

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

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ICS 77.140.20; 77.140.60

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National foreword

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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.

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

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English Version

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

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

Warmgewalzte schweißgeeignete Stäbe aus Stahl für
Druckbehälter mit festgelegten Eigenschaften bei erhöhten
Temperaturen

This European Standard was approved by CEN on 21 October 2007.

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Foreword

This document (EN 10273:2007) 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of an identical text or by endorsement, at the latest by June 2008, and conflicting national standards shall be withdrawn at the latest by June 2008.

This document supersedes EN 10273:2000.

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 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

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

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1 Scope

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

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

NOTE Once this European Standard is published in the Official Journal of the European Union (OJEU) under Directive 97/23/EC, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 97/23/EC is limited to technical data of materials in this European Standard and does not presume adequacy of the material to a specific item of equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of this specific item of equipment to verify that the ESRs of the Pressure Equipment Directive 97/23/EC are satisfied, needs to be done.

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 10002-1:2001, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10002-5:1991, *Metallic materials — Tensile testing — Part 5: Method of testing at elevated temperatures*

EN 10020:2000, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions for steel products*

EN 10045-1:1990, *Metallic materials — Charpy impact test — Part 1: Test method*

EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products*

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*

EN 10079:2007, *Definition of steel products*

EN 10168:2004, *Steel products — Inspection documents — List of information and description*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10221, *Surface quality classes for hot-rolled bars and rods — Technical delivery conditions*

EN ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*

EN ISO 14284, *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 10079:2007 and the following apply.

3.1

normalizing rolling

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

NOTE The symbol for this delivery condition and for the normalised condition is N.

[deviating from EN 10052:1993]

3.2

quenching and tempering

[as defined in EN 10052:1993]

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

3.3

purchaser

person or organization that orders products in accordance with this European Standard. The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA

NOTE Where a purchaser has responsibilities under this EU Directive, this European 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 shall be agreed at the time of enquiry and order with reference to the relevant dimensional standard EN 10058, EN 10059, EN 10060 or EN 10061.

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 steel grades.

6 Classification and designation

6.1 Classification

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

6.2 Designation

The steel grades are designated with steel names in accordance with EN 10027-1. The corresponding steel numbers have been allocated in accordance with EN 10027-2.

7 Information to be supplied by the purchaser

7.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) quantity required;
- b) shape of bars;
- c) European Standard specifying tolerances on dimensions, shape and mass (see Clause 4);
- d) nominal dimensions of the product;
- e) number of this European Standard, i.e. EN 10027-2;
- f) steel name or number;
- g) delivery condition (see 8.2);
- h) inspection document to be issued (see 9.1.1).

7.2 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 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 higher minimum chromium content (see Table 1, footnote h);
- 4) specification of a lower maximum copper content and a maximum tin content (see Table 1, footnote i);
- 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 b);
- 7) elevated temperature values for diameters or thicknesses > 100 mm, steel grade P460NH (see Table 6, footnote e);
- 8) special surface condition (see 8.5);
- 9) requirements for and verification of internal soundness (see 8.6);
- 10) delivery of data on suitable welding conditions (see 8.7.2);
- 11) product analysis (see Table 7, 10.1.1 and 11.1);
- 12) verification of proof strength $R_{p0.2}$ at an agreed elevated temperature (see Table 7 and 11.3);

- 13) verification of the impact energy at a temperature other than +20 °C (see 11.4);
- 14) special marking requirements (see 12.2).

7.3 Examples for ordering

EXAMPLE 1 5 t bars, dimensional tolerances as specified in EN 10059, 50 mm x 50 mm, supplied in fixed lengths of 10 000 mm, made of the steel grade 16Mo3 (steel number 1.5415) in accordance with EN 10273, with inspection document 3.1 as specified in EN 10204:

5 t bars EN 10059 – 50x50x10000(F) – steel EN 10273 – 16Mo3 – inspection document 3.1

or

5 t bars EN 10059 – 50x50x10000(F) – steel EN 10273 – 1.5415 – inspection document 3.1

EXAMPLE 2 2 t rounds, dimensional tolerances as specified in EN 10060, 75 mm diameter, supplied in exact lengths of 5 000 mm made of a steel grade 16Mo3 (steel number 1.5415) in accordance with EN 10273, surface quality class B in accordance with EN 10221; inspection document 3.1 as specified in EN 10204:

2 t rounds EN 10060 – 75x5000(E) – steel EN 10273 – 16Mo3 – EN 10221 – class B – inspection document 3.1

or

2 t rounds EN 10060 – 75x5000(E) – steel EN 10273 – 1.5415 – EN 10221 – class B – inspection document 3.1

8 Requirements

8.1 Steelmaking process

•• Unless a special steelmaking process is agreed at the time of enquiry and order, the steelmaking process 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 delivery condition 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 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 A 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 cast analysis reported by the steel producer shall apply and comply with the requirements of Table 1.

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.

NOTE Unless otherwise noted, the $R_{p0.2}$ values in Table 6 were derived in accordance with EN 10314.

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 B 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 may be agreed at the time of enquiry and order, where appropriate on the basis of EN 10221.

8.6 Internal soundness

The products shall be sound and free from defects that preclude their intended use.

●● Where appropriate, requirements together with the conditions for their verification (see 11.5.3 and Table 7) may be agreed at the time of enquiry and order.

8.7 Weldability

8.7.1 The steels specified in this European Standard are suitable for welding processes in current use (see NOTES 1 to 3 in 8.7.2). Information on welding is given in EN 1011-1 and EN 1011-2.

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:

- 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 EN 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 Types of inspection and inspection documents

9.1.1 The compliance with the requirements of the order shall be checked for products in accordance with this European Standard by specific inspection.

• The purchaser shall state the required type of inspection document (3.1 or 3.2) in accordance with EN 10204.

If an inspection document 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document. It shall also be agreed which party shall issue the certificate.

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

A	commercial transactions and parties involved;
B	description of products to which the inspection certificate applies (including tempering temperature in the case of quenched and tempered or tempered products);
C03	test temperature;
C10-C13	tensile test at room temperature and, if applicable, at elevated temperatures;
C40-C43	Impact test;
C70	steelmaking process, if applicable;
C71-C92	cast analysis and, if applicable, product analysis;
D01	marking, dimensional and visual inspection;
D02-D99	non-destructive tests, if applicable;
Z	validation.

9.2 Tests to be carried out

The mandatory and optional tests to be carried out, the size of the test units, and the number of samples and test pieces to be taken are specified in 10.1 and Table 7.

9.3 Retests, sorting and reprocessing

For retests, sorting and reprocessing the requirements of EN 10021 shall apply.

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 30 000 kg, coming from the same cast and having been heat treated in the same batch and in the same heat treatment facility¹⁾.

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 EN 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 Table 8 for the tensile test at room temperature, the tensile test at elevated temperature and the impact test.

10.2.2 Preparation of test pieces for mechanical tests

10.2.2.1 Circular 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 taking into account the relevant existing European Standards. The list of available European Standards is given in prEN/TR 10261.

1) 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.

11.2 Tensile test at room temperature

The tensile test at room temperature shall be carried out as specified 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 proof strength $R_{p0,2}$.

11.3 Tensile test at elevated temperature

The tensile test for verification of proof strength $R_{p0,2}$ at elevated temperature shall be determined as specified in EN 10002-5.

•• Unless a test temperature for which values are specified has been agreed, the test shall be carried out at 300 °C.

11.4 Impact test

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

•• Where minimum impact energy values are specified for several temperatures in Table 5, the impact energy shall, unless otherwise agreed, be verified at +20 °C.

The minimum impact values given apply for the mean of 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 be met:

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

11.5.1 The dimensions of the products shall be checked.

11.5.2 The surface condition of the products shall be checked for conformity with 8.5 by visual examination without optical aids or, at the discretion of the manufacturer, by an approved automated process.

11.5.3 The verification of internal soundness, if agreed, shall be carried out to an agreed procedure.

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 9).

12.2 •• Any other marking may be agreed at the time of enquiry and order.

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Table 1 — Chemical composition (cast analysis)

Steel grade		% by mass ^a																	
Steel name	Steel number	C	Si	Mn	P	S	A _{total}	N	B	Cr	Cu	Mo	Nb	Ne	Ti	V	Zr	Nb+Ti +V max.	Cu+Ni+Mo +Ne max.
P235GH	1.0345	≤ 0.16	0.35	0.40 to 1.20	0.025	0.015	≥ 0.020	≤ 0.012 ^f	—	≤ 0.30	≤ 0.30 ¹	≤ 0.08	≤ 0.020	≤ 0.30	0.03	0.02	—	—	0.70
P255GH	1.0460	0.18 to 0.23	0.40	0.30 to 0.90	0.025	0.015	≥ 0.020	≤ 0.012 ^f	—	≤ 0.30	≤ 0.30 ¹	≤ 0.08	≤ 0.020	≤ 0.30	0.03	0.02	—	—	0.70
P275GH	1.0425	≤ 0.20	0.40	0.50 to 1.40	0.025	0.015	≥ 0.020	≤ 0.012 ^f	—	≤ 0.30	≤ 0.30 ¹	≤ 0.08	≤ 0.020	≤ 0.30	0.03	0.02	—	—	0.70
P285GH	1.0481	0.08 to 0.20	0.40	0.90 to 1.50	0.025	0.015	≥ 0.020	≤ 0.012 ^f	—	≤ 0.30	≤ 0.30 ¹	≤ 0.08	≤ 0.020	≤ 0.30	0.03	0.02	—	—	0.70
P355GH	1.0473	0.10 to 0.22	0.60	1.10 to 1.70	0.025	0.015	≥ 0.020	≤ 0.012 ^f	—	≤ 0.30	≤ 0.30 ¹	≤ 0.08	≤ 0.020	≤ 0.30	0.03	0.02	—	—	0.70
P275NH	1.0487	≤ 0.18	0.40	0.50 to 1.40	0.025	0.015	≥ 0.020 ^g	≤ 0.020	—	≤ 0.30 ^h	≤ 0.30 ^h	≤ 0.08 ^h	0.05	≤ 0.50	0.03	0.05	—	0.05	—
P355NH	1.0585	≤ 0.20	0.50	0.90 to 1.70	0.025	0.015	≥ 0.020 ^g	≤ 0.020	—	≤ 0.30 ^h	≤ 0.30 ^h	≤ 0.08 ^h	0.05	≤ 0.50	0.03	0.10	—	0.12	—
P460NH	1.8935	≤ 0.20	0.80	1.00 to 1.70	0.025	0.015	≥ 0.020 ^g	≤ 0.025	—	≤ 0.30	≤ 0.70 ¹	≤ 0.10	0.05	≤ 0.80	0.03	0.20 ^k	—	0.22	—
P460QH ^b	1.8937	≤ 0.16	0.40	≤ 1.50	0.025	0.015	^d	≤ 0.015	0.005	≤ 0.30	0.30 ¹	≤ 0.25	0.05	≤ 0.50	0.03	0.06	0.05	—	—
P460QH ^b	1.8971	≤ 0.18	0.50	≤ 1.70	0.025	0.015	^d	≤ 0.015	0.005	≤ 0.50	0.30 ¹	≤ 0.50	0.05	≤ 1.00	0.03	0.08	0.05	—	—
P500QH ^b	1.8874	≤ 0.18	0.80	≤ 1.70	0.025	0.015	^d	≤ 0.015	0.005	≤ 1.00	0.30 ¹	≤ 0.70	0.05	≤ 1.50	0.05	0.08	0.15	—	—
P690QH ^b	1.8880	≤ 0.20	0.80	≤ 1.70	0.025	0.015	^d	≤ 0.015	0.005	≤ 1.50	0.30 ¹	≤ 0.70	0.06	≤ 2.50	0.05	0.12	0.15	—	—
16Mn3	1.5415	0.12 to 0.20	0.35	0.40 to 0.90	0.025	0.010	^e	≤ 0.012	—	≤ 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	0.025	0.010	^e	≤ 0.012	—	0.70 ^h to 1.15	≤ 0.30	0.40 to 0.80	—	—	—	—	—	—	—
10CrMo9-10	1.7380	0.08 to 0.14	0.50	0.40 to 0.80	0.020	0.010	^e	≤ 0.012	—	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	0.020	0.010	^e	≤ 0.012	—	2.00 to 2.50	≤ 0.25	0.90 to 1.10	—	—	—	—	—	—	—

^a 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 affect the mechanical properties and usability.

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

^c If nitrogen is additionally fixed by niobium, titanium or vanadium, the specification for the minimum aluminium content does not apply. If only aluminium is used for nitrogen binding, a ratio Al/N ≥ 2 shall apply.

^d 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 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 shall be determined.

^e The Al content of the cast shall be determined and given in the inspection document.

^f A ratio Al/N ≥ 2 shall apply.

^g The sum of the percentage by mass of the three elements chromium, copper and molybdenum shall not exceed 0.45 %.

^h ** If resistance to pressurized hydrogen is of importance, a minimum content of 0.00 % Cr should be agreed at the time of enquiry and order.

ⁱ ** 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.

^j 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.

^k 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 in Table 1 for the cast analysis

Element	Specified value in the cast analysis according to Table 1	Permissible deviation ^a of the product analysis
	% by mass	% by mass
C	$\leq 0,23$	$\pm 0,02$
Si	$\leq 0,80$	$\pm 0,05$
Mn	$\geq 0,30$ to $\leq 1,70$	+ 0,10 - 0,05
P	$\leq 0,015$	+ 0,003
	$> 0,015$ to $\leq 0,025$	+ 0,005
S	$\leq 0,015$	+ 0,003
Al _{total}	$\geq 0,020$	$\pm 0,005$
B	$\leq 0,005$	$\pm 0,000 5$
N	$\leq 0,025$	+ 0,002
Cr	$\leq 1,00$	$\pm 0,05$
	$> 1,00$ to $\leq 2,50$	$\pm 0,10$
Cu	$\leq 0,30$	$\pm 0,05$
	$> 0,30$ to $\leq 0,70$	$\pm 0,07$
Mo	$\leq 0,35$	$\pm 0,03$
	$> 0,35$ to $\leq 1,10$	+ 0,04
Nb	$\leq 0,08$	$\pm 0,01$
Ni	$\leq 1,00$	+ 0,05
	$> 1,00$ to $\leq 2,50$	$\pm 0,10$
Cr+Cu+Mo+Ni	$\leq 0,70$	+ 0,05
Ti	$\leq 0,03$	$\pm 0,01$
V	$\leq 0,05$	$\pm 0,01$
	$> 0,05$ to $\leq 0,20$	$\pm 0,03$
Zr	$\leq 0,15$	+ 0,01

^a If several product analyses are carried out on one cast, and the contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis then it is only allowed to exceed the permissible maximum value or fall short of the permissible minimum value, but not both for one cast.

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

Steel grade		Carbon equivalent (CEV) ^a		
		% max.		
		for specified diameter or thickness in mm		
Steel name	Steel 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
^a $CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$				

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Table 4 — Mechanical properties at room temperature

Steel grade		Usual delivery condition ^a	Diameter <i>d</i> or thickness <i>t</i> ^b mm	Yield strength <i>R_{eH}</i> ^c MPa min.	Tensile strength <i>R_m</i> MPa	Elongation after fracture <i>A</i> (longitudinal) % min.
Steel name	Steel number					
P235GH	1.0345	+N	≤ 16	235	360 to 480	25
			16 < (<i>d</i> or <i>t</i>) ≤ 40	225		
			40 < (<i>d</i> or <i>t</i>) ≤ 60	215		
			60 < (<i>d</i> or <i>t</i>) ≤ 100	200	350 to 480	24
			100 < (<i>d</i> or <i>t</i>) ≤ 150	185		
P250GH	1.0460	+ N	≤ 50	250	410 to 540	25
			50 < (<i>d</i> or <i>t</i>) ≤ 100	240		
			100 < (<i>d</i> or <i>t</i>) ≤ 150	230		
P265GH	1.0425	+N	≤ 16	265	410 to 530	23
			16 < (<i>d</i> or <i>t</i>) ≤ 40	255		
			40 < (<i>d</i> or <i>t</i>) ≤ 60	245		
			60 < (<i>d</i> or <i>t</i>) ≤ 100	215	400 to 530	22
			100 < (<i>d</i> or <i>t</i>) ≤ 150	200		
P295GH	1.0481	+N	≤ 16	295	460 to 580	22
			16 < (<i>d</i> or <i>t</i>) ≤ 40	290		
			40 < (<i>d</i> or <i>t</i>) ≤ 60	285		
			60 < (<i>d</i> or <i>t</i>) ≤ 100	260	440 to 570	21
			100 < (<i>d</i> or <i>t</i>) ≤ 150	235		
P355GH	1.0473	+N	≤ 16	355	510 to 650	21
			16 < (<i>d</i> or <i>t</i>) ≤ 40	345		
			40 < (<i>d</i> or <i>t</i>) ≤ 60	335		
			60 < (<i>d</i> or <i>t</i>) ≤ 100	315	490 to 630	20
			100 < (<i>d</i> or <i>t</i>) ≤ 150	295	480 to 630	
P275NH	1.0487	+N	≤ 16	275	390 to 510	24
			16 < (<i>d</i> or <i>t</i>) ≤ 35	275		
			35 < (<i>d</i> or <i>t</i>) ≤ 50	265		
			50 < (<i>d</i> or <i>t</i>) ≤ 70	255		
			70 < (<i>d</i> or <i>t</i>) ≤ 100	235	370 to 490	23
			100 < (<i>d</i> or <i>t</i>) ≤ 150	225	350 to 470	

Table 4 (continued)

Steel grade		Usual delivery condition ^a	Diameter <i>d</i> or thickness <i>t</i> ^b	Yield strength <i>R_{eH}</i> ^c	Tensile strength <i>R_m</i>	Elongation after fracture <i>A</i> (longitudinal) %
Steel name	Steel number		mm	MPa	MPa	(longitudinal) %
				min.		min.
P355NH	1.0565	+N	≤ 16	355	490 to 630	22
			16 < (<i>d</i> or <i>t</i>) ≤ 35	355		
			35 < (<i>d</i> or <i>t</i>) ≤ 50	345		
			50 < (<i>d</i> or <i>t</i>) ≤ 70	325		
			70 < (<i>d</i> or <i>t</i>) ≤ 100	315	470 to 610	21
100 < (<i>d</i> or <i>t</i>) ≤ 150	295	450 to 590				
P460NH	1.8935	+N ^d	≤ 16	460	570 to 720	17
			16 < (<i>d</i> or <i>t</i>) ≤ 35	450		
			35 < (<i>d</i> or <i>t</i>) ≤ 50	440		
			50 < (<i>d</i> or <i>t</i>) ≤ 70	420		
			70 < (<i>d</i> or <i>t</i>) ≤ 100	400	540 to 710	16
			100 < (<i>d</i> or <i>t</i>) ≤ 150	380	520 to 690	
P355QH	1.8867	+QT	≤ 50	355	490 to 630	22
			50 < (<i>d</i> or <i>t</i>) ≤ 100	335	450 to 590	
			100 < (<i>d</i> or <i>t</i>) ≤ 150	315		
P460QH	1.8871	+QT	≤ 50	460	550 to 720	19
			50 < (<i>d</i> or <i>t</i>) ≤ 100	440	500 to 670	
			100 < (<i>d</i> or <i>t</i>) ≤ 150	400		
P500QH	1.8874	+QT	≤ 50	500	590 to 770	17
			50 < (<i>d</i> or <i>t</i>) ≤ 100	480	540 to 720	
			100 < (<i>d</i> or <i>t</i>) ≤ 150	440		
P690QH	1.8880	+QT	≤ 50	690	770 to 940	14
			50 < (<i>d</i> or <i>t</i>) ≤ 100	670	720 to 900	
			100 < (<i>d</i> or <i>t</i>) ≤ 150	630		
16Mo3	1.5415	+N ^e	≤ 16	275	440 to 590	24
			16 < (<i>d</i> or <i>t</i>) ≤ 40	270		
			40 < (<i>d</i> or <i>t</i>) ≤ 60	260		23
			60 < (<i>d</i> or <i>t</i>) ≤ 100	240	430 to 580	22
			100 < (<i>d</i> or <i>t</i>) ≤ 150	220	420 to 570	19
13CrMo4-5	1.7335	+NT	≤ 16	300	450 to 600	20
			16 < (<i>d</i> or <i>t</i>) ≤ 60	295		
		+NT or +QA or +QL	60 < (<i>d</i> or <i>t</i>) ≤ 100	275	440 to 590	19
		+QL	100 < (<i>d</i> or <i>t</i>) ≤ 150	255	430 to 580	

Table 4 (concluded)

Steel grade		Usual delivery condition ^a	Diameter d or thickness t ^b	Yield strength R_{eH} ^c	Tensile strength R_m	Elongation after fracture A (longitudinal) %
Steel name	Steel number		mm	MPa	MPa	min.
10CrMo9-10	1.7380	+NT	≤ 16	310	480 to 630	18
			$16 < (d \text{ or } t) \leq 40$	300		
			$40 < (d \text{ or } t) \leq 60$	290		
		+NT or +QA or +QL	$60 < (d \text{ or } t) \leq 100$	270	470 to 620	17
			$100 < (d \text{ or } t) \leq 150$	250	460 to 610	
11CrMo9-10	1.7383	+NT or +QA or +QL	≤ 60	310	520 to 670	18
		+QL	$60 < (d \text{ or } t) \leq 100$ ^f			17

^a +N: normalized (including normalizing rolled; see 6.2.2); +QT: quenched and tempered; +NT: normalized and tempered; +QA: air quenched and tempered; +QL: liquid quenched and tempered

^b ** Mechanical properties for diameters or thicknesses > 150 mm may be agreed.

^c 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 MPa lower minimum values apply for $R_{p0,2}$.

^d See 6.2.2 (second paragraph).

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

^f Footnote b does not apply.

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Table 5 — Impact energy values

Steel grade		Minimum impact energy value KV (longitudinal) J at temperatures in °C		
Steel name	Steel number	-20	0	+20
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 — Minimum proof strength $R_{p0.2}$ at elevated temperatures ^a

Steel grade		Diameter d or thickness t mm	Proof strength $R_{p0.2}$ MPa min. at a temperature in °C of									
Steel name	Steel number		50	100	150	200	250	300	350	400	450	500
P235GH ^c	1.0345	≤ 16	227	214	198	182	167	153	142	133	—	—
		$16 < (d \text{ or } t) \leq 40$	218	205	190	174	160	147	136	128	—	—
		$40 < (d \text{ or } t) \leq 80$	208	196	181	167	153	140	130	122	—	—
		$80 < (d \text{ or } t) \leq 100$	193	182	169	155	142	130	121	114	—	—
		$100 < (d \text{ or } t) \leq 150$	179	168	156	143	131	121	112	105	—	—
P250GH ^c	1.0480	≤ 50	242	237	216	190	170	150	130	110	90	—
		$50 < (d \text{ or } t) \leq 100$	234	230	210	185	165	145	125	100	80	—
		$100 < (d \text{ or } t) \leq 150$	224	220	200	175	155	135	115	90	70	—
P265GH ^c	1.0425	≤ 16	258	241	223	205	188	173	160	150	—	—
		$16 < (d \text{ or } t) \leq 40$	247	232	215	197	181	166	154	145	—	—
		$40 < (d \text{ or } t) \leq 80$	237	223	206	190	174	160	146	139	—	—
		$80 < (d \text{ or } t) \leq 100$	208	196	181	167	153	140	130	122	—	—
		$100 < (d \text{ or } t) \leq 150$	193	182	169	155	142	130	121	114	—	—
P295GH ^c	1.0481	≤ 16	285	268	249	228	209	192	178	167	—	—
		$16 < (d \text{ or } t) \leq 40$	280	264	244	225	206	189	175	165	—	—
		$40 < (d \text{ or } t) \leq 80$	276	259	240	221	202	186	172	162	—	—
		$80 < (d \text{ or } t) \leq 100$	251	237	219	201	184	170	157	148	—	—
		$100 < (d \text{ or } t) \leq 150$	227	214	198	182	167	153	142	133	—	—
P355GH ^c	1.0473	≤ 16	343	323	299	275	252	232	214	202	—	—
		$16 < (d \text{ or } t) \leq 40$	334	314	291	267	245	225	208	196	—	—
		$40 < (d \text{ or } t) \leq 80$	324	305	282	259	238	219	202	190	—	—
		$80 < (d \text{ or } t) \leq 100$	305	287	265	244	224	206	190	179	—	—
		$100 < (d \text{ or } t) \leq 150$	285	268	249	228	209	192	178	167	—	—
P275NH	1.0487	≤ 16	268	250	232	213	195	179	166	156	—	—
		$16 < (d \text{ or } t) \leq 40$	258	241	223	205	188	173	160	150	—	—
		$40 < (d \text{ or } t) \leq 80$	247	232	215	197	181	166	154	145	—	—
		$80 < (d \text{ or } t) \leq 100$	227	214	198	182	167	153	142	133	—	—
		$100 < (d \text{ or } t) \leq 150$	218	205	190	174	160	147	136	128	—	—
P355NH	1.0565	≤ 16	343	323	299	275	252	232	214	202	—	—
		$16 < (d \text{ or } t) \leq 40$	334	314	291	267	245	225	208	196	—	—
		$40 < (d \text{ or } t) \leq 80$	324	305	282	259	238	219	202	190	—	—
		$80 < (d \text{ or } t) \leq 100$	305	287	265	244	224	206	190	179	—	—
		$100 < (d \text{ or } t) \leq 150$	295	277	257	236	216	199	184	173	—	—
P460NH	1.8835	≤ 16	445	419	388	358	328	300	276	261	—	—
		$16 < (d \text{ or } t) \leq 40$	430	405	375	345	316	290	269	253	—	—
		$40 < (d \text{ or } t) \leq 80$	416	391	362	333	305	281	260	244	—	—
		$80 < (d \text{ or } t) \leq 100$	387	364	337	310	284	261	242	227	—	—
		$100 < (d \text{ or } t) \leq 150^b$	—	—	—	—	—	—	—	—	—	—
P355QH	1.8867	≤ 50	340	310	285	260	235	215	—	—	—	—
		$50 < (d \text{ or } t) \leq 100$	320	290	265	240	215	195	—	—	—	—
		$100 < (d \text{ or } t) \leq 150$	280	250	225	200	175	155	—	—	—	—

Table 6 (continued)

Steel grade		Diameter d or thickness t mm	Proof strength $R_{p0.2}$ MPa min. at a temperature in °C of									
Steel name	Steel number		50	100	150	200	250	300	350	400	450	500
P460QH	1.8871	≤ 50	445	425	405	380	360	340	—	—	—	—
		$50 < (d \text{ or } t) \leq 100$	425	405	385	360	340	320	—	—	—	—
		$100 < (d \text{ or } t) \leq 150$	385	365	345	320	300	280	—	—	—	—
P500QH	1.8874	≤ 50	490	470	450	420	400	380	—	—	—	—
		$50 < (d \text{ or } t) \leq 100$	470	450	430	400	380	360	—	—	—	—
		$100 < (d \text{ or } t) \leq 150$	430	410	390	360	340	320	—	—	—	—
P680QH	1.8880	≤ 50	87	645	615	585	575	570	—	—	—	—
		$50 < (d \text{ or } t) \leq 100$	650	625	595	575	555	550	—	—	—	—
		$100 < (d \text{ or } t) \leq 150$	610	585	555	535	515	510	—	—	—	—
16Mn3	1.5415	≤ 16	273	264	250	233	213	194	175	159	147	141
		$16 < (d \text{ or } t) \leq 40$	268	259	245	228	209	190	172	158	145	139
		$40 < (d \text{ or } t) \leq 60$	258	250	236	220	202	183	165	150	139	134
		$60 < (d \text{ or } t) \leq 100$	238	230	218	203	186	169	153	139	129	123
		$100 < (d \text{ or } t) \leq 150$	218	211	200	186	171	155	140	127	118	113
13CrMo4-5	1.7335	≤ 16	294	285	269	252	234	216	200	188	175	164
		$16 < (d \text{ or } t) \leq 60$	285	275	260	243	226	209	194	180	169	159
		$60 < (d \text{ or } t) \leq 100$	265	258	242	227	210	195	180	168	157	148
		$100 < (d \text{ or } t) \leq 150$	250	242	228	214	199	184	170	159	148	139
10CrMo9-10	1.7380	≤ 16	288	288	254	248	243	236	225	212	197	185
		$16 < (d \text{ or } t) \leq 40$	279	257	246	240	235	228	218	205	191	179
		$40 < (d \text{ or } t) \leq 60$	270	249	238	232	227	221	211	198	185	173
		$60 < (d \text{ or } t) \leq 100$	260	240	230	224	220	213	204	191	178	167
		$100 < (d \text{ or } t) \leq 150$	250	237	226	222	219	213	204	191	178	167
11CrMo9-10 ^a	1.7383	≤ 100	—	—	—	—	255	235	225	215	205	195

^a The values correspond to the lower band of the relevant trend curve determined in accordance with EN 10314 with a confidence limit of about 98 % (2 s).

^b Delivery condition as given in Table 4.

^c The values are reflecting the minimum values for furnace normalized test pieces.

^d $R_{p0.2}$ not determined in accordance with EN 10314. They are minimum values of the scatter band considered until now.

^e Values may be agreed at the time of enquiry and order.

Table 7 — Summary of tests and extent of testing

Type of inspection and test		Test frequency ^a	Refer to
Mandatory tests	Cast analysis	1 per cast	8.3.1
	Tensile test at room temperature	1 per sample	10.1.2, 10.2 and 11.2
	Impact test	3 per sample	10.1.2, 10.2 and 11.4
	Dimensional and visual inspection	Each product	11.5.1 and 11.5.2
Optional tests	Product analysis	1 per cast	10.1.1, 10.2.1 and 11.1
	Tensile test at elevated temperature	1 per cast	10.1.2, 10.2 and 11.3
	Verification of internal soundness	^b	8.6 and 11.5.3

^a For sampling and the size of test units, see 10.1.

^b To be agreed at the time of enquiry and order.

Table 8 — Position of the (longitudinal) test pieces

Dimensions in millimetres

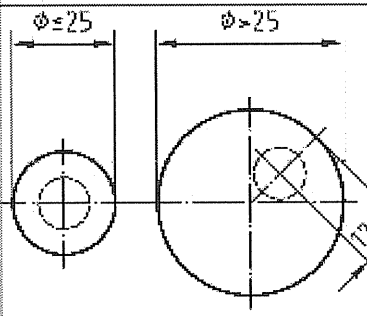
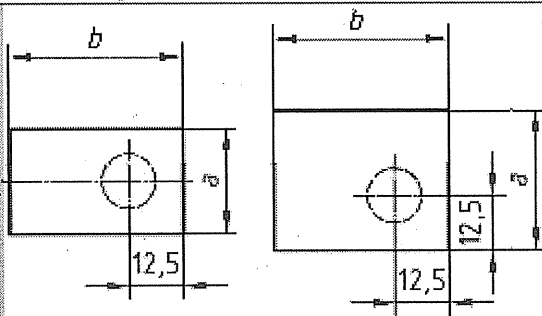
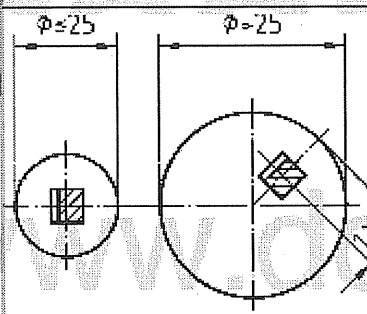
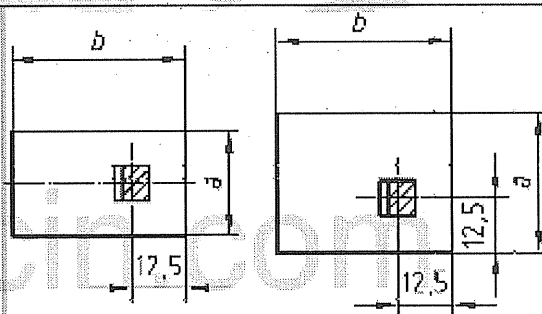
Type of test	Products with circular cross-section	Products with rectangular cross-section
Tensile	 Tensile test piece	
		
Impact ^a	 Impact test piece	
		
^a For products with circular cross-section, the axis of the notch is approximately a diagonal: For products with rectangular cross-section, the axis of the notch is perpendicular to the greatest rolled surface.		

Table 9 — Marking of the products

Marking of	Symbol ^a
Manufacturer's name, trade mark or logo	+
Number of this European Standard	(+)
Steel name or number	+
Type of finish	(+)
Identification number	+ ^b
Nominal diameter or thickness	(+)
Nominal dimensions other than diameter or thickness	(+)
Inspector's mark	+ ^c
Customer's order No.	(+)
^a The symbols mean: + = the marking shall be applied; (+) = the marking shall be applied if so agreed, or at the manufacturer's discretion. ^b 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. ^c The inspector's mark may be omitted if the relevant inspector can be identified in another way.	

Annex A (informative)

Guidelines for heat treatment

Table A.1 gives reference data for heat treatment temperatures.

Table A.1 — Guidelines on the temperatures for heat treatment

Steel grade		Temperatures, °C		
name	number	Normalizing	Austenitizing	Tempering ^a
P235GH	1.0345	890 to 950 ^a	—	—
P250GH	1.0460	890 to 950 ^a	—	—
P265GH	1.0425	890 to 950 ^a	—	—
P295GH	1.0481	890 to 950 ^a	—	—
P355GH	1.0473	890 to 950 ^a	—	—
16Mo3	1.5415	890 to 950 ^a	—	— ^a
13CrMo4-5	1.7335	—	890 to 950	630 to 730
10CrMo9-10	1.7380	—	920 to 980	650 to 750
11CrMo9-10	1.7383	—	920 to 980	650 to 750
^a When normalizing, after the required temperatures have been attained over the whole cross-section, no further holding is necessary and should be generally avoided. ^b When tempering, the specified temperatures shall, when they have been attained over the whole cross-section, be maintained for at least 20 min. ^c In certain cases, tempering at 550 °C to 650 °C may be necessary.				

Annex B (informative) Reference data on creep strain and creep rupture

NOTE 1 The values given in Table B.1 were derived as mean values in accordance with ISO 6303 with a scatter band of $\pm 20\%$.

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. Where relevant it is important that the oxidation conditions are also taken into account.

Table B.1 — Strength for 1 % (plastic) creep strain and creep rupture

Steel grade		Temperature °C	Strength for 1 % (plastic) creep strain in MPa for		Creep rupture strength in MPa for		
Steel name	Steel number		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
P235GH, P285GH	1.0345, 1.0425	380	164	118	229	165	145
		390	150	108	211	148	129
		400	138	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	88	50	40
P250GH	1.0460	480	53	30	75	42	33
		380	164	118	229	165	145
		390	150	108	211	148	129
		400	138	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
P295GH, P355GH	1.0481, 1.0473	470	62	35	88	50	42
		480	53	30	75	42	33
		380	195	153	291	227	206
		390	182	137	268	203	181
		400	167	118	243	179	157
		410	150	105	221	157	135
		420	135	92	200	138	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
		490	55	33	84	47	37
		500	49	29	74	41	30

Table B.1 (concluded)

Steel grade		Temperature °C	Strength for 1 % (plastic) creep strain in MPa for		Creep rupture strength in MPa for		
Steel name	Steel number		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
16Mo3	1.5415	450	216	167	238	239	217
		460	199	146	273	208	186
		470	162	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
		540	71	28	81	41	35
13CrMo4-5	1.7335	450	245	191	370	285	260
		460	228	172	348	251	228
		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	66
		550	83	49	108	68	58
		560	73	41	95	58	50
		570	65	35	85	51	43
		580	57	30	75	44	37
		590	50	26	66	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	

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and the essential requirements of the EU Directive 97/23/EC, Annex I

Clauses/subclauses of this EN	Essential Requirements (ERs) of the Directive 97/23/EC, Annex I	Qualifying remarks / notes
8.4	4.1a	Appropriate material properties
8.2	4.1c	Ageing
8.2, 8.6 and 8.7	4.1d	Suitable for the processing procedures
9.1	4.3	Documentation

WARNING: Other requirements and other EC Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*
- [2] EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels*
- [3] EN 10027-1, *Designation systems for steel — Part 1: Steel names*
- [4] EN 10027-2, *Designation systems for steel — Part 2: Numerical system*
- [5] EN 10314, *Method for the derivation of minimum values of proof strength of steel at elevated temperatures*
- [6] ISO 6303, *Pressure vessel steels not included in ISO 2604, Parts 1 to 6 – Derivation of long-time stress rupture properties*
- [7] prCEN/TR 10261, *Iron and steel — Review of available methods of chemical analysis*

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