purchaser shall notify the manufacturer of the name and the address of the organisation or person who is to carry out the inspection and to produce the inspection document. In the case of the inspection report 3.2 the party to issue the certificate shall be agreed.

9.2.2 The inspection document shall contain, in accordance with EN 10168, the following codes and information:

- a) Information blocks A, B and Z; the tempering temperature shall also be given in the case of quenched and tempered or tempered products.
- b) The results of the cast analysis in accordance with boxes C 71 to C 92.
- c) The results of the tensile tests at room temperature in accordance with boxes C 00 to C 03 and C 10 to C 13.
- d) The results of the impact test with V-notched test pieces in accordance with boxes C 00 to C 03 and C 40 to C 43.
- e) The result of the visual examination of the products (see information block D).
- f) If one or several of the following options have been agreed at the time of enquiry and order, the relevant information on:
 - 1) the steelmaking process (section C 70);
 - 2) the product analysis (boxes C 71 to C 92);
 - 3) verification of the 0,2 % proof strength at elevated temperature (boxes C 00 to C 03, C 10 and C 11).

9.3 Tests to be carried out

9.3.1 The tests to be carried out, either mandatorily (m) or optional (o) and the number of samples and test pieces are given in table 7.

9.3.2 ●● The following tests may be agreed:

- product analysis;
- tensile test for verification of 0,2% proof strength at a specified temperature.

9.4 Retests

See EN 10021.

10 Sampling

10.1 Frequency of testing

10.1.1 ●● For the product analysis, unless otherwise agreed, one sample per cast shall be taken for determining the elements indicated with numerical values for the particular steel grade in table 1.

10.1.2 The test unit for the tensile test at room temperature and the impact test shall be the batch of products or part thereof, at maximum 30000 kg, coming from the same cast and having been heat treated in the same batch and in the same heat treatment facility²⁾.

The maximum diameter may be 1,25 times the smallest diameter in the batch, provided all diameters are within the same diameter range as specified in the corresponding tables of this European Standard (see tables 4 and 6).

For tensile test at elevated temperature the test unit shall be the cast.

One sample shall be taken for preparing the test pieces indicated in 10.2.2 from each test unit.

10.2 Selection and preparation of samples and test pieces

10.2.1 Sampling and sample preparation

10.2.1.1 Sampling and sample preparation shall be in accordance with the requirements of ISO 14284 and EN ISO 377. In addition, the requirements in 10.2.1.2 shall apply to the mechanical tests.

10.2.1.2 If, following agreement (see 8.2.3), the products are not to be delivered in a delivery condition in accordance with table 4, the samples shall be heat treated to the specified condition prior to the test.

10.2.1.3 The samples shall be taken in accordance with figure 1 for the tensile test at room temperature, the tensile test at elevated temperature and the impact test.

²⁾ In the case of a continuous furnace or in process annealing a batch is the lot heat treated without intermission with the same process parameters.

10.2.2 Preparation of test pieces for mechanical tests

10.2.2.1 Round test pieces for the tensile test at room temperature in accordance with EN 10002-1 and, where applicable, for the tensile test at elevated temperature in accordance with EN 10002-5 shall be prepared.

10.2.2.2 Longitudinal V-notched test pieces in accordance with EN 10045-1 shall be prepared for the impact test. The notch of impact test pieces shall be perpendicular to the surface of the product.

11 Test methods

11.1 ●● Chemical analysis

Unless otherwise agreed at the time of enquiry and order, the choice of a suitable physical or chemical analytical method for the product analysis shall be at the discretion of the manufacturer. In cases of dispute, the analysis shall be carried out by a laboratory approved by both parties. In this case, the analysis method to be used shall be agreed upon, if possible, with reference to the corresponding European Standards or EURONORMs.

11.2 Tensile test at room temperature

The tensile test at room temperature shall be carried out as described in EN 10002-1, using a proportional test piece of gauge length $L_0 = 5,65 \sqrt{S_0}$ (S_0 = initial cross-sectional area of the gauge length).

The yield strength to be determined shall be the upper yield strength (R_{eH}) or, if this is not pronounced, the 0,2 % proofstrength ($R_{p0,2}$).

11.3 ●● Tensile test at elevated temperature

The 0,2 % proof strength at elevated temperature shall be determined as described in EN 10002-5 at a temperature to be agreed at the time of enquiry and order.

11.4 Impact test

The impact test on V-notched test pieces shall be carried out as described in EN 10045-1, at the lowest temperature for which a value is specified in table 5.

The minimum impact values apply for the mean from three test pieces. One individual value may be lower than the specified value provided that it is not less than 70 % of this value.

If the above conditions are not met, an additional set of three test pieces shall be taken from the same sample and shall be tested. In order to regard the test unit as acceptable after testing the second set, the following requirements shall also be met:

- a) the mean value of six tests shall be greater than or equal to the specified minimum value;
- b) not more than two of the six individual values shall be less than the specified minimum value;
- c) not more than one of the six individual values shall be less than 70 % of the specified minimum value.

If these requirements are not met, the sample product shall be rejected and re-tests shall be carried out on the remainder of the test unit.

11.5 Other testing (see also 9.1)

11.5.1 The dimensions of the products shall be checked.

11.5.2 The surface condition of the products shall be checked by visual examination without optical aids.

12 Marking

12.1 The products or the bundle or boxes shall be marked in a suitable way such that it is possible to determine the cast, the steel grade and the origin of the delivery (see table 8).

12.2 ●● Special marking may be agreed at the time of enquiry and order.

dimensions in mm

Type of test	Round cross-section products	Rectangular cross-section products
Tensile		<p>Tensile test piece</p>
Impact ¹⁾		<p>Impact test piece</p>
<p>¹⁾ For products of a round cross-section the axis of the notch is approximately a diagonal; for products with a rectangular cross-section the axis of the notch is perpendicular to the greatest rolled surface.</p>		

Figure 1: Position of test pieces (longitudinal test pieces)

Table 1: Chemical composition (cast analysis)

Steel designation		% by mass ¹⁾																	
Name	Number	C	Si max.	Mn	P max.	S max.	Al _{tot}	N max.	B max.	Cr	Cu max.	Mo	Nb	Ni	Ti	V	Zr	Nb+Ti+V	Cr+Cu+Mo+Ni max.
P235GH	1.0345	max. 0,16	0,35	0,40 to 1,20	0,030	0,025	min. 0,020	-	-	max. 0,30	0,30 ²⁾	max. 0,08	0,010	0,30	0,03	0,02	-	-	0,70
P250GH	1.0460	0,18 to 0,23	0,40	0,30 to 0,90	0,025	0,015	0,015 to 0,050	-	-	max. 0,30	-	-	0,010	0,30	0,03	0,02	-	-	0,70
P265GH	1.0425	max. 0,20	0,40	0,50 to 1,40	0,030	0,025	min. 0,020	-	-	max. 0,30	0,30 ²⁾	max. 0,08	0,010	0,30	0,03	0,02	-	-	0,70
P295GH	1.0481	0,08 to 0,20	0,40	0,90 to 1,50	0,030	0,025	min. 0,020	-	-	max. 0,30	0,30 ²⁾	max. 0,08	0,010	0,30	0,03	0,02	-	-	0,70
P355GH	1.0473	0,10 to 0,22	0,60	1,00 to 1,70	0,030	0,025	min. 0,020	-	-	max. 0,30	0,30 ²⁾	max. 0,08	0,010	0,30	0,03	0,02	-	-	0,70
P275NH	1.0487	Max. 0,18	0,40	0,50 to 1,40	0,030	0,025	min. 0,020 ³⁾	0,020	-	max. 0,30 ⁴⁾	0,30 ⁴⁾	max. 0,08 ⁴⁾	0,05	0,50	0,03	0,05	-	0,05	-
P355NH	1.0565	max. 0,20	0,50	0,90 to 1,70	0,030	0,025	min. 0,020 ³⁾	0,020	-	max. 0,30 ⁴⁾	0,30 ⁴⁾	max. 0,08 ⁴⁾	0,05	0,50	0,03	0,10	-	0,12	-
P460NH	1.8935	max. 0,20	0,60	1,00 to 1,70	0,030	0,025	min. 0,020 ³⁾	0,025	-	max. 0,30	0,70 ⁵⁾	max. 0,10	0,05	0,80	0,03	0,20 ¹⁰⁾	-	0,22	-
P355QH	1.8867	max. 0,16	0,40	max. 1,50	0,025	0,015	7)	0,015	0,005	max. 0,30	0,30 ²⁾	max. 0,25	0,05	0,50	0,03	0,06	0,05	-	-
P460QH ⁶⁾	1.8871	max. 0,18	0,50	max. 1,70	0,025	0,015		0,015	0,005	max. 0,50	0,30 ²⁾	max. 0,50	0,05	1,00	0,03	0,08	0,05	-	-
P500QH	1.8874	max. 0,18	0,60	max. 1,70	0,025	0,015		0,015	0,005	max. 1,00	0,30 ²⁾	max. 0,70	0,05	1,50	0,05	0,08	0,15	-	-
P690QH	1.8880	max. 0,20	0,80	max. 1,70	0,025	0,015		0,015	0,005	max. 1,50	0,30 ²⁾	max. 0,70	0,06	2,50	0,05	0,12	0,15	-	-
16Mo3	1.5415	0,12 to 0,20	0,35	0,40 to 0,90	0,030	0,025	8)	-	-	max. 0,30	0,30	0,25 to 0,35	-	0,30	-	-	-	-	-
13CrMo4-5	1.7335	0,08 to 0,18	0,35	0,40 to 1,00	0,030	0,025		-	-	0,70 to 1,15 ⁹⁾	0,30	0,40 to 0,60	-	-	-	-	-	-	-
10CrMo9-10	1.7380	0,08 to 0,14	0,50	0,40 to 0,80	0,030	0,025		-	-	2,00 to 2,50	0,30	0,90 to 1,10	-	-	-	-	-	-	-
11CrMo9-10	1.7383	0,08 to 0,15	0,50	0,40 to 0,80	0,030	0,025		-	-	2,00 to 2,50	0,30	0,90 to 1,10	-	-	-	-	-	-	-

¹⁾ Elements not listed in this table shall not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate measures shall be taken to prevent the addition from scrap or other materials used in steelmaking of these elements which may adversely affect the mechanical properties and usability.

²⁾ ●● For reasons of hot formability, a lower maximum copper content and additionally a maximum tin content may be agreed at the time of enquiry and order.

³⁾ If nitrogen is additionally fixed by niobium, titanium or vanadium, the minimum aluminium content specification does not apply.

⁴⁾ The sum of the percentage by mass of the three elements chromium, copper and molybdenum shall not exceed 0,45 %.

⁵⁾ If the percentage by mass of copper exceeds 0,30 %, the percentage by mass of nickel shall be at least half the percentage by mass of copper.

⁶⁾ The manufacturer may add one or several alloying element(s) up to the maximum values specified in the order as a function of the products thickness and the steelmaking conditions in order to attain the specified properties. The chemical composition range for each manufacturer's analysis shall be given in the offer and confirmation of the order.

⁷⁾ The percentage of grain refining elements shall be at least 0,015 %. Aluminium is also included in these elements. The minimum content of 0,015 % applies here to dissolved aluminium. This value is regarded as attained if the total aluminium content is at least 0,018 %, in cases of dispute, the dissolved aluminium content is to be determined.

⁸⁾ The Al content of the cast shall be determined and given in the inspection document.

⁹⁾ ●● If resistance to pressurized hydrogen is of importance, a minimum percentage by mass of Cr of 0,80 % should be agreed at the time of enquiry and order.

¹⁰⁾ For V contents > 0,10 % special precautions should be taken to avoid reheat cracking.

Table 2: Permissible product analysis tolerances on the limiting values given for the cast analysis

Element	Specified limits of the cast analysis according to table 1 % by mass	Permissible deviations ¹⁾ of the product analysis from the specified values listed in table 1 for the cast analysis % by mass
C	≤ 0,23	+ 0,02
Si	≤ 0,80	+ 0,05
Mn	≥ 0,30 to 1,70	+ 0,10 - 0,05
P	≤ 0,030	+ 0,005
S	≤ 0,015 > 0,015 to 0,025	+ 0,003 + 0,005
Al _{tot}	≤ 0,050	± 0,005
N	≤ 0,025	+ 0,002
B	≤ 0,005	+ 0,0005
Cr	≤ 1,00 > 1,00 to 2,50	± 0,05 ± 0,10
Cu	≤ 0,30 > 0,30 to 0,70	+ 0,05 + 0,07
Mo	≤ 0,35 > 0,35 to 1,10	± 0,03 ± 0,04
Nb	≤ 0,06	+ 0,01
Ni	≤ 1,00 > 1,00 to 2,50	+ 0,05 + 0,10
Ti	≤ 0,05	+ 0,01
V	≤ 0,12 > 0,12 to 0,20	+ 0,01 + 0,02
Zr	≤ 0,15	+ 0,01
<p>¹⁾ If several product analyses are carried out for one cast and if, in this case, values for an individual element are established which fall outside the permitted range for the chemical composition of the cast analysis, then it is only permissible that the values either exceed the maximum permitted value or fall short of the minimum permitted value. It is not acceptable for both to apply for one cast.</p>		

Table 3: Maximum carbon equivalent value
 (if agreed at the time of enquiry and order, see 8.3.3)

Steel designation		Max. carbon equivalent ¹⁾ in % for specified diameters or thicknesses in mm		
name	number	≤63	> 63 to 100	> 100 to 150
P275NH	1.0487	0,40	0,40	0,42
P355NH	1.0565	0,43	0,45	0,45

1) Carbon equivalent:

$$CEV = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

Table 4: Mechanical properties at room temperature

Steel designation		Usual delivery condition 1)	Diameter or thickness 2)		Yield strength R_{eH} 3) N/mm ² min.	Tensile strength R_m N/mm ²	Elongation after fracture ($L_0 = 5,65\sqrt{S_0}$) A (longitudinal) % min.
Name	number		over	up to			
P235GH	1.0345	+N	16	16	235	360 to 480	25
			40	40	225		
			60	60	215		
			100	100	200		
				150	185	350 to 480	24
P250GH	1.0460	+N	50	50	250	410 to 540	25
			100	100	240		
				150	230		
P265GH	1.0425	+N	16	16	265	410 to 530	23
			40	40	255		
			60	60	245		
			100	100	215		
				150	200	400 to 530	22
P295GH	1.0481	+N	16	16	295	460 to 580	22
			40	40	290		
			60	60	285		
			100	100	260		
				150	235	440 to 570	21
P355GH	1.0473	+N	16	16	355	510 to 650	21
			40	40	345		
			60	60	335		
			10	100	315	490 to 630	20
				150	295	480 to 630	
P275NH	1.0487	+N	16	16	275	390 to 510	24
			35	35	275		
			50	50	265		
			70	70	255	370 to 490	23
			100	100	235		
				150	225		
P355NH	1.0565	+N	16	16	355	490 to 630	22
			35	35	355		
			50	50	345		
			70	70	325		
			100	100	315	470 to 610	21
				150	295	450 to 590	
P460NH	1.8935	+N ⁴⁾	16	16	460	570 to 720	17
			35	35	50		
			50	50	440		
			70	70	420	540 to 710	16
			100	100	400		
				150	380		

(continued)

Table 4 (concluded)

Steel Designation		Usual delivery condition 1)	Diameter or thickness 2)		Yield strength R_{eH} 3) N/mm ² min.	Tensile strength R_m N/mm ²	Elongation after fracture ($L_0 = 5,65\sqrt{S_0}$) A (longitudinal) % min.
Name	Number		over	up to			
P355QH	1.8867	+QT		50	355	490 to 630	22
			50	100	335		
			100	150	315	450 to 590	
P460QH	1.8871	+QT		50	460	550 to 720	19
			50	100	440		
			100	150	400	500 to 670	
P500QH	1.8874	+QT		50	500	590 to 770	17
			50	100	480		
			100	150	440	540 to 720	
P690QH	1.8880	+QT		50	690	770 to 940	14
			50	100	670		
			100	150	630	720 to 900	
16Mo3	1.5415	+N ⁵⁾		16	275	440 to 590	24
			16	40	270		
			40	60	260	430 to 580	23
			60	100	240		
			100	150	220		
13CrMo4-5	1.7335	+NT		16	300	450 to 600	20
			16	60	295		
		+ NT or +QA or +QL	60	100	275	440 to 590	19
			+QL	100	150		
10CrMo9-10	1.7380	+NT		6	310	480 to 630	18
			16	40	300		
			40	60	290		
		+NT or +QA or +QL	60	100	270	470 to 620	17
			100	150	250		
11CrMo9-10	1.7383	+NT or +QA or +QL		60	310	520 to 670	18
			+QL	60	100 ⁶⁾		

1) +N: normalized (including normalizing rolled; see 8.2.2); +QT: quenched and tempered; +NT: normalized and tempered; +QA: air quenched and tempered, +QL: liquid quenched and tempered

2) ●● Mechanical properties for diameters or thicknesses > 150 mm may be agreed.

3) If the upper yield strength (R_{eH}) is not pronounced, this shall be replaced by determination of the 0,2 % proof strength ($R_{p0.2}$). In this case, 10 N/mm² lower minimum values apply for $R_{p0.2}$.

4) See 8.2.2 (second paragraph).

5) This steel grade may, at the discretion of the manufacturer, also be supplied in the condition +NT.

6) Footnote 2) does not apply.

Table 5: Impact energy values

Steel designation		Minimum impact energy value KV (longitudinal) J at temperatures in °C		
		- 20	0	+ 20
name	number			
P235GH	1.0345	-	40	47
P250GH	1.0460	-	-	47
P265GH	1.0425	-	40	47
P295GH	1.0481			
P355GH	1.0473			
P275NH	1.0487	40	47	55
P355NH	1.0565			
P460NH	1.8935			
P355QH	1.8867	40	60	80
P460QH	1.8871			
P500QH	1.8874			
P690QH	1.8880			
16Mo3	1.5415	-	-	40
13CrMo4-5	1.7335			
10CrMo9-10	1.7380			
11CrMo9-10	1.7383			

Table 6: 0,2 % proof strength at elevated temperatures¹⁾

Steel designation		Diameter or thickness mm		0,2 % proof strength at temperature, °C									
				50	100	150	200	250	300	350	400	450	500
name	number	over	up to	N/mm ² min.									
P235GH	1.0345		60	206	190	180	170	150	130	120	110	---	---
		60	100	191	175	165	160	140	125	115	105		
		100	150	176	160	155	150	130	115	110	100		
P250GH	1.0460		50	242	237	216	190	170	150	130	110	90	---
		50	100	234	230	210	185	165	145	125	100	80	---
		100	150	224	220	200	175	155	135	115	90	70	---
P265GH	1.0425		60	234	215	205	195	175	155	140	130	---	---
		60	100	207	195	185	175	160	145	135	125		
		100	150	192	180	175	165	155	135	130	120		
P295GH	1.0481		60	272	250	235	225	205	185	170	155	---	---
		60	100	249	230	220	210	195	180	165	145		
		100	150	226	210	200	195	185	170	155	135		
355GH	1.0473		60	318	290	270	255	235	215	200	180	---	---
		60	100	298	270	255	240	220	200	190	165		
		100	150	278	250	240	230	210	195	175	155		
P275NH	1.0487		35	264	245	226	196	177	147	127	108	---	---
		35	70	247	235	216	196	177	147	127	108		
		70	100	229	216	196	176	157	127	108	88		
		100	150	214	196	176	157	137	108	88	69		
P355NH	1.0565		35	336	304	284	245	226	216	196	167	---	---
		35	70	313	294	275	245	226	216	196	167		
		70	100	300	275	255	235	216	196	177	147		
		100	150	280	255	235	216	196	177	157	127		
P460NH	1.8871		35	---	402	373	333	314	294	265	235	---	---
		35	70	---	392	363	333	314	294	265	235		
		70	100	---	373	343	324	294	275	245	216		
		100	150	---	353	324	304	275	255	226	196		

(continued)

Table 6 (concluded)

Steel designation		Diameter or thickness mm		0,2 % proof strength at temperature, °C									
				50	100	150	200	250	300	350	400	450	
name	number	over	up to	N/mm ² min.									
P355QH	1.8867		50 ¹⁾	340	310	285	260	235	215	---	---	---	---
P460QH	1.8871			445	425	405	380	360	340	---	---	---	---
P500QH	1.8874			490	470	450	420	400	380	---	---	---	---
P690QH	1.8880			670	645	615	595	575	570	---	---	---	---
16Mo3	1.5415		60	---	---	---	215	200	170	160	150	145	140
		60	100	---	---	---	200	185	165	155	145	140	135
		100	150	---	---	---	190	175	155	145	140	135	130
13CrMo4-5	1.7335		60	---	---	---	230	220	205	190	180	170	165
		60	100	---	---	---	220	210	195	185	175	165	160
		100	150	---	---	---	210	200	185	175	170	160	155
10CrMo9-10	1.7380		60	---	---	---	245	230	220	210	200	190	180
		60	100	---	---	---	225	220	210	195	185	175	165
		100	150	---	---	---	215	205	195	185	175	165	155
11CrMo9-10	1.7383		100	---	---	---	---	255	235	225	215	205	195

¹⁾ These values are valid for diameters and thicknesses ≤ 80 mm. For larger diameters and thicknesses, the minimum 0,2 % proof strength values are reduced by 20 N/mm².

Table 7: Tests to be carried out and extent of testing

Test	Test status ¹⁾	Number of test pieces per sample
Chemical analysis	o ²⁾	(see 10.1.1)
Tensile test at room temperature	m	1
Tensile test at elevated temperature	o ³⁾	1
Impact test	m	3
Other tests	o	4)

¹⁾ Tests marked with an “m” (mandatory) shall be carried out. In all cases, those marked with an “o” (optional) shall be carried out as specific test only if agreed at the time of enquiry and order.
²⁾ See 9.3.2, 10.1.1 and 11.1.
³⁾ See 9.3.2 and 11.3.
⁴⁾ See 8.6, 9.1 and 11.5.

Table 8: Marking of the products

Marking of	Symbol ¹⁾
Manufacturer's name, trade mark or logo	+
The number of this European Standard	(+)
Steel name or number	+
Type of finish	(+)
Identification number	+ ²⁾
Nominal diameter or thickness	(+)
Nominal dimensions other than diameter or thickness	(+)
Inspector's mark	+ ³⁾
Customer's order No.	(+)

¹⁾ The symbols mean:
 + = the marking shall be applied;
 (+) = the marking shall be applied if so agreed, or at the manufacturer's discretion.

²⁾ The numbers or letters used for identification shall allow the product(s) to be related to the relevant inspection certificate or inspection report. This shall permit the traceability of the cast number.

³⁾ The inspector's mark may be omitted if the relevant inspector can be identified in another way.

Annex A
(informative)

Reference data of strength values for 1 % (plastic) creep strain and creep rupture

NOTE 1: The values given in table A.1 are only for information purposes. If referred to in regulations, however, they will be binding for calculation purposes.

NOTE 2: The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperatures listed in table A.1 do not mean that the steels can be used in continuous duty up to these temperatures. The governing factor is the total stressing during operation. However, where relevant the oxidation conditions should be taken into account.

Table A.1: Strength values for 1% (plastic) creep strain and creep rupture ¹⁾

Steel designation		Temperature ° C	Strength for 1 % (plastic) creep strain ²⁾		Creep rupture strength for ³⁾		
name	number		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
			N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²
P235GH P265GH	1.0345 1.0425	380	164	118	229	165	145
		390	150	106	211	148	129
		400	136	95	191	132	115
		410	124	84	174	118	101
		420	113	73	158	103	89
		430	101	65	142	91	78
		440	91	57	127	79	67
		450	80	49	113	69	57
		460	72	42	100	59	48
		470	62	35	86	50	40
		480	53	30	75	42	33
P250GH	1.0460	380	164	118	229	165	145
		390	150	106	211	148	129
		400	136	95	191	132	115
		410	124	84	174	118	101
		420	113	73	158	103	89
		430	101	65	142	91	78
		440	91	57	127	79	67
		450	80	49	113	69	57
		460	72	42	100	59	48
		470	62	35	86	50	42
		480	53	30	75	42	33
P295GH P355GH	1.0481 1.0473	380	195	153	291	227	206
		390	182	137	266	203	181
		400	167	118	243	179	157
		410	150	105	221	157	135
		420	135	92	200	136	115
		430	120	80	180	117	97
		440	107	69	161	100	82
		450	93	59	143	85	70
		460	83	51	126	73	60
		470	71	44	110	63	52
		480	63	38	96	55	44

(continued)

Table A.1 (continued)

Steel designation		Temperature ° C	Strength for 1 % (plastic) creep strain ²⁾		Creep rupture strength for ³⁾		
name	number		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
			N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²
16Mo3	1.5415	450	216	167	298	239	217
		460	199	146	273	208	188
		470	182	126	247	178	159
		480	166	107	222	148	130
		490	149	89	196	123	105
		500	132	73	171	101	84
		510	115	59	147	81	69
		520	99	46	125	66	55
		530	84	36	102	53	45
13CrMo4-5	1.7335	450	245	191	370	285	260
		460	228	172	348	251	226
		470	210	152	328	220	195
		480	193	133	304	190	167
		490	173	116	273	163	139
		500	157	98	239	137	115
		510	139	83	209	116	96
		520	122	70	179	94	76
		530	106	57	154	78	62
		540	90	46	129	61	50
		550	76	36	109	49	39
		560	64	30	91	40	32
		570	53	24	76	33	26
10CrMo9-10	1.7380	450	240	166	306	221	201
		460	219	155	286	205	186
		470	200	145	264	188	169
		480	180	130	241	170	152
		490	163	116	219	152	136
		500	147	103	196	135	120
		510	132	90	176	118	105
		520	119	78	156	103	91
		530	107	68	138	90	79
		540	94	58	122	78	68
		550	83	49	108	68	58
		560	73	41	96	58	50
		570	65	35	85	51	43
		580	57	30	75	44	37
		590	50	26	68	38	32
600	44	22	61	34	28		
11CrMo9-10	1.7383	450				221	
		460				205	
		470				188	
		480				170	
		490				152	
		500				135	
		510				118	
520				103			

¹⁾ The values listed in the table are mean values from the scatter range determined previously which will be assessed from time to time after further test results are available and corrected if necessary. From available documentation on long-term creep tests, it may be assumed that the lower limit of this scatter range is about 20 % lower than the mean value given at the temperatures stated for the steel grades in the table.

²⁾ This is the stress relative to the initial cross-section leading to a permanent elongation of 1 % after 10 000 and 100 000 hours (h).

³⁾ This is the stress relative to the initial cross-section leading to fracture after 10 000, 100 000 and 200 000 hours (h).

**Annex B
(informative)**

Guidance for heat treatment

Table B.1 gives reference data for the temperatures to be used in the heat treatment.

Table B.1: Guidance for heat treatment

Steel designation		Temperature range for		
		Normalizing ¹⁾	Quenching	
name	number			Austenitizing
P235GH	1.0345	890 to 950	--	--
P250GH	1.0460	890 to 950	--	--
P265GH	1.0425	890 to 950	-	--
P295GH	1.0481	890 to 950	--	--
P355GH	1.0473	890 to 950	--	--
16Mo3	1.5415	890 to 950	--	-- ³⁾
13CrMo4-5	1.7335	--	890 to 950	630 to 730
10CrMo9-10	1.7380	--	920 to 980	680 to 760
11CrMo9-10	1.7383	--	920 to 980	670 to 750
<p>¹⁾ When normalizing, after the required temperatures have been attained over the whole cross-section, no further holding is necessary and should be generally avoided.</p> <p>²⁾ When tempering, the specified temperatures shall be maintained for at least 30 minutes when they have been attained over the whole cross-section.</p> <p>³⁾ In certain cases, tempering at 590 to 650 °C may be necessary.</p>				

Annex C
Bibliography
(informative)

EURONORM 58	Hot rolled flat steel for general use
EURONORM 59	Hot rolled square steel for general use
EURONORM 60	Hot rolled round steel for general use
EURONORM 61	Hot rolled hexagon steel

Annex D
(informative)

National A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

In the relevant CEN/CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed. This A-deviation becomes however invalid when the EU Directive 97/23/EC comes generally into force, at latest 2002-05-30.

<u>Clause</u>	<u>Deviation</u>
	Sweden (Ordinance AFS 1994:39)
General	The cited ordinance restricts in its Chapter 3 - the use of quenched and tempered products to a yield strength level of 500 N/mm ² . The steel grade P690QH is therefore not accepted. - the use of weldable fine grain steels in the normalized condition to a yield strength level of 390 N/mm ² . The steel grade P460N is therefore not accepted.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and supports essential requirements of EU Directive 97/23/EC.

Warning: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this European Standard.

The clauses of this European Standard are likely to support the essential requirements of section 4 of annex 1, 'Essential safety requirements' of the Pressure Equipment Directive 97/23/EC.

Compliance with this European Standard provides one means of conforming with the specific essential requirements of the Directive concerned.

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