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ICS 77.120.40; 77.140.20

Supersedes
DIN EN 10269:1999-11

Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties (includes Amendment A1:2006 and Corrigenda Ber 1:2006-10 + Ber 2:2007-02)
English version of DIN EN 10269:2006-07

Stähle und Nickellegierungen für Befestigungselemente für den Einsatz bei erhöhten und/oder tiefen Temperaturen (enthält Änderung A1:2006 und Berichtigungen Ber 1:2006-10 + Ber 2:2007-02)
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National foreword

This standard has been prepared by ECISSC/TC 22 'Steels for pressure purposes — Qualities' (Secretariat: Germany).

The responsible German body involved in its preparation was the *Normenausschuss Eisen und Stahl* (Steel and Iron Standards Committee), Technical Committee 19/5 *Stabstahl und Walzdraht für Befestigungsmittel*.

The main changes included in Amendment A1:2006 refer to table 1 and Annex ZA.

This standard also includes the corrections from Corrigenda DIN EN 10269 Ber 1:2006-10 and DIN EN 10269 Ber 2:2007-02.

Amendments

This standard differs from DIN EN 10269:1999-11 as follows:

a) The chemical composition of stainless steels is now in accordance with DIN EN 10088-3 (see table 1).

b) The maximum phosphorus content of steels for quenching and tempering is now in accordance with E DIN EN 10083-2 and E DIN EN 10083-3 (see table 1).

c) Subclause 8.6 has been revised.

d) Clause 9 has been revised taking into account the new edition of DIN EN 10204.

e) Annex ZA has been revised and the relevant notes in table 3 and 4 have been changed accordingly.

f) The standard has been editorially revised.

Previous editions

DIN 17240: 1976-07
DIN 17240-1: 1959-01
DIN 17240-2: 1959-01
DIN 17280: 1985-07
DIN EN 10269:1999-11

National Annex NA
(informative)

Bibliography

E DIN EN 10083-2, *Steels for quenching and tempering — Part 2: Technical delivery conditions for non-alloy steels*

E DIN EN 10083-3, *Steels for quenching and tempering — Part 3: Technical delivery conditions for alloy steels*

DIN EN 10088-3, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes*

DIN EN 10204, *Metallic products — Types of inspection documents*

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10269

August 1999

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ICS 77.120.40; 77.140.20

English version

Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties (includes Amendment A1:2006)

Aciers et alliages de nickel pour éléments de fixation utilisés à température élevée et/ou basse température (amendement A1:2006 inclus)

Stähle und Nickellegierungen für Befestigungselemente für den Einsatz bei erhöhten und/oder tiefen Temperaturen (enthält Änderung A1:2006)

EN 10269:1999 was approved by CEN on 1999-07-01 and Amendment A1 on 2006-03-09.

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

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Foreword to EN 10269:1999

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 February 2000, and conflicting national standards shall be withdrawn at the latest by February 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.

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 1 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 with two points (••) contain information relating to agreements which may be made at the time of enquiry and order.

NOTE 2 For this harmonised supporting standard for materials, presumption of conformity to the Essential Safety Requirements is limited to technical data of materials in the standard and does not presume adequacy of the material to a specific equipment. Consequently the technical data stated in the material standard should be assessed against the design requirements of the specific equipment to verify that the Essential Safety Requirements of Directive 97/23/EC are satisfied.

Foreword to EN 10269:1999/A1:2006

This European Standard (EN 10269:1999/A1:2006) has been prepared by Technical Committee ECISS/TC 22 “Steels for pressure purposes — Qualities”, the secretariat of which is held by DIN.

This Amendment to the European Standard EN 10269:1999 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2006, and conflicting national standards shall be withdrawn at the latest by October 2006.

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 European Standard specifies requirements for semi-finished products, bars and rods for fasteners with properties specified at elevated and/or low temperatures made of non-alloy and alloy (including stainless) steels and nickel alloys as given in table 1.

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

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. 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 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*

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 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, *Definitions of steel products*

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

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

EN 10204, *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 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

CR 10261, *ECISS — Information Circular 11 Iron and steel — Review of available methods of chemical analysis*

3 Definitions

3.1 For the purpose of this European Standard the definitions in

— EN 10020 for classification of steels,

— EN 10052 for the types of heat treatment and

— EN 10079 for the various product forms

apply.

Additionally to the definitions in EN 10052 the following should be noted:

NOTE 1 Normalizing (symbol N) also includes normalizing forming.

NOTE 2 Quenching and tempering (symbol QT) also includes direct hardening plus tempering.

3.2
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 shall be agreed at the time of enquiry and order with reference to the relevant dimensional standard EN 10058, EN 10059, EN 10060, EN 10061 or EN 10108.

5 Calculation of mass

The values of density given in annex A shall be used as the basis for the calculation of the nominal mass from the nominal dimensions. For grades not mentioned in annex A, the following density values apply:

— 11/12 % Cr steels: 7,7 kg/dm^3

— X8Ni9 7,89 kg/dm^3

— austenitic CrNiMo steels: 8,0 kg/dm^3

For all other steels a density of 7,85 kg/dm^3 applies.

6 Classification and designation

6.1 Classification

In accordance with EN 10020 the steel grades C35E, C45E and 20Mn5 are non-alloy special steels. All other steel grades are alloy special including austenitic steels. Additionally, austenitic nickel alloys are specified.

6.2 Designation

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

NOTE Explanation on the designation of nickel alloys

— name: The preceding chemical symbols indicate the main alloy elements and the figure immediately following indicates the average content of these alloys subsequently followed by the symbol for the other added important alloy elements.

— material number: The structure is set out according to EN 10027-2 with the number 2 for the material group number. This material group comprises chemically resisting and heat resisting or creep resisting nickel and cobalt alloys.

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) the quantity required (mass or number of pieces);

b) the type of product;

c) the European Standard specifying the tolerances on dimensions and shape (see clause 4) and the tolerance of mass and, if the relevant European Standard permits the purchaser certain options, e.g. regarding edge finishes or tolerance classes, specific information on these aspects;

d) the nominal dimensions of the product;

e) the number of this European Standard;

f) the material name or number;

g) the delivery condition (see 8.2.1);

h) the surface quality class (see 8.5);

i) the type of inspection document (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 a wish to implement any of these options at the time of enquiry and order, the supplier shall supply in accordance with the basic specification (see 7.1).

1) special melting process (see 8.1);

2) test on simulated treated samples (see 8.2.2);

3) stress relieving treatment (see 8.2.3);
4) verification of internal soundness (see 8.6 and Table 8, footnote f);
5) inspection certificate 3.2 (see 9.1)
6) product analysis and its extent (see Table 8, footnote b);
7) tensile test at elevated temperatures (see Table 8, footnote c);
8) impact test at room temperature for austenitic steels (see Table 8, footnote d);
9) impact test at low temperature (see Table 8, footnote e; 11.5);
10) additional tests (see Table 8, footnote g);
11) specification of an analytical method (see 11.1);
12) number of test pieces for the product analysis (see 10.1.1);
13) temperature for the tensile test at elevated temperature (see 11.4);
14) special marking (see 12.2).

7.3 Example of ordering

2 t rounds made of a steel grade with the name X8Ni9 and the number 1.5662 as specified in EN 10269 of 30 mm diameter; dimensional tolerances as specified in EN 10060; surface quality class B in accordance with EN 10221; inspection certificate 3.1 as specified in EN 10204:

2 t rounds EN 10060–30–Steel EN 10269–X8Ni9–EN 10221–class B–Inspection certificate 3.1

or

2 t rounds EN 10060–30–Steel EN 10269–1.5662–EN 10221–class B–Inspection certificate 3.1

8 Requirements

8.1 •• Melting process

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

8.2 Delivery condition

8.2.1 • Table 3 covers delivery conditions +A, +S, +AC normally applied for further processing (such as shearing, cold heading, etc.).

Table 4 covers delivery conditions normally applied without additional heat treatment after delivery.

The purchaser shall specify in his enquiry and order the delivery condition required.

NOTE Depending on the type (e. g. billet) and the dimensions of the product and the intended type of further processing the material, in special cases the delivery in the untreated condition may be agreed.

8.2.2 •• When delivery in a condition not covered in table 4 is agreed, for the verification of compliance with the requirements of this European Standard tests on simulated treated samples may be agreed at the time of enquiry and order. In the case of billets, this simulated treatment may also include a hot forming operation.

8.2.3 •• By agreement at the time of enquiry and order, for the steels for quenching and tempering a stress relieving treatment after straightening may be specified. See footnote 3 to table B.1.

8.3 Chemical composition

8.3.1 The information in table 1 applies for the chemical composition according to the cast analysis.

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

8.4 Mechanical properties

8.4.1 General

The hardness and mechanical properties specified in this European Standard apply when billets, bars and rods are delivered in a condition given in table 3 or table 4 and where the relevant tests are carried out in accordance with the sampling and testing conditions in 10.2 and clause 11.

8.4.2 Hardness and mechanical properties at room temperature

The mechanical properties at room temperature are specified in tables 3 and 4. They apply for the relevant specified heat treatment condition and dimensions.

8.4.3 Mechanical properties at elevated temperatures

The values in table 5 apply for the 0,2 % proof strength at elevated temperatures.

The values in table 6 apply for the tensile strength at elevated temperatures.

Reference data of strength values for 1 % (plastic) creep and creep rupture are given in table C.1.

Reference data for relaxation properties are given in table D.1.

8.4.4 Mechanical properties at low temperatures

Low temperature impact energy values are specified in table 7.

NOTE 1 Austenitic steels are insensitive to brittle fracture in the solution annealed condition. Because they do not have a pronounced transition temperature, which is characteristic of other steels, they are also useful for application at cryogenic temperatures.

NOTE 2 In the case of billets verification of the capability of the material to comply with the property requirements for the bars by testing simulated heat treated test pieces may be agreed.

8.5 • Surface condition

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

The purchaser shall specify a surface quality class in accordance with 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 may be agreed at the time of enquiry and order.

9 Prüfung

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 non-specific or specific inspection.

• • The applicable inspection document according to EN 10204 for products in a delivery condition in accordance with Table 3 is the test report 2.2, for all other delivery conditions the inspection certificate 3.1, unless an inspection certificate 3.2 is agreed.

The purchaser shall state the required type of inspection document. If an inspection certificate 3.2 is ordered, the purchaser shall notify the manufacturer of the name and the address of the organization or person who is to carry out the inspection and to produce the inspection document. In this case, it shall be agreed which party shall issue the certificate.

9.1.2 If a test report 2.2 is ordered, this shall include, in accordance with EN 10168, the following codes and information:

A	Commercial transactions and parties involved;
B	Description of the products to which the test report applies;
C03	Test temperature;
C71-C92	Cast analysis;
D01	Visual examination and marking;
Z	Validation.

9.1.3 If an inspection certificate 3.1 or an inspection certificate 3.2 is ordered, this 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, if applicable;
C50-C69	Hardness test, if applicable;
C71-C92	Cast analysis and, if applicable, product analysis and steelmaking process;
D01	Marking and dimensional checking and, if applicable, verification of the surface quality;
D02-D99	NDT, 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 Table 8.

9.3 Re-tests, sorting and reprocessing

For re-tests, 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 other tests shall be the batch of products or part thereof coming from the same cast and having been heat treated in the same batch and in the same heat treatment facility[1)]. 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 to 7).

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 10.2.2 shall apply to the mechanical tests.

10.2.1.2 If the products are not to be delivered in the usual delivery condition (see 8.2.2) , the samples shall be treated to the usual delivery condition prior to the test.

10.2.1.3 The samples shall be taken in accordance with figure 1. All test pieces including those for the hardness test shall be taken from the same location.

10.2.2 Preparation of test pieces

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

10.2.2.2 Three longitudinal V-notched test pieces in accordance with EN 10045-1 shall be prepared for the impact test.

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 CR 10261.

11.2 Härteprüfung

The Brinell hardness test shall be carried out in accordance with EN ISO 6506-1.

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.

11.3 Zugversuch bei Raumtemperatur

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

The 0,2% proof strength, the tensile strength, the elongation after fracture and, if applicable, the reduction of area shall be determined.

11.4 •• Tensile test at elevated temperature

The 0,2 % proof strength or tensile strength at elevated temperature shall be determined in accordance with EN 10002-5. Verification shall be obtained at one of the temperatures given in tables 5 and 6. This temperature shall be agreed at the time of enquiry and order.

11.5 •• Impact test

The impact test shall be carried out in accordance with EN 10045-1 at room temperature unless otherwise agreed.

The minimum impact energy values 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 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.

11.6 Other testing

11.6.1 Visual examination of the surface condition shall be carried out without optical aids.

11.6.2 The dimensions of the products shall be checked.

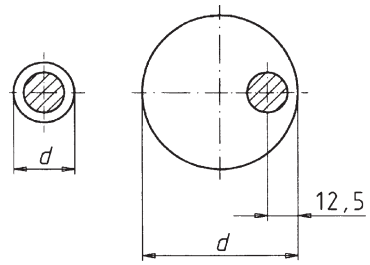
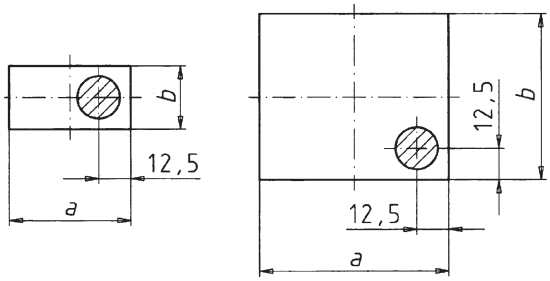
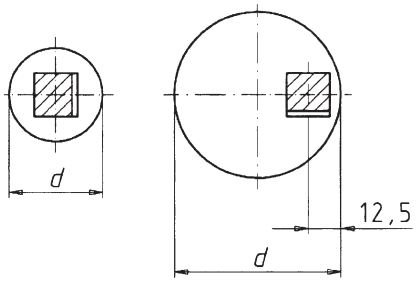
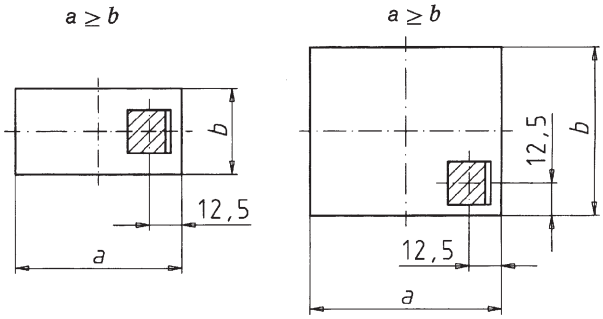
11.6.3 If an non-destructive (e. g. ultrasonic) test has been agreed for checking internal soundness (see 8.6), the requirements shall also be agreed.

11.6.4 The manufacturer shall take suitable measures to prevent materials becoming mixed up.

12 Marking

12.1 The products or the bundles 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 •• Special marking may be agreed at the time of enquiry and order.

Type of test	Round cross-section products	Rectangular cross-section products
Tensile	$d \leq 25$ [b] $\quad 25 < d \leq 160$  (full cross section where possible)	$b \leq 25$, $a \geq b$ $\quad 25 < b \leq 160$, $a \geq b$ 
Impact[a]	$15 \leq d \leq 25$ $\quad 25 < d \leq 160$  	$b \leq 25$, $a \geq b$ $\quad 25 < b \leq 160$, $a \geq b$ 

[a] 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.

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

Table 1 — Chemical composition (cast analysis)[a]

Material designation		Chemical composition, % by mass											
name	number	C	Si	Mn	P max.	S max.	Al_{tot}	B	Cr	Mo	Ni	V	Others
Steels for quenching and tempering													
19MnB4	1.5523	0,17 to 0,24	≤ 0,40	0,80 to 1,15	0,030	0,035	≥ 0,020 *)	0,000 8 to 0,005 0					
C35E	1.1181	0,32 to 0,39	≤ 0,40	0,50 to 0,80	0,030	0,035			≤ 0,40	≤ 0,10	≤ 0,40		Cr+Mo+Ni: ≤ 0,63
C45E	1.1191	0,42 to 0,50	≤ 0,40	0,50 to 0,80	0,030	0,035			≤ 0,40	≤ 0,10	≤ 0,40		Cr+Mo+Ni: ≤ 0,63
35B2	1.5511	0,32 to 0,39	≤ 0,40	0,50 to 0,80	0,030	0,035	≥ 0,020 *)	0,000 8 to 0,005 0					
20Mn5	1.1133	0,17 to 0,23	≤ 0,40	1,00 to 1,50	0,030	0,035	≥ 0,020 *)		≤ 0,40	≤ 0,10	≤ 0,40		Cr+Mo+Ni: ≤ 0,63
25CrMo4	1.7218	0,22 to 0,29	≤ 0,40	0,60 to 0,90	0,025	0,035			0,90 to 1,20	0,15 to 0,30			
42CrMo4	1.7225	0,38 to 0,45	≤ 0,40	0,60 to 0,90	0,025	0,035			0,90 to 1,20	0,15 to 0,30			
42CrMo5-6	1.7233	0,39 to 0,45	≤ 0,40	0,40 to 0,70	0,025	0,035			1,20 to 1,50	0,50 to 0,70			
40CrMoV4-6	1.7711	0,36 to 0,44	≤ 0,40	0,45 to 0,85	0,025	0,030	≤ 0,015		0,90 to 1,20	0,50 to 0,65		0,25 to 0,35	
41NiCrMo7-3-2	1.6563	0,38 to 0,44	≤ 0,30	0,60 to 0,90	0,025	0,025			0,70 to 0,90	0,15 to 0,30	1,65 to 2,00		Cu: ≤ 0,25
21CrMoV5-7	1.7709	0,17 to 0,25	≤ 0,40	0,40 to 0,80	0,025	0,030	≤ 0,030		1,20 to 1,50	0,55 to 0,80	≤ 0,60	0,20 to 0,35	
20CrMoVTiB4-10	1.7729	0,17 to 0,23	≤ 0,40	0,35 to 0,75	0,020	0,020	0,015 to 0,080	0,001 to 0,010	0,90 to 1,20	0,90 to 1,10	≤ 0,20	0,60 to 0,80	Ti: 0,07 to 0,15 As: ≤ 0,020 Sn: ≤ 0,020 Cu: ≤ 0,20
34CrNiMo6	1.6582	0,30 to 0,38	≤ 0,40	0,50 to 0,80	0,025	0,035			1,30 to 1,70	0,15 to 0,30	1,30 to 1,70		
30CrNiMo8	1.6580	0,26 to 0,34	≤ 0,40	0,30 to 0,60	0,025	0,035			1,80 to 2,20	0,30 to 0,50	1,80 to 2,20		
X12Ni5	1.5680	≤ 0,15	≤ 0,35	0,30 to 0,80	0,020	0,010					4,75 to 5,25	≤ 0,05	
X8Ni9	1.5662	≤ 0,10	≤ 0,35	0,30 to 0,80	0,020	0,010				≤ 0,10	8,5 to 10,0	≤ 0,05	
X15CrMo5-1	1.7390	≤ 0,18	≤ 0,40	0,30 to 0,80	0,025	0,015			4,0 to 6,0	0,45 to 0,65			
X22CrMoV12-1	1.4923	0,18 to 0,24	≤ 0,50	0,40 to 0,90	0,025	0,015			11,0 to 12,5	0,80 to 1,20	0,30 to 0,80	0,25 to 0,35	
X12CrNiMoV12-3	1.4938	0,08 to 0,15	≤ 0,50	0,40 to 0,90	0,025	0,015			11,0 to 12,5	1,50 to 2,00	2,00 to 3,00	0,25 to 0,40	N: 0,020 to 0,040
X19CrMoNbVN11-1	1.4913	0,17 to 0,23	≤ 0,50	0,40 to 0,90	0,025	0,015	≤ 0,020	≤ 0,001 5	10,0 to 11,5	0,50 to 0,80	0,20 to 0,60	0,10 to 0,30	Nb: 0,25 to 0,55 N: 0,05 to 0,10

*) Correction from DIN EN 10269 Ber 1:2006-10.

Table 1 (*continued*)

Material designation		Chemical composition, % by mass											
name	number	C	Si	Mn	P max.	S max.	Al_{tot}	B	Cr	Mo	Ni	V	Others
Austenitic steels													
X2CrNi18-9	1.4307	≤ 0,030	≤ 1,00	≤ 2,00	0,045	0,030[b]			17,5 to 19,5		8,0 to 10,0		N: ≤ 0,11
X5CrNi18-10	1.4301	≤ 0,07	≤ 1,00	≤ 2,00	0,045	0,030[b]			17,0 to19,5		8,0 to 10,5		N: ≤ 0,11
X4CrNi18-12	1.4303	≤ 0,06	≤ 1,00	≤ 2,00	0,045	0,030[b]			17,0 to 19,0		11,0 to13,0		N: ≤ 0,11
X2CrNiMo17-12-2	1.4404	≤ 0,030	≤ 1,00	≤ 2,00	0,045	0,030[b]			16,5 to 18,5	2,00 to 2,50	10,0 to 13,0		N: ≤ 0,11
X5CrNiMo17-12-2	1.4401	≤ 0,07	≤ 1,00	≤ 2,00	0,045	0,030[b]			16,5 to 18,5	2,00 to 2,50	10,0 to 13,0		N: ≤ 0,11
X2CrNiMoN17-13-3	1.4429	≤ 0,030	≤ 1,00	≤ 2,00	0,045	0,030[b]			16,5 to 18,5	2,50 to 3,00	11,0 to 14,0		N: 0,12 to 0,22
X3CrNiCu18-9-4	1.4567	≤ 0,04	≤ 1,00	≤ 2,00	0,045	0,030[b]			17,0 to 19,0		8,5 to 10,5		N: ≤ 0,11 Cu: 3,0 to 4,0
X6CrNi18-10	1.4948	0,04 to 0,08	≤ 1,00	≤ 2,00	0,035	0,015			17,0 to 19,0		8,0 to 11,0		N: ≤ 0,11
X10CrNiMoMnNbVB1510-1	1.4982	0,07 to 0,13	≤ 1,00	5,50 to 7,00	0,040	0,030		0,003 to 0,009	14,0 to 16,0	0,80 to 1,20	9,0 to 11,0	0,15 to 0,40	Nb: 0,75 to 1,25 N: ≤ 0,11
X3CrNiMoBN17-13-3	1.4910	≤ 0,04	≤ 0,75	≤ 2,00	0,035	0,015		0,001 5 to 0,005 0	16,0 to 18,0	2,00 to 3,00	12,0 to 14,0		N: 0,10 to 0,18
X6CrNiMoB17-12-2	1.4919	0,04 to 0,08	≤ 1,00	≤ 2,00	0,035	0,015		0,001 5 to 0,005 0	16,5 to 18,5	2,00 to 2,50	10,0 to 13,0		N: ≤ 0,11
X6CrNiTiB18-10	1.4941	0,04 to 0,08	≤ 1,00	≤ 2,00	0,035	0,015		0,001 5 to 0,005 0	17,0 to 19,0		9,0 to 12,0		Ti: 5 x C to 0,80
X6NiCrTiMoVB25-15-2	1.4980	0,03 to 0,08	≤ 1,00	1,00 to 2,00	0,025	0,015	≤ 0,35	0,003 0 to 0,010	13,5 to 16,0	1,00 to 1,50	24,0 to 27,0	0,10 to 0,50	Ti: 1,90 to 2,30
X7CrNiMoBNb16-16	1.4986	0,04 to 0,10	0,30 to 0,60	≤ 1,50	0,045	0,030		0,05 to 0,10	15,5 to 17,5	1,60 to 2,00	15,5 to 17,5		Nb+Ta: 10 x C to 1,20
Nickel alloys													
NiCr20TiAl	2.4952	0,04 to 0,10	≤ 1,00	≤ 1,00	0,020	0,015	1,00 to 1,80	≤ 0,008	18,0 to 21,0		≥ 65		Co: ≤ 1,00, Cu: ≤ 0,20 Ti: 1,80 to 2,70 Fe: ≤ 1,50
NiCr15Fe7TiAl	2.4669	≤ 0,08	≤ 0,50	≤ 1,00	0,020	0,015	0,40 to 1,00		14,0 to 17,0		≥ 70		Co: ≤ 1,00, Cu: ≤ 0,50 Ti: 2,25 to 2,75 Nb+Ta: 0,70 to 1,20 Fe: 5,0 to 9,0

[a] Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the usefulness of the steel.

[b] A controlled sulfur content of 0,015 to 0,030 % improves the machinability and is therefore recommended.

Table 2 — Permissible product analysis tolerances on the limiting values given in table 1 for the cast analysis

Element	Specified limits, cast analysis % by mass		Permissible tolerance[a] % by mass
C		≤ 0,20	± 0,01
	> 0,20	≤ 0,50	± 0,02
Si		≤ 0,40	± 0,03
	> 0,40	≤ 1,00	± 0,05
Mn		≤ 2,00	± 0,04
	> 2,00	≤ 7,0	± 0,10
P		≤ 0,045	+ 0,005
S		≤ 0,015	+ 0,003
	> 0,015	≤ 0,035	+ 0,005
N		≤ 0,040	± 0,005
	> 0,040	≤ 0,18	± 0,01
Al	≥ 0,015	≤ 0,08	+0,01 –0,005
	> 0,08	≤ 0,35	± 0,05
	> 0,35	≤ 1,80	± 0,10
B		≤ 0,010	± 0,000 5
	> 0,010	≤ 0,10	± 0,005
Cr		≤ 2,00	± 0,05
	> 2,00	< 10,0	± 0,10
	≥ 10,0	< 15,0	± 0,15
	≥ 15,0	≤ 21,0	± 0,20
Cu		≤ 0,50	+ 0,05
	> 0,50	≤ 4,0	± 0,10
Mo		≤ 0,60	± 0,03
	> 0,60	< 1,75	± 0,05
	≥ 1,75	≤ 3,00	± 0,10
Ni		≤ 1,00	± 0,03
	> 1,00	≤ 5,0	± 0,07
	> 5,0	≤ 10,0	± 0,10
	> 10,0	≤ 20,0	± 0,15
	> 20,0	≤ 27,0	± 0,20
Cr+Mo+Ni		≤ 0,63	+ 0,05
Nb		≤ 1,25	± 0,05
Nb+Ta	≥ 0,70	≤ 1,20	± 0,10
Ti		≤ 0,15	± 0,01
	> 0,15	≤ 1,00	± 0,05
	> 1,00	≤ 2,75	± 0,10
V		≤ 0,05	± 0,01
	> 0,05	≤ 0,80	± 0,03
As		≤ 0,020	± 0,003
Sn		≤ 0,020	± 0,003
Fe[b]		≤ 1,50	+ 0,05
	> 1,50	≤ 9,0	± 0,10

[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 to fall short of the permissible minimum value, but not both for one cast.

[b] For nickel alloys.

Table 3 — Mechanical properties at room temperature for delivery conditions normally applied for further processing

Steel designation		Heat treatment condition[a]	Hard-ness	Tensile strength	Reduction in area
name	number		HB	R_m MPa	Z %
			max.	max.	min.
19MnB4	1.5523	+AC	–	520	64
35B2	1.5511	+AC	–	570	62
25CrMo4	1.7218	+S	255	–	–
		+A	212	–	–
		+AC	–	580	59
42CrMo4	1.7225	+S	255	–	–
		+A	241	–	–**)
		+AC	–	630	57
42CrMo5-6	1.7233	+S	255	–	–
		+A	241	–	–
40CrMoV4-6	1.7711	+A	241	–	–
41NiCrMo7-3-2	1.6563	+A	255	–	–
21CrMoV5-7	1.7709	+S	255	–	–
		+AC	229	–	–
34CrNiMo6	1.6582	+A	255	–	–
30CrNiMo8	1.6580	+A	255	–	–
X22CrMoV12-1	1.4923	+A	302	–	–
X12CrNiMoV12-3	1.4938	+A	311	–	–
X19CrMoNbVN11-1	1.4913	+A	302	–	–

[a] + AC = annealed to achieve spheroidized carbides; + S = treated for cold shearing; + A = soft annealed

NOTE Products made to these heat treatment conditions do not support the Essential Safety Requirements of Directive 97/23/EC, unless other criteria are taken into account, see Annex 1, 7.5 of this directive.

**) Correction from DIN EN 10269 Ber 2:2007-02.

Table 4 — Mechanical properties at room temperature for delivery conditions normally applied as final heat treatment

Material designation		Heat-treatment condition[a]	Diameter	Proof strength	Tensile strength	Elongation after fracture	Reduction in area	Impact energy (ISO-V)
name	number		d mm	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	Z % min.	KV J min.
Steels for quenching and tempering								
19MnB4	1.5523	+QT	$d \leq 16$	640	800 to 950	14	52	40
C35E	1.1181	+N	$d \leq 60$	300	500 to 650	20	–	27
		+QT	$d \leq 60$	300	500 to 650	22	45	55
			$60 < d \leq 150$	300	500 to 650	22	45	39
C45E	1.1191	+N	$d \leq 60$	340	560 to 710	17	–	27
		+QT	$d \leq 60$	340	560 to 710	19	40	50
			$60 < d \leq 150$	340	560 to 710	19	40	35
35B2	1.5511	+QT	$d \leq 60$	300	500 to 650	22	45	55
			$60 < d \leq 150$	300	500 to 650	22	45	39
20Mn5	1.1133	+N	$d \leq 60$	320	500 to 650	22	55	55
			$60 < d \leq 150$	300	500 to 650	20	55	55
25CrMo4	1.7218	+QT	$d \leq 100$	440	600 to 750	18	60	60
			$100 < d \leq 150$	420	600 to 750	18	60	45
42CrMo4	1.7225	+QT	$d \leq 60$	730	860 to 1 060	14	50	50
42CrMo5-6	1.7233	+QT	$d \leq 100$	700	860 to 1 060	16	50	50
			$100 < d \leq 150$	640	850 to 1 000	16	50	40
40CrMoV4-6	1.7711	+QT	$d \leq 100$	700	850 to 1 000	14	45	30
			$100 < d \leq 160$	640	850 to 1 000	14	45	25
41NiCrMo7-3-2	1.6563	+QT	$d \leq 100$	725	860 to 1 060	16	50	50
			$100 < d \leq 160$	690	790 to 950	15	50	50
21CrMoV5-7	1.7709	+QT	$d \leq 160$	550	700 to 850	16	60	63
20CrMoVTiB4-10	1.7729	+QT	$d \leq 100$	660	820 to 1 000	15	50	40
			$100 < d \leq 160$	660	820 to 1 000	15	50	27
34CrNiMo6	1.6582	+QT	$d \leq 100$	940	1 040 to 1 200	14	40	45
30CrNiMo8	1.6580	+QT	$d \leq 100$	940	1 040 to 1 200	14	40	45
X12Ni5	1.5680	(+N), +NT or +QT	$d \leq 40$	390	530 to 710	19	50	70
			$40 < d \leq 75$	380	530 to 710	19	50	70
X8Ni9	1.5662	+N+NT or +QT	$d \leq 40$	490	640 to 840	18	50	70
			$40 < d \leq 75$	480	640 to 840	18	50	70
		+QT	$d \leq 40$	585	680 to 820	18	50	120
			$40 < d \leq 75$	575	680 to 820	18	50	120

Table 4 (*continued*)

Material designation		Heat-treatment condition[a]	Diameter	Proof strength	Tensile strength	Elongation after fracture	Reduction in area	Impact energy (ISO-V)
name	number		d mm	$R_{p0,2}$ MPa min.	R_m MPa	A % min.	Z % min.	KV J min.
X15CrMo5-1	1.7390	+NT or +QT	$d \leq 160$	420	640 to 780	14	45	40
X22CrMoV12-1	1.4923	+QT1	$d \leq 160$	600	800 to 950	14	40	27
		+QT2[b]	$d \leq 160$	700	900 to 1 050	11	35	20
X12CrNiMoV12-3	1.4938	+QT	$d \leq 160$	760	930 to 1 130	14	40	40
X19CrMoNbVN11-1[b]	1.4913	+QT	$d \leq 160$	750	900 to 1 050	12	40	20
Austenitic steels								
X2CrNi18-9	1.4307	+AT	$d \leq 160$	175	450 to 680	45	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
		+C800[b]	$d \leq 25$	500	800 to 1 000	12	–	80
X5CrNi18-10	1.4301	+AT	$d \leq 160$	190	500 to 700	45	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
X4CrNi18-12	1.4303	+AT	$d \leq 160$	190	500 to 700	45	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
		+C800[b]	$d \leq 25$	500	800 to 1 000	12	–	80
X2CrNiMo17-12-2	1.4404	+AT	$d \leq 160$	200	500 to 700	40	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
		+C800[b]	$d \leq 25$	500	800 to 1 000	12	–	80
X5CrNiMo17-12-2	1.4401	+AT	$d \leq 160$	200	500 to 700	40	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
		+C800[b]	$d \leq 25$	500	800 to 1 000	12	–	80
X2CrNiMoN17-13-3	1.4429	+AT	$d \leq 160$	280	580 to 800	40	–	100
X3CrNiCu18-9-4	1.4567	+AT	$d \leq 160$	175	450 to 650	45	–	100
		+C700	$d \leq 35$	350	700 to 850	20	–	80
X6CrNi18-10	1.4948	+AT	$d \leq 160$	185	500 to 700	40	–	90
X10CrNiMoMnNbVB15-10-1	1.4982	+AT+WW	$d \leq 100$	510	650 to 850	25	–	50
X3CrNiMoBN17-13-3	1.4910	+AT	$d \leq 160$	260	550 to 750	35	–	100
X6CrNiMoB17-12-2	1.4919	+AT	$d \leq 160$	205	490 to 690	35	–	100
X6CrNiTiB18-10	1.4941	+AT	$d \leq 160$	195	490 to 680	35	–	100
X6NiCrTiMoVB25-15-2	1.4980	+AT+P	$d \leq 160$	600	900 to 1 150	15	–	50
X7CrNiMoBNb16-16	1.4986	+WW+P	$d \leq 100$	500	650 to 850	16	–	50

Table 4 (*continued*)

Material designation		Heat-treatment condition[a]	Diameter	Proof strength	Tensile strength	Elongation after fracture	Reduction in area	Impact energy (ISO-V)
name	number		d	$R_{p0,2}$	R_m	A	Z	KV
			mm	MPa min.	MPa	% min.	% min.	J min.
Nickel alloys								
NiCr20TiAl[b]	2.4952	+AT+P	$d \leq 160$	600	1 000 to 1 300	12	12	20
NiCrFe7TiAl[b]	2.4669	+AT+P	$d \leq 25$	650	1 000 to 1 200	20	28	22

[a] +AT = solution annealed; +C = cold work hardened; +N = normalized; +NT = normalized and tempered; +P = precipitation hardened; +QT = quenched and tempered; WW = Warm worked.

[b] Products made to these material grades and to this heat treatment conditions respectively do not support the essential requirements of Directive 97/23/EC unless other criteria are taken into account, see Annex 1, section 7.5 of this directive.

Table 5 — Minimum 0,2 %-proof strength values at elevated temperatures

Material designation		Heat-treatment condition[a]	Diameter d	Minimum 0,2 %-proof strength $R_{p0,2}$ in MPa at a temperature (in °C) of												
name	number		mm	50	100	150	200	250	300	350	400	450	500	550	600	650
Steels for quenching and tempering																
C35E	1.1181	+N	$d \leq 60$	289*)	270*)	251	229	213	192	182	173	–	–	–	–	–
		+QT	$d \leq 60$	289*)	270*)	251	229	213	192	182	173	–	–	–	–	–
			$60 < d \leq 150$	287*)	264*)	242*)	220	203	186	167	147	–	–	–	–	–
C45E	1.1191	+QT	$d \leq 150$	330*)	314	299*)	284	255	235	206	–	–	–	–	–	–
35B2	1.5511	+QT	$d \leq 60$	289*)	270*)	251	229	213	192	182	173	–	–	–	–	–
			$60 < d \leq 150$	287*)	264*)	242*)	220	203	186	167	147	–	–	–	–	–
20Mn5	1.1133	+N	$d \leq 60$	306*)	283*)	260	237	213	192	182	173	–	–	–	–	–
			$60 < d \leq 150$	304*)	278*)	251	229	213	192	182	173	–	–	–	–	–
25CrMo4	1.7218	+QT	$d \leq 100$	435*)	428*)	420*)	412	392	363	333	304	275	235	–	–	–
			$100 < d \leq 150$	414*)	403*)	393*)	382	372	344	324	294	265	226	–	–	–
42CrMo4	1.7225	+QT	$d \leq 60$	720*)	702	677	640	602	562	518	475	420	375	–	–	–
42CrMo5-6	1.7233	+ QT	$d \leq 100$	681*)	662	639	616	601	585	570	547	516	462	362	223	–
			$100 < d \leq 150$	625*)	605	584	563	549	535	521	500	472	422	331	204	–
40CrMoV4-6	1.7711	+QT	$d \leq 100$	687*)	670	647	631	608	593	577	554	523	470	400	293	–
			$100 < d \leq 160$	631*)	612	591	577	556	542	528	507	479	429	366	268	–
21CrMoV5-7	1.7709	+QT	$d \leq 160$	542*)	530	515*)	500	480*)	460	435*)	410	380	350	–	–	–
20CrMoVTiB4-10	1.7729	+QT	$d \leq 160$	642*)	624	603	595	581	573	559	537	508	464	–	–	
X15CrMo5-1	1.7390	+NT or +QT	$d \leq 160$	392*)	345	335	327	323	322	316	306	285	256	–	–	–
X22CrMoV12-1	1.4923	+QT1	$d \leq 160$	585*)	560	545*)	530	505*)	480	450*)	420	380	335	–	–	–
		+QT2	$d \leq 160$	681*)	650	625*)	600	575*)	550	518*)	485	440	390	–	–	–
X12CrNiMoV12-3[b]	1.4938[b]	+QT	$d \leq 160$	730*)	680	668*)	655	653*)	650	630*)	610	560	505	400	–	–
X19CrMoNbVN11-1	1.4913	+QT	$d \leq 160$	726*)	701	676	651	643	627	610	577	544	495	412	305	–

Table 5 (*continued*)

Material designation		Heat-treatment condition[a]	Diameter d mm	Minimum 0,2 %-proof strength $R_{p0,2}$ in MPa at a temperature (in °C) of												
name	number			50	100	150	200	250	300	350	400	450	500	550	600	650
Austenitic steels																
X2CrNi18-9	1.4307	+AT	$d \leq 160$	164*)	145	130	118	108	100	94	89	85	81	80	–	–
X5CrNi18-10	1.4301	+AT	$d \leq 160$	177*)	155	140	127	118	110	104	98	95	92	90	–	–
X4CrNi18-12	1.4303	+AT	$d \leq 160$	177*)	155	140	127	118	110	104	98	95	92	90	–	–
X2CrNiMo17-12-2	1.4404	+AT	$d \leq 160$	187*)	165	150	137	127	119	113	108	103	100	98	–	–
X5CrNiMo17-12-2	1.4401	+AT	$d \leq 160$	191*)	175	158	145	135	127	120	115	112	110	108	–	–
X2CrNiMoN17-13-3	1.4429	+AT	$d \leq 160$	256*)	215	195	175	165	155	150	145	140	138	136	–	–
X6CrNi18-10	1.4948	+AT	$d \leq 160$	174*)	157	142	127	117	108	103	98	93	88	83	78	–
X10CrNiMoMnNbVB15-10-1	1.4982	+AT+WW	$d \leq 100$	490	463	446	434	423	413	405	396	391	386	378	365	346
X3CrNiMoBN17-13-3	1.4910	+AT	$d \leq 160$	239*)	205	187	170	159	148	141	134	130	127	124	121	–
X6CrNiMoB17-12-2	1.4919	+AT	$d \leq 160$	194*)	177	162	147	137	127	122	118	113	108	103	98	–
X6CrNiTiB18-10	1.4941	+AT	$d \leq 160$	183*)	162	152	142	137	132	127	123	118	113	108	103	–
X6NiCrTiMoVB25-15-2	1.4980	+AT+P	$d \leq 160$	592*)	580	570	560	550	540	530	520	510	490	460	430	380
X7CrNiMoBNb16-16	1.4986	+WW+P	$d \leq 100$	489*)	470*)	451*)	432	412	393	372	353	334	314	284	255	206
Nickel alloys																
NiCr20TiAl	2.4952	+AT+P	$d \leq 160$	595*)	586*)	577*)	568	564	560	550	540	530	520	510	500	480
NiCr15Fe7TiAl	2.4669	+AT+P	$d \leq 25$	625*)	620	615	610	606	601	596	592	587	582	578	573	565

a + AT = solution annealed; + N = normalized; + NT = normalized and tempered; + P = precipitation hardened; + QT =quenched and tempered; + WW = warm worked.

b This steel grade is generally not applied in the creep range.

*) Values calculated by linear interpolation

Table 6 — Minimum tensile strength values at elevated temperatures of austenitic steels and nickel alloys

Material designation		Heat-treatment condition[a]	Diameter d	Minimum tensile strength R_m in MPa at a temperature (in °C) of												
name	number		mm	50	100	150	200	250	300	350	400	450	500	550	600	650
Austenitic steels[b]																
X2CrNi18-9	1.4307	+AT	$d \leq 160$	440	410	380	360	350	340	340	330	–	–	–	–	–
X5CrNi18-10	1.4301	+AT	$d \leq 160$	480	450	420	400	390	380	380	380	375	360	335	300	–
X4CrNi18-12	1.4303	+AT	$d \leq 160$	480	450	420	400	390	380	380	380	375	360	335	300	–
X2CrNiMo17-12-2	1.4404	+AT	$d \leq 160$	460	430	410	390	385	380	380	380	375	360	335	–	–
X5CrNiMo17-12-2	1.4401	+AT	$d \leq 160$	480	460	440	420	415	410	410	410	405	390	375	350	–
X2CrNiMoN17-13-3	1.4429	+AT	$d \leq 160$	550	520	490	460	450	440	435	435	435	430	410	380	–
X6CrNi18-10	1.4948	+AT	$d \leq 160$	480	450	420	400	390	380	380	380	375	360	335	300	–
X10CrNiMoMnNbVB15-10-1	1.4982	+AT+WW	$d \leq 100$	610	565	530	505	490	475	465	460	450	440	430	410	390
X3CrNiMoBN17-13-3	1.4910	+AT	$d \leq 160$	550	520	490	460	450	440	435	435	435	430	410	380	–
X6CrNiMoB17-12-2	1.4919	+AT	$d \leq 160$	490	460	440	420	415	410	410	410	405	390	375	350	–
X7CrNiTiB18-10	1.4941	+AT	$d \leq 160$	490	460	440	420	415	410	410	410	405	390	375	350	–
X6NiCrTiMoVB25-15-2	1.4980	+AT+P	$d \leq 160$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	720	710	700	690	670	–
X7CrNiMoBNb16-16	1.4986	+WW+P	$d \leq 100$	635	615	590	570	550	530	505	485	460	440	420	395	375
Nickel alloys																
NiCr20TiAl	2.4952	+AT+P	$d \leq 160$	1070	1044*)	1017*)	990	966*)	942	932*)	922	903*)	883	859*)	834	–
NiCr15Fe7TiAl	2.4669	+AT+P	$d \leq 25$	1117	1103	1096	1090	1082	1075	1055	1035	1000	975	950	896	827

a + AT = solution annealed; + N = normalized; + NT = normalized and tempered; + P = precipitation hardened; + QT =quenched and tempered; + WW = warm worked.

b n.a. no values available.

*) Values calculated by linear interpolation.

Table 7 — Minimum impact energy (longitudinal direction) at low temperature

Material designation		Heat-treatment condition[a]	Diameter d mm	Minimum impact energy KV in J[b] (ISO-V test pieces) at a temperature (in °C) of														
name	number			–270	–196	–160	–140	–120	–110	–100	–90	–80	–70	–60	–50	–40	–20	0	+20
Steels for quenching and tempering																			
19MnB4	1.5523	+QT	$d \leq 16$											27			40	40	
20Mn5	1.1133	+N	$d \leq 60$												27	31	47	55	55
			$60 < d \leq 150$														40	55	55
25CrMo4	1.7218	+QT	$d \leq 60$											40	40	45	50		60
			$60 < d \leq 100$												40	40	50		60
42CrMo4	1.7225	+QT	$d \leq 60$							27						40			50
41NiCrMo7-3-2	1.6563	+QT	$d \leq 100$							27							47	50	
			$100 < d \leq 160$														47	50	
34CrNiMo6	1.6582	+QT	$d \leq 100$													40			45
30CrNiMo8	1.6580	+QT	$d \leq 100$													40			45
X12Ni5	1.5680	(+N), +NT	$d \leq 45$					40	45	50	55	60	60	65	65	65	70	70	70
			$45 < d \leq 75$						40	45	50	55	60	60	65	65	65		70
X8Ni9	1.5662	+N +NT (or +QT)	$d \leq 75$		40	45	50	50		60		70	70	70	70	70	70	70	70
		+QT	$d \leq 75$		70			100		110		120	120	120	120	120	120	120	120

Table 7 (*continued*)

Material designation		Heat-treatment condition[a]	Diameter d mm	Minimum impact energy KV in J[b] (ISO-V test pieces) at a temperature (in °C) of															
name	number			–270	–196	–160	–140	–120	–110	–100	–90	–80	–70	–60	–50	–40	–20	0	+20
Austenitic steels																			
X2CrNi18-9	1.4307	+C700	$d \leq 35$		50														80
X5CrNi18-10	1.4301	+AT	$d \leq 160$		60														100
		+C700	$d \leq 35$		50														80
X4CrNi18-12	1.4303	+AT	$d \leq 160$		60														100
		+C700	$d \leq 35$		50														80
X2CrNiMo17-12-2	1.4404	+C700	$d \leq 35$		50														80
X5CrNiMo17-12-2	1.4401	+C700	$d \leq 35$		50														80
X2CrNiMoN17-13-3	1.4429	+AT	$d \leq 160$	50	60														100
X6CrNi18-10	1.4948	+AT	$d \leq 160$		60														100
X3CrNiMoBN17-13-3	1.4910	+AT	$d \leq 160$	50	60														100
X6CrNiMoB17-12-2	1.4919	+ AT	$d \leq 160$		60														100
X6CrNiTiB18-10	1.4941	+ AT	$d \leq 160$		60														100
X6NiCrTiMoVB25-15-2	1.4980	+AT+P	$d \leq 160$		40														50
Nickel alloys																			
NiCr20TiAl	2.4952	+AT+P	$d \leq 160$		20														20
NiCr15Fe7TiAl	2.4669	+AT+P	$d \leq 25$		20														22

[a] + AT = solution annealed; + C = cold work hardened; + N = normalized; + NT = normalized and tempered; + P = precipitation hardened; + QT = quenched and tempered.

[b] Average of 3 test results.

Table 8 — Tests to be carried out and extent of testing

Test	Test status[a]	Number of samples for batches of			Number of test pieces per sample
		> 10 t	> 10 t to 15 t	> 15 t	
Chemical analysis	o[b]	(see 10.1.1)			
Hardness test on homogeneity/shearability	m	(see 10.2.1.3)			
Tensile test at room temperature	m	2	3	4	1
Tensile test at elevated temperature	o[c]				1
Impact test at room temperature	m[d]				3
Impact test at low temperature	o[e]				3
Non-destructive testing	o[f]	not applicable			
Verification of surface quality	o				
Other tests	m[g]				

a 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 tests only if agreed at the time of enquiry and order.

b •• A product analysis (per cast) may be agreed at the time of enquiry and order; additionally a deviating extent of testing may be agreed (see 10.1.1).

c •• For verification of $R_{p0,2}$ and, in the case of austenitic steels and nickel alloys, of the tensile strength at elevated temperatures for products to be used at elevated temperatures.

d •• Optional for austenitic steels, except austenitic grades for cryogenic service (> 20 mm diameter or thickness).

e •• For materials for use at low temperatures.

f For verification of internal soundness.

g See 11.6.1 and 11.6.2.

Table 9 — Marking of the products

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

[a] The symbols in the table 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 document.

[c] This shall permit the traceability of the cast number.

Annex A
(informative)

Reference data on some physical properties

Table A.1 — Density and static modulus of elasticity

Material designation		Density	Static modulus of elasticity at a temperature in °C of								
			20	100	200	300	400	500	600	700	800
name	numberr	kg/dm^3	GPa								
Steels for quenching and tempering											
C35E	1.1181	7,85	211	204	196	186	177	164	127	–	–
21CrMoV5-77	1.7709										
40CrMoV4-6	1.7711										
X22CrMoV12-1	1.4923	7,7	216	209	200	190	179	167	127	–	–
X19CrMoNbVN11-1	1.4913										
Austenitic steels											
X2CrNi18-9	1.4307	7,9	200	194	186	179	172	165	–	–	–
X5CrNi18-10	1.4301										
X4CrNi18-12	1.4303										
X2CrNiMo17-12-2	1.4404	8,0									
X5CrNiMo17-12-2	1.4401										
X2CrNiMoN17-13-3	1.4429										
X3CrNiCu18-9-4	1.4567	7,9									
X6CrNi18-10	1.4948	7,9									
X10CrNiMoMnNbVB15-10-1	1.4982	7,95	207	201	193	184	175	165	158	150	–
X3CrNiMoBN17-13-3	1.4910	8,0	198[a]	192[a]	183[a]	175[a]	167[a]	159[a]	150[a]	142[a]	–
X6CrNiMoB17-12-2	1.4919										
X6CrNiTiB18-10	1.4941	7,9									
X6NiCrTiMoVB25-15-2	1.4980	8,0	211[a]	206[a]	200[a]	192[a]	183[a]	173[a]	162[a]	–	–
X7CrNiMoBNb16-16	1.4986	7,9	196	192	186	181	174	165	157	147	–
Nickel alloys											
NiCr20TiAl	2.4952	8,2	216[a]	212[a]	208[a]	202[a]	196[a]	189[a]	179[a]	161[a]	130[a]
NiCr15Fe7TiAl	2.4669	8,2	215	208	200	192	183	175	165	150	131

[a] Dynamic modulus of elasticity.

Table A.2 — Coefficient of thermal expansion, thermal conductivity, thermal capacity and electrical resistivity[a]

Material designation		Coefficient of thermal expansion between 20 °C and						Thermal conductivity at 20 °C	Specific thermal capacity at 20 °C	Electrical resistivity at 20 °C
name	number	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	$\frac{W}{m \times K}$	$\frac{J}{kg \times K}$	$\frac{\Omega \times mm^2}{m}$
		$10^{-6} \times K^{-1}$								
Steels for quenching and tempering										
C35E	1.1181	11,1	12,1	12,9	13,5	13,9	14,1	42	460	n.a.
21CrMoV5-7	1.7709							33		
40CrMoV4-6	1.7711									
Austenitic steels										
X2CrNi18-9	1.4307	16,0	16,5	17,0	18,0	18,0	n.a.	15	500	0,73
X5CrNi18-10	1.4301	16,0	16,5	17,0	17,5	18,0	n.a.			
X4CrNi18-12	1.4303						n.a.			
X2CrNiMo17-12-2	1.4404						n.a.			0,75
X5CrNiMo17-12-2	1.4401						n.a.			
X2CrNiMoN17-13-3	1.4429						n.a.			
X3CrNiCu18-9-4	1.4567	16,7	17,2	17,7	18,1	18,4	n.a.	n.a.	n.a.	n.a.
X6CrNi18-10	1.4948	16,3	16,9	17,3	17,6	18,2	18,5	16	450	0,71
X10CrNiMoMnNbVB15-10-1	1.4982	15,7	16,8	17,7	18,3	18,6	19,0	12,5	480	0,74
X3CrNiMoBN17-13-3	1.4910	16,3	16,9	17,3	17,6	18,2	18,5	16	450	0,77
X6CrNiMoB17-12-2	1.4919									
X6CrNiTiB18-10	1.4941									0,71
X6NiCrTiMoVB25-15-2	1.4980	17,0	17,5	17,8	18,0	18,2	18,5	n.a.	n.a.	n.a.
X7CrNiMoBNb16-16	1.4986	16,6	17,7	17,9	17,9	17,9	18,1	15	460	n.a.
Nickel alloys										
NiCr20TiAl	2.4952	12,9	13,4	13,8	14,3	14,7	15,2	13	460	n.a.
NiCr15Fe7TiAl	2.4669	12,6	13,0	13,4	13,9	14,4	14,8	12	431	n.a.

[a] n.a. — no values available.

Annex B
(informative)

Guidance for heat treatment

Reference data on heat treatment temperatures and cooling media are given in table B.1.

Table B.1 — Guidance for heat treatment of the products in accordance with this European Standard

Material designation		Heat-treatment symbol[a]	Normalizing, quenching or solution annealing temperature °C	Type of cooling[b]	Tempering or precipitation treatment temperature (and time) °C[c]
name	number				
Steels for quenching and tempering					
C35E	1.1181	+N	860 to 900	a	—
		+QT	840 to 880	w, o	550 to 660
C45E	1.1191	+N	840 to 880	a	—
		+QT	820 to 860	w, o	550 to 660
35B2	1.5511	+QT	840 to 880	w, o	550 to 660
20Mn5	1.1133	+N	880 to 920	a	—
25CrMo4	1.7218	+QT	840 to 880	w, o	540 to 680
42CrMo4	1.7225	+QT	820 to 860	o, w	540 to 680
42CrMo5-6	1.7233	+QT	840 to 870	o	600 to 700
40CrMoV4-6	1.7711	+QT[d]	880 to 950	o	670 to 720
		+QT[e]	940 to 970	o	600 to 700
41NiCrMo7-3-2	1.6563	+QT	840 to 880	a, o, w	600 to 700
21CrMoV5-7	1.7709	+QT	900 to 950	a, o	680 to 720 (min. 2 h)
20CrMoVTiB4-10	1.7729	+QT	660 to 700 +970 to 990	a, w, o[**)]	680 to 720
34CrNiMo6	1.6582	+QT	830 to 860	o	540 to 660
30CrNiMo8	1.6580	+QT	830 to 860	o	540 to 660
X12Ni5	1.5680	+N	800 to 850	a	—
		+NT	800 to 850	a	580 to 660
X8Ni9	1.5662	+N +N +T	880 to 930+770 to 830	a	540 to 600
		+ QT	770 to 830	w, o	540 to 600
X15CrMo5-1	1.7390	+ NT	925 to 975	a	690 to 750
		+QT	925 to 975	o	690 to 750
X22CrMoV12-1	1.4923	+QT1	1 020 to 1 070	a, o, w	680 to 740 (min. 2 h)
		+QT2	1 020 to 1 070	a, o, w	660 to 720 (min. 2 h)
X12CrNiMoV12-3	1.4938	+QT	1 035 to 1 065	o	600 to 670
X19CrMoNiNbVN11-1	1.4913	+QT	1 100 to 1 130	a, o	670 to 720 (min. 2 h)

[**)] Correction from DIN EN 10269 Ber 2:2007-02.

Table B.1 (*continued*)

Material designation		Heat-treatment symbol[a]	Normalizing, quenching or solution annealing temperature °C	Type of cooling[b]	Tempering or precipitation treatment temperature (and time) °C[c]
name	number				
Austenitic steels					
X2CrNi18-9	1.4307	+AT	1 000 to 1 100	w, a[h]	–
X5CrNi18-10	1.4301	+AT	1 000 to 1 100	w, a[h]	–
X4CrNi18-12	1.4303	+AT	1 000 to 1 100	w, a[h]	–
X2CrNiMo17-12-2	1.4404	+AT	1 020 to 1 120	w, a[h]	–
X5CrNiMo17-12-2	1.4401	+AT	1 020 to 1 120	w, a[h]	–
X2CrNiMoN17-13-3	1.4429	+AT	1 020 to 1 120	w, a[h]	–
X3CrNiCu18-9-4	1.4567	+AT	1 000 to 1 100	w, a[h]	–
X6CrNi18-10	1.4948	+AT	1 000 to 1 080	w, a[h]	–
X4CrNi18-12	1.4303	+AT	1 000 to 1 100	w, a[h]	–
X10CrNiMoMnNbVB15-10-1	1.4982	+AT+WW	1 030 to 1 070 + 650 to 750[f]	w a	–
X3CrNiMoBN17-13-3	1.4910	+AT	1 020 to 1 100	w, a[h]	–
X6CrNiMoB17-12-2	1.4919	+AT	1 020 to 1 100	w, a[h]	–
X6CrNiTiB18-10	1.4941	+AT	1 070 to 1 150	w, a[h]	–
X6NiCrTiMoVB25-15-2	1.4980	+AT+P	970 to 990	o, w	710 to 730
X7CrNiMoBNb16-16	1.4986	+WW+P	g		750 to 800 (5 to 1 h; a[b])
Nickel alloys					
NiCr20TiAl	2.4952	+AT+P	1 050 to 1 080	a	840 to 860, 24 h, a[b] + 690 to 710, 16 h, a[b]
NiCr15Fe7TiAl	2.4669	+AT+P	1 100 to 1 200	a	840 to 870, 24h, a[b] + 700 to 710, 16h, a[b]

[a] + AT = solution annealed; + N = normalized;
+ NT = normalized and tempered; + P = precipitation hardened; + QT = quenched and tempered;
+ WW = warm worked;

[b] a = air; o = oil; w = water.

[c] Where in accordance with 8.2.3 a stress relieving after straightening has been agreed, the stress relieving temperature shall be chosen so that the specified properties are still obtained.

[d] For diameters ≤ 100 mm.

[e] For diameters > 100 mm to 160 mm.

[f] Temperature range of warmworking.

[g] warm worked at 750 to 850 °C.

[h] Cooling sufficiently rapid.

Annex C
(informative)

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

NOTE 1 The values given in table C.1 are mean values of the scatter band considered until now. 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 C.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, the oxidation conditions should also be taken into account.

Table C.1 — Strength values for 1 % (plastic) creep strain and creep rupture[a,b]

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
name	number	°C	10 000 h MPa	100 000 h MPa	10 000 h MPa	100 000 h MPa	200 000 h MPa
Steels for quenching and tempering							
C35E	1.1181	350 360 370 380 390	208 197 185 174 161	151 139 130 120 109	246 236 224 212 200	218 202 185 169 154	
		400 410 420 430 440	147 132 116 102 89	98 87 77 67 58	187 173 156 138 118	138 122 106 93 80	
		450 460 470 480 490	78 68 58 49 42	49 40 34 29 26	100 87 77 69 61	69 61 53 45 39	
		500	35	22	53	34	
20Mn5	1.1133	380 390			291 266	227 203	(206) (181)
		400 410 420 430 440			243 221 200 180 161	179 157 136 117 100	(157) (135) (115) (97) (82)
		450 460 470 480 490			143 126 110 96 84	85 73 63 55 (47)	(70) (60) (52) (44) (37)
		500			74	(41)	–

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
name	number	°C	10 000 h MPa	100 000 h MPa	10 000 h MPa	100 000 h MPa	200 000 h MPa
25 CrMo4	1.7218	420 430 440	274 258 242	221 203 186	387 364 338	308 281 253	
		450 460 470 480 490	226 210 195 180 163	171 155 141 127 112	311 283 255 226 200	226 200 178 157 136	
		500 510 520 530 540	147 130 115 98 81	98 83 69 54 39	176 153 133 114 95	118 100 82 66 51	
		550	64	25	79	36	
42CrMo5-6	1.7233	450 460 470 480 490			495 450 399 342 281	410 345 276 219 177	381 310 242 193 158
		500 510 520 530 540			229 190 160 137 118	148 124 102 – –	131 109 84 – –
		550			98		
40CrMoV4-6	1.7711	450 460 470 480 490			513 483 451 413 371	463 422 374 319 259	446 400 347 286 229
		500 510 520 530 540			321 269 223 187 160	210 174 146 122 –	187 155 130 103 –
		550			137	–	–
21CrMoV5-7	1.7709	420 430 440	429 407 385	365 340 315	466 443 420	399 375 350	379 353 328
		450 460 470 480 490	363 339 314 289 263	288 262 235 208 182	396 373 349 325 301	325 300 274 249 224	303 277 252 226 201
		500 510 520 530 540	238 212 186 161 138	156 132 109 89 71	277 253 228 204 180	199 174 150 126 103	176 151 127 104 82
		550	116	56	157	82	62

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
			10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
name	number	°C	MPa	MPa	MPa	MPa	MPa
20CrMoVTiB4-10	1.7729	450			520	453	(430)
		460			491	423	(399)
		470			463	394	(369)
		480			437	365	(338)
		490			412	337	(307)
		500			388	307	(274)
		510			364	276	(237)
		520			340	241	(198)
		530			315	204	162
		540			288	169	135
		550			261	142	114
		560			231	121	96
		570			200	103	–
		580			170	–	–
		590			146	–	–
		600			127	–	–
X15CrMo5-1	1.7390	450			–	276	237
		460			–	218	192
		470			226	181	158
		480			220	153	135
		490	88	63	190	132	114
		500	85	61	164	113	96
		510	76	54	145	96	80
		520	67	47	129	81	68
		530	60	42	114	70	57
		540	55	37	100	59	47
		550	49	32	88	50	40
		560	43	30	77	43	–
		570	37	26	68	37	–
		580			60	–	–
		590			53	–	–
		600			46	–	–
X22CrMoV12-1	1.4923	450	436	373	480	432	
		460	405	341	451	397	
		470	375	308	422	368	
		480	344	278	394	336	
		490	316	248	366	306	
		500	289	221	338	275	
		510	262	195	312	245	
		520	235	170	286	216	
		530	211	148	261	187	
		540	187	127	235	161	
		550	165	108	211	137	
		560	144	91	187	118	
		570	126	77	165	99	
		580	108	64	143	83	
		590	92	53	122	70	
		600	79	44	103	59	

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
name	number	°C	10 000 h MPa	100 000 h MPa	10 000 h MPa	100 000 h MPa	200 000 h MPa
X19CrMoNbVN11-1	1.4913	450 460 470 480 490	500 475 450 424 398	448 416 388 358 328	559 529 500 473 446	500 472 444 414 383	486 450 425 395 364
		500 510 520 530 540	374 349 323 298 274	298 268 238 210 181	417 392 366 340 314	349 314 276 237 201	330 291 253 209 172
		550 560 570 580 590	250 225 201 177 154	153 – – – –	288 259 234 208 181	161 132 105 86 72	130 102 81 66 52
		600	133	–	155	65	49
Austenitic steels							
X6CrNi18-10	1.4948	550 560 570 580 590	121 116 111 106 100	96 92 88 84 79	191 177 165 154 143	140 128 117 107 98	125 114 104 95 86
		600 610 620 630 640	94 88 82 75 68	74 69 63 56 49	132 122 113 104 95	89 81 73 65 58	78 70 62 55 49
		650 660 670 680 690	61 55 49 44 39	43 37 32 28 25	87 80 73 67 61	52 47 42 37 32	43 38 34 30 26
		700	35	22	55	28	22
X10CrNiMoMnNb VB15-10-1	1.4982	550 560 570 580 590			410 400 385 370 355	365 350 335 315 295	350 335 315 295 275
		600 610 620 630 640			340 325 305 285 265	275 250 215 180 155	250 215 185 150 135
		650			240	135	115

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
name	number	°C	10 000 h MPa	100 000 h MPa	10 000 h MPa	100 000 h MPa	200 000 h MPa
X3CrNiMoBN17-13-3	1.4910	550			290	220	(200)
		560			272	202	(184)
		570			254	186	(166)
		580			237	170	(151)
		590			220	155	(137)
		600			205	141	(122)
		610			190	127	(113)
		620			174	114	(100)
		630			162	102	(91)
		640			148	92	(81)
		650			135	83	(73)
		660			122	75	(65)
		670			112	68	(58)
		680			102	61	(52)
		690			93	56	(46)
		700			84	52	(42)
		710			78	48	(39)
		720			71	45	(36)
		730			65	41	(34)
		740			58	37	(31)
		750[**)]			52	34	(28)
		760[**)]			48	31	(26)
		770[**)]			44	28	(24)
		780[**)]			41	25	(21)
		790[**)]			37	22	(19)
		800			33	20	(17)
X3CrNiMoBN17-13-3	1.4919	550			247	188	172
		560			230	172	157
		570			213	158	142
		580			198	144	129
		590			183	130	117
		600			168	118	105
		610			155	107	94
		620			142	96	85
		630			130	87	76
		640			119	78	68
		650			109	70	61
		660			99	63	54
		670			90	56	48
		680			82	50	43
		690			75	45	38
		700			68	40	34
		710			61	36	30
		720			56	32	27
		730			50	29	24
		740			46	26	22
		750			41	23	19
		760			37	21	17
		770			34	19	16
		780			31	17	14
		790			28	15	13

[**)] Details to temperatures from 750 °C to 790 °C from DIN EN 10269 Ber 2:2007-02.

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
		°C	10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
name	number		MPa	MPa	MPa	MPa	MPa
		800			25	14	11
		810			23	12	10*
		820			21	11	–
		830			19	10*	–
		840			18	–	–
		850			16	–	–
X7CrNiTiB18-10	1.4941	550			223	170	150
		560			210	154	135
		570			196	140	122
		580			182	127	110
		590			170	114	100
		600			156	102	91
		610			142	92	82
		620			130	84	74
		630			119	76	67
		640			108	68	60
		650			98	62	54
		660			89	56	49
		670			80	50	43
		680			73	44	39
		690			66	39	33
		700			60	35	29
X6NiCrTiMoVB25-15-2	1.4980[**)]	500	580	495	608	545	
		510	555	475	590	520	
		520	530	450	570	495	
		530	505	425	550	470	
		540	485	400	525	445	
		550	460	375	500	415	
		560	435	345	475	385	
		570	410	315	450	355	
		580	380	280	420	320	
		590	350	250	395	285	
		600	320	220	365	250	
		610	290	195	340	220	
		620	260	170	310	195	
		630	235	150	285	170	
		640	210	130	260	150	
		650	190	110	235	132	
X7CrNiMoBNb16-16	1.4986	580	358	302	381	323	
		590	336	278	364	298	
		600	324	255	344	275	
		610	306	230	325	251	
		620	287	204	306	228	
		630	268	179	287	204	
		640	247	153	267	181	
		650	226	128	245	157	
		660	204	104	221	133	
		670	182	85	198	113	

[**)] Correction from DIN EN 10269 Ber 2:2007-02.

Table C.1 (*continued*)

Material designation		Temperature	Strength for 1% (plastic) creep strain[c]		Creep rupture strength for[d]		
			10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
name	number	°C	MPa	MPa	MPa	MPa	MPa
Nickel alloys							
NiCr20TiAl	2.4952	500	624	530	(745)	(578)	
		510	608	504	(711)	(545)	
		520	586	477	(680)	(510)	
		530	567	450	646	480	
		540	544	418	615	447	
		550	523	390	582	416	
		560	500	362	552	384	
		570	474	334	520	354	
		580	450	308	491	327	
		590	425	282	462	298	
		600	398	257	433	272	
		610	370	230	403	247	
		620	348	210	378	222	
		630	326	187	351	198	
		640	303	167	325	176	
		650	275	149	300	157	
		660	260	132	275	135	
		670	240	115	251	118	
		680	219	99	229	102	
		690	201	85	208	88	
		700	183	72	186	75	
		710	167	64	170	65	
		720	150	55	153	57	
		730	135	47	137	49	
		740	122	40	125	44	
		750	106	33	114	37	
		760	97	29	103	33	
		770	85	24	94	29	
		780	75	20	86	25	
		790	68	17	78	23	
		800	58	16	70	20	
NiCr15Fe7TiAl	2.4669	500	790	650	800	659	
		550	596	477	605	488	
		600	425	345	440	360	
		650	325	258	340	265	
		700	245	75	255	135	
		750	65	16	123	61	
		800	15	4	60	28	

[a] The values given in this table are the mean values of the scatter band so far obtained, which will be checked from time to time as further test results become available and if necessary corrected.

[b] * and () indicate values of extended stress extrapolation or time extrapolation, respectively.

[c] This is the stress relative to the initial cross-section leading to a permanent elongation of 1 % after 10 000 h and 100 000 h.

[d] This is the stress relative to the initial cross-section leading to fracture after 10 000 h, 100 000 h and 200 000 h.

Annex D
(informative)

Reference data for the relaxation properties

Table D.1 — Reference data for the relaxation properties

Material designation		Temperature	for an initial strain	Residual stress in MPa after stressing duration for		
name	number		$\varepsilon_{A\ total}$ %	1 000 h	10 000 h	30 000 h
42CrMo5-6	1.7233	350 400 450 500	0,15	211 198 157 93	205 179 118 30	201 164 96
40CrMoV4-6	1.7711	400 450 500	0,15	234 188 136	215 157 83	192 141 47
21CrMoV5-7	1.7709	300	0,2	328	325	317
		350		314	299	292
		400 410 420 430 440		288 281 273 263 253	262 252 242 227 211	250 235 222 200 180
		450 460 470 480 490		239 224 208 191 172	186 163 138 117 98	154 130 108 90 70
		500 510 520 530 540		150 128 109 92 75	81 67 53 41 33	56 43 33 25 18
20CrMoVTiB4-10	1.7729	400 450 500 550 600	0,15	247 216 180 134 61	224 188 141 70	212 173 118 42

Table D.1 (*continued*)[a]

Material designation		Temperature	for an initial strain	Residual stress in MPa after stressing duration for		
name	number		$\varepsilon_{A\ total}$ %	1 000 h	10 000 h	30 000 h
X22CrMoV12-1	1.4923	400 410 420 430 440	0,2	255 250 243 234 225	232 223 212 200 189	216 206 193 180 170
		450 460 470 480 490		216 206 195 183 170	173 159 143 130 115	155 140 125 110 98
		500 510 520 530 540		157 142 127 114 100	103 91 80 69 60	85 75 64 54 45
		550 560 570 580		87 75 65 56	51 44 37 32	38 30 25 20
X19CrMoNbVN11-1	1.4913	400 410 420 430 440	0,2	262 257 252 246 240	237 231 225 218 212	206 202 199 195 190
		450 460 470 480 490		234 228 221 214 207	206 198 191 183 175	185 180 173 165 157
		500 510 520 530 540		199 190 181 171 160	166 155 143 130 114	147 136 124 108 92
		550 560 570 580 590		149 134 118 100 80	98 78 63 48 39	79 66 53 40 30
		600		61	30	21
X10CrNiMoMnNbVB15-10-1	1.4982	550 600 625 650 700	0,15		200 165 140 122 55	

Table D.1 (*continued*)

Material designation		Temperature	for an initial strain	Residual stress in MPa after stressing duration for		
name	number		$\varepsilon_{A\ total}$ %	1 000 h	10 000 h	30 000 h
NiCr20TiAl	2.4952	450	0,15	280	266	256
		500		271	250	234
		510		269	245	228
		520		266	239	221
		530		263	232	213
		540		259	225	205
		550		255	218	196
		560		249	209	187
		570		244	201	176
		580		238	193	166
		590		231	183	155
		600		224	174	144
		610		216	163	133
		620		208	153	121
		630		200	141	108
		640		190	129	96
		650	0,15 and 0,20	181	119	85
		660		170	107	75
		670		160	97	65
		680		149	88	56
		690		138	79	48
		700		127	70	40
		710		117	61	33
		720		107	53	27
		730		97	45	22
		740		88	38	17
		750		79	31	13

[a] The values given in this table are the mean values of the scatter band so far obtained, which will be checked from time to time as further test results become available and if necessary corrected.

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 (but see Table 4, footnote b).

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

Clauses/sub-clauses of this EN	Essential Requirements (ERs) of the Directive 97/23/EC	Qualifying remarks/ Notes
8.4	Annex I, 4.1a	Appropriate material properties
8.2.1 and Table 4	Annex I, 4.1c	Ageing
8.2 and 8.5	Annex I, 4.1d	Suitable for the processing procedures
9 and 10	Annex I, 4.3	Documentation

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