August 2021

DIN EN 10222-2

DIN

ICS 77.140.30; 77.140.85

Supersedes
DIN EN 10222-2:2017-06

Steel forgings for pressure purposes – Part 2: Ferritic and martensitic steels with specified elevated temperatures properties; English version EN 10222-2:2017+A1:2021, English translation of DIN EN 10222-2:2021-08

Schmiedestücke aus Stahl für Druckbehälter –
Teil 2: Ferritische und martensitische Stähle mit festgelegten Eigenschaften bei erhöhten Temperaturen;
Englische Fassung EN 10222-2:2017+A1:2021,
Englische Übersetzung von DIN EN 10222-2:2021-08

Pièces forgées en acier pour appareils à pression –
Partie 2: Aciers ferritiques et martensitiques avec propriétés spécifiées à température élevée;
Version anglaise EN 10222-2:2017+A1:2021,
Traduction anglaise de DIN EN 10222-2:2021-08

Document comprises 29 pages

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original shall be considered authoritative.

© DIN Deutsches Institut für Normung e. V. (German Institute for Standardization) is the owner of all exclusive rights for Germany – all rights of exploitation, irrespective of the form and procedure – are reserved for DIN e. V. For other countries, DIN e. V. holds all non-exclusive rights of exploitation. Beuth Verlag GmbH, 10772 Berlin, Germany, has the exclusive right of sale.

www.din.de
www.beuth.de

07.21 3282494

This standard was downloaded from the normsplash.com

A comma is used as the decimal marker.

National foreword

This document (EN 10222-2:2017+A1:2021) has been prepared by Technical Committee CEN/TC 459/SC 11 “Steel castings and forgings” (Secretariat: AFNOR, France).

The responsible German body involved in its preparation was *DIN-Normenausschuss Eisen und Stahl* (DIN Standards Committee Iron and Steel), Working Committee NA 021-00-10 AA "Steel forgings".

For current information on this document, please go to DIN’s website (www.din.de) and search for the document number in question.

Amendments

This standard differs from DIN EN 10222-2:2017-06 as follows:

a) some technical changes have been made in Tables 2, 4, 5, A.1a, A.2a and A.2b;

b) the standard has been editorially revised.

Previous editions

DIN 17243: 1987-01
DIN EN 10222-2: 2000-04, 2017-06

This standard was downloaded from the normsplash.com

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10222-2:2017+A1

June 2021

ICS 77.140.30; 77.140.85

Supersedes EN 10222-2:2017

English Version

Steel forgings for pressure purposes - Part 2: Ferritic and martensitic steels with specified elevated temperatures properties

Pièces forgées en acier pour appareils à pression - Partie 2: Aciers ferritiques et martensitiques avec propriétés spécifiées à température élevée

Schmiedestücke aus Stahl für Druckbehälter - Teil 2: Ferritische und martensitische Stähle mit festgelegten Eigenschaften bei erhöhten Temperaturen

This European Standard was approved by CEN on 25 December 2016 and includes Amendment 1 approved by CEN on 2 May 2021.

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

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

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2021 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN 10222-2:2017+A1:2021 E

This standard was downloaded from the normsplash.com

Contents

Page

This standard was downloaded from the normsplash.com

European foreword

This document (EN 10222-2:2017+A1:2021) has been prepared by Technical Committee ECISS/TC 459/SC 11 “Steel castings and forgings”, the secretariat of which is held by AFNOR.

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 December 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN not be held responsible for identifying any or all such patent rights.

This document supersedes A1 EN 10222-2:2017 A1.

This document includes Amendment 1 approved by CEN on 11 April 2021.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

This document 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 2014/68/EU.

For relationship with EU Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

EN 10222 consists of the following parts under the general title “Steel forgings for pressure purposes”:

— *Part 1: General requirements for open die forgings*

— *Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

— *Part 3: Nickel steels with specified low temperature properties*

— *Part 4: Weldable fine grain steels with high proof strength*

— *Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.*

A1 *deleted sentence* A1.

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

This standard was downloaded from the normsplash.com

1 Scope

This part of this European Standard specifies the technical delivery conditions for forgings for pressure purposes, made of ferritic and martensitic steels with specified elevated temperature properties. Chemical composition and mechanical properties are specified.

NOTE Once this standard is published in the EU Official Journal (OJEU) under Directive 2014/68/EU, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 2014/68/EU is limited to technical data of materials in this 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 Directive 2014/68/EU are satisfied, needs to be done. The series EN 10222–1 to EN 10222–5 is structured so that the data related to different materials is in the part allocated for that material. The presumption of conformity to the Essential Safety Requirements of Directive 2014/68/EU depends on both the text in part 1 and the data in part 2, 3, 4 or 5.

General information on technical delivery condition is given in EN 10021.

2 Normative references

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

EN 10222-1:2017, *Steel forgings for pressure purposes — Part 1: General requirements*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 10222-1:2017 apply.

4 Classification and designation

4.1 Classification

In accordance with EN 10020, the grades P235GH, P245GH, P250GH, P265GH, P280GH, P295GH and P305GH are non-alloy quality steels. All others are alloy special steels.

4.2 Designation

See EN 10222-1:2017.

5 Information to be supplied by the purchaser

5.1 Mandatory informations

See EN 10222-1:2017

This standard was downloaded from the normsplash.com

5.2 Options

A number of options are specified in this European Standard and listed below. Additionally the relevant options of EN 10222-1:2017 apply. If the purchaser does not give any information to implement any of these options at the time of enquiry and order, the products shall be supplied in accordance with the basic specification (see also EN 10222-1:2017).

1) test temperature for the tensile test at elevated temperature, if applicable (see 6.4);
2) normalized forming instead normalizing (see Table 1, footnote c);
3) carbon equivalent for non-alloy steels (see Table 2);
4) increased minimum chromium content (see Table 2, footnote b);
5) minimum impact energy values (see Table 4, footnote d);
6) test to evaluate the resistance to hydrogen induced cracking (see 6.7);
7) different test temperature for the impact energy and appropriate values (see Table 4, footnote e);
8) higher sulphur content for alloy steels (see Table 2, footnote e).

6 Requirements

6.1 Steelmaking process and manufacture of the product

Shall be in accordance with EN 10222-1:2017.

6.2 Delivery condition

The products shall be delivered in the heat treatment condition specified of Table 1.

6.3 Chemical composition and chemical composition properties

6.3.1 Cast analysis

The chemical composition (cast analysis), determined in accordance with EN 10222-1:2017 shall conform the requirements of Table 2.

6.3.2 Product analysis

The product analysis shall not be deviate from the specified cast analysis (see 6.3.1) by more than the values specified in Table 3.

6.4 Mechanical properties

When heat treated in accordance with Table 1, the mechanical properties at room temperature determined in accordance with EN 10222-1:2017, shall conform to the requirements of Table 4.

Elevated temperature proof strength ($R_{p0,2}$) properties shall conform to the requirements of Table 5.

If verification of specified proof strength at elevated temperature is requested (see option in EN 10222-1:2017), the testing temperature should be agreed at the time of enquiry and order. Otherwise, the test shall be carried out at 300 °C.

This standard was downloaded from the normsplash.com

Reference data for 1 % (plastic) creep strain and creep rupture are given in Annex A.

6.5 Surface condition

See EN 10222-1:2017.

6.6 Internal soundness

See EN 10222-1:2017.

6.7 Resistance to hydrogen induced cracking

Non-alloy and low alloy steels may be susceptible to cracking when exposed to corrosive H_2S containing environments, usually referred to as „sour service“.

A test to evaluate the resistance to hydrogen induced cracking in accordance with EN 10229 may be agreed at the time of enquiry and order.

7 Inspection

See EN 10222-1:2017.

8 Sampling

See EN 10222-1:2017.

9 Test methods

See EN 10222-1:2017.

10 Retests

See EN 10222-1:2017.

11 Marking

See EN 10222-1:2017.

This standard was downloaded from the normsplash.com

A1 Table 1 — Heat treatment

Steel designation		Heat treatment				
Name	Number	Symbol[b]	Austenizing or solution annealing		Tempering	
			Temperature °C	Cooling in[a]	Temperature °C	Cooling in[a]
P235GH	1.0345	+N[c]	890 to 950	a	–	–
P245GH	1.0352	+A	890 to 930	f	–	–
		+N[c]		a		
		+NT or +QT		a, o, p, w	600 to 640	a, f
P250GH	1.0460	+N[c]	890 to 950	a	–	–
P265GH	1.0425	+N[c]	890 to 950	a	–	–
P280GH	1.0426	+N[c]	880 to 920	a	–	–
		+NT or +QT		a, o, p, w	600 to 640	a, f
P295GH	1.0481	+N[c]	890 to 950	a	–	–
		+NT or +QT		a, o, p, w	600 to 640	a, f
P305GH	1.0436	+N[c]	880 to 920	a	–	–
		+NT or +QT		a, o, p, w	620 to 660	a, f
16Mo3	1.5415	+N	890 to 950	a	–	–
		+QT	890 to 960	o, p, w	620 to 700	a, f
13CrMo4–5	1.7335	+NT	890 to 950	a	630 to 740	a, f
		+NT or +QT		a, o, p, w		
15MnMoV4–5	1.5402	+NT or +QT	875 to 925	a, w	600 to 675	a, f
18MnMoNi5–5	1.6308	+QT	850 to 925	w	625 to 675	a, f
14MoV6–3	1.7715	+NT or +QT	950 to 990	a, o, p	670 to 720	a, f
15MnCrMoNiV5–3	1.6920	+NT or +QT	900 to 950	a, w	625 to 675	a, f
11CrMo9–10	1.7383	+NT	900 to 980	a, o, p	670 to 770	a, f
		+NT or +QT		a, o, p, w		
X16CrMo5–1	1.7366	+A	850 to 880	f	-	-

This standard was downloaded from the normsplash.com

Steel designation		Heat treatment				
Name	Number	Symbol[b]	Austenizing or solution annealing		Tempering	
			Temperature °C	Cooling in[a]	Temperature °C	Cooling in[a]
		+NT or +QT	925 to 975	a, o, p	690 to750	a, f
X10CrMoVNb9–1	1.4903	+NT	1040 to 1090	a, o, p	730 to 780	a,
X20CrMoV11–1	1.4922	+QT	1020 to 1070	a, o, p	730 to 780	a, f

a a = air; f = furnaced; o = oil; p = polymer; w = water.

b A = annealed; *N* = normalized; QT = quenched and tempered; NT = normalized and tempered.

c If agreed at time of enquiry and order normalizing “N” may be replaced by normalizing forming

This standard was downloaded from the normsplash.com

Table 2 — Chemical composition

Steel designation		Chemical composition (cast analysis) % [a]															
Name	**Number**	C	Si max.	Mn	P max.	S max.	Al total	N	Cr	Cu	Mo	Nb	Ni	Ti max.	V	Others	Carbon equivalent value max. %
P235GH [c]	1.0345	≤ 0,16	0,35	0,40 to 1,20	0,025	0,010	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01f	≤ 0,30	0,03	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	–
P245GH [c]	1.0352	0,08 to 0,20	0,40	0,50 to 1,30	0,025	0,015	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01	≤ 0,30	–	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,41
P250GH [c] [d]	1.0460	0,18 to 0.23	0,40	0,30 to 0,90	0,025	0,015	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01f	≤ 0,30	0,03	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,43
P265GH [c]	1.0425	≤ 0,20	0,40	0,60 to 1,40	0,025	0,010	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01f	≤ 0,30	0,03	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,43
P280GH [c]	1.0426	0,08 to 0,20	0,40	0,90 to1,50	0,025	0,015	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01	≤ 0,30	–	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,45
P295GH [c]	1.0481	0,08 to 0,20	0,40	0,70 to 1,50	0,025	0,010	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01f	≤ 0,30	0,03	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,45
P305GH [c]	1.0436	0,15 to 0,20	0,40	0,90 to 1,60	0,025	0,015	≥ 0,020	≤ 0,012	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,01	≤ 0,30	–	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70	0,47
16Mo3 [e]	1.5415	0,12 to 0,20	0,35	0,40 to 0,90	0,025	0,010	–	≤ 0,012	≤ 0,30	≤ 0,30	0,25 to 0,35	–	≤ 0,30	–	–	–	–
13CrMo4 –5 [e]	1.7335	0,08 to 0,18	0,35	0,40 to 1,00	0,025	0,010	–	≤ 0,012	0,70 [b] to 1,15	≤ 0,30	0,40 to 0,60	–	≤ 0,30	–	–	–	–

This standard was downloaded from the normsplash.com

Steel designation		Chemical composition (cast analysis) % [a]														
Name	Number	C	Si max.	Mn	P max.	S max.	Al total	N	Cr	Cu	Mo	Nb	Ni	Ti max.	V	Others	Carbon equivalent value max. %
15MnMoV4–5	1.5402	≤ 0,18	0,40	0,90 to 1,40	0,025	0,015	–	–	≤ 0,030	≤ 0,030	0,40 to 0,60	≤ 0,01	≤ 0,30	–	0,04 to 0,08	–	–
18MnMoNi5–5	1.6308	≤ 0,20	0,40	1,15 to 1,55	0,025	0,015	–	–	≤ 0,30	≤ 0,30	0,45 to 0,55	≤ 0,01	0,50 to 0,80	–	≤ 0,03	–	–
14MoV6–3 [e]	1.7715	0,10 to 0,18	0,40	0,40 to 0,70	0,025	0,010	≤ 0,020	–	0,30 to 0,60	–	0,50 to 0,70	–	–	–	0,22 to 0,28	Sn ≤ 0,025	–
15MnCrMoNiV5–3	1.6920	≤ 0,17	0,40	1,00 to 1,50	0,025	0,015	–	–	0,50 to 1,00	–	0,20 to 0,35	–	0,30 to 0,70	–	0,05 to 0,10	–	–
11CrMo9–10 [e]	1.7383	0,08 to 0,15	0,50	0,40 to 0,80	0,020	0,010	–	≤ 0,012	2,00 to 2,50	≤ 0,25	0,90 to 1,10	–	–	–	–	–	–
X16CrMo5–1	1.7366	≤ 0,18	0,40	0,30 to 0,80	0,025	0,015	–	–	4,00 to 6,00	–	0,45 to 0,65	–	–	–	–	–	–
X10CrMoVNb9–1	1.4903	0,08 to 0,12	0,50	0,30 to 0,60	0,020	0,005	≤ 0,040	0,030 to 0,070	8,0 to 9,5	≤ 0,30	0,85 to 1,05	0,06 to 0,10	≤ 0,30	–	0,18 to 0,25	–	–
X20CrMoV11–1	1.4922	0,17 to 0,23	0,40	0,30 to 1,00	0,025	0,015	–	–	10,00 to12,50	–	0,80 to 1,20	–	0,30 to 0,80	–	0,20 to 0,35	–	–

a Elements not listed in this table shall not be intentionally added to the steel without the approval of the purchase 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 have adversely affect the mechanical properties and usability.

b If resistance to pressurized hydrogen is of importance, a min. content of Cr of 0,80 % may be agreed at the time of enquiry and order.

This standard was downloaded from the normsplash.com

Steel designation		Chemical composition (cast analysis) % [a]															
Name	**Number**	C	Si max.	Mn	P max.	S max.	Al total	N	Cr	Cu	Mo	Nb	Ni	Ti max.	V	Others	Carbon equivalent value max. %

c A ratio Al/N ≥ 2 shall apply. If only aluminium is used for nitrogen binding, a ratio Al/N ≥ 2 shall apply.

d For teq > 100 mm, the lower limit for Mn shall be increased to Mn ≥ 0,40 % (see EN 10222-1:2017, Table A.1).

e For these steel grades a higher content of sulfur up to 0,015 % may be agreed at time of enquiry or order.

f For these steel grades, a higher content of niobium up to 0,02 % may be agreed at time of enquiry or order.

This standard was downloaded from the normsplash.com

Table 3 — Permissible deviations of the product analysis above the maximum or below the minimum limits of the requirement of cast analysis

Element	Specified value in the cast analysis according to Table 2 %	Permissible deviations[a] of the product analysis %
C	≤ 0,23	+0,02
Si	≤ 0,50	+0,05
Mn	≤ 1,00	+0,05
	> 1,00 to ≤ 1,60	±0,10
P	≤ 0,015	+0,003
	> 0,015 to ≤ 0,025	+0,005
S	≤ 0,010	+0,003
	> 0,010 to ≤ 0,015	+0,005
Al	≤ 0,040	+0,005
Cr	≤ 2,00	+0,05
	> 2,00 to ≤ 10,0	±0,10
	> 10,0 to ≤ 12,5	±0,15
Mo	≤ 0,35	+0,03
	> 0,35 to ≤ 1,20	±0,04
N	≤ 0,07	+0,01
Nb	≤ 0,10	+0,005
Ni	≤ 0,80	+0,05
Sn	≤ 0,025	+0,005
V	≤ 0, 05	+0,01
	> 0,05 to ≤ 0,35	±0,03
Cu	≤ 0,30	+0,05

[a] If several product analyses are carried out for one cast and if, in this case, values for individual elements are established which fall outside the permitted range for the chemical composition, then it is only permissible that the values either exceed the maximum permitted value or fall short of the minimum permitted value. It is not acceptable for both to apply for one cast.

This standard was downloaded from the normsplash.com

Table 4 — Mechanical properties at room temperature

Steel designation		Thickness of the ruling section t_R [a] mm	Mechanical properties at room temperature				Impact energy [e] [c] KV_2 J min.	
			Yield strength R_{eH} [b] MPa min.	Tensile strength R_m MPa	Elongation after fracture A% [c] min.			
Name	Number				l	tr/t	l	tr/t
P235GH	1.0345	$t_R \leq 35$	235	360 to 480	29	27	40	27 [d]
		$35 < t_R \leq 60$	225		28	26		
		$60 < t_R \leq 160$	210		27	25		
P245GH	1.0352	$t_R \leq 35$	245	410 to 530	25	23	40	27 [d]
		$35 < t_R \leq 160$	220					
P250GH	1.0460	$t_R \leq 60$	250	410 to 540	25	20	44	31 [d]
		$60 < t_R \leq 105$	240					
		$105 < t_R \leq 225$	230			19		
		$225 < t_R \leq 375$	210	400 to 520			40	27 [d]
		$375 < t_R \leq 750$	200					
P265GH	1.0425	$t_R \leq 60$	245	410 to 530	29	27	40	27 [d]
		$60 < t_R \leq 100$	215		26	24		
P280GH	1.0426	$t_R \leq 35$	280	460 to 580	23	21	48	27 [d]
		$35 < t_R \leq 160$	255					
P295GH	1.0481	$t_R \leq 60$	285	460 to 580	24	22	40	27 [d]
		$60 < t_R \leq 100$	260		23	21		
P305GH	1.0436	$t_R \leq 35$	305	510 to 630	22	20	48	27 [d]
		$35 < t_R \leq 70$	285					
		$70 < t_R \leq 160$	280	490 to 610				
16Mo3	1.5415	$t_R \leq 35$	295	440 to 570	23	21	50	31 [d]
		$35 < t_R \leq 70$	285					
		$70 < t_R \leq 100$	275					
		$100 < t_R \leq 250$	265					
		$250 < t_R \leq 500$	250	420 to 550				
13CrMo4–5	1.7335	$t_R \leq 35$	295	440 to 590	20	18	44	27 [d]
		$35 < t_R \leq 70$	285					
		$70 < t_R \leq 100$	275					
		$100 < t_R \leq 250$	265					
		$250 < t_R \leq 500$	240	420 to 570				
15MnMoV4–5	1.5402	$t_R \leq 35$	345	510 to 650	23	21	40	40
		$35 < t_R \leq 70$			22	20		

This standard was downloaded from the normsplash.com

Steel designation		Thickness of the ruling section t_R [a] mm	Mechanical properties at room temperature				Impact energy [e] [c] KV_2 J min.	
Name	Number		Yield strength R_{eH} [b] MPa min.	Tensile strength R_m MPa	Elongation after fracture A% [c] min.			
					l	tr/t	l	tr/t
		70 < t_R ≤ 250	325		21	19		
18MnMoNi5–5	1.6308	t_R ≤ 200	400	550 to 670	20	20	56	40
14MoV6–3	1.7715	t_R ≤ 500	300	460 to 610	20	18	27 [d]	27 [d]
15MnCrMoNiV 5–3	1.6920	t_R ≤ 100	370	560 to 710	17	17	40	40
11CrMo9–10	1.7383	t_R ≤ 200	310	520 to 670	20	20	40	27 [d]
							60	50
		200 < t_R ≤ 500	265	450 to 600	23	21	40	27 [d]
							50	34 [d]
X16CrMo5–1	1.7366	t_R ≤ 300	205 [f]	410 to 510 [f]	18 [f]	16 [f]	40	27 [d]
			420 [g]	640 to 780 [g]	16 [g]	14 [g]		
X10CrMoVNb9 –1	1.4903	t_R ≤ 130	450	630 to 830	19	17	40	34 [d]
X20CrMoV11–1	1.4922	t_R ≤ 100	500	750 to 850	16	14	39 [d]	27 [d]
		100 < t_R ≤ 250					31 [d]	
		250 < t_R ≤ 330					27 [d]	

[a] The thickness ranges given in this column apply for the as heat treated thickness of forgings with the ruling section. This is characterized by rectangular shape, a width to thickness ratio of ≥ 2 and a length to thickness ratio of ≥ 4. For forgings with other sections the equivalent thickness shall be determined according to EN 10222-1:2017, Annex A or be agreed at the time of enquiry and order.

[b] Until the yield point criteria are harmonized in the various national codes, determination of R_{eH} may be replaced by determination of $R_{p0,2}$. In this case $R_{p0,2}$ values are 10 MPa lower for R_{eH} values up to 355 MPa and 15 MPa lower for R_{eH} values greater than 355 MPa.

[c] l = longitudinal to main forging directions; t = tangential; tr = transverse to main forging directions.

[d] A minimum impact energy value of 40 J may be agreed at the time of enquiry and order.

[e] The upper line represents the minimum values for 0°C and the bottom line represents the values for 20°C

[f] Normalized and tempered.

[g] Quenched and tempered

This standard was downloaded from the normsplash.com

Table 5 — Minimum 0,2 % proof strength ($R_{p0,2}$) properties at elevated temperatures

Steel designation		Thickness of the ruling section t_R, mm	$R_{p0,2}$ min. in MPa at a temperature of:										
Name	Number		100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C	600 °C
P235GH	1.0345	$t_R \leq 60$ $60 < t_R \leq 100$	190 175	180 165	170 160	150 140	130 125	120 115	110 105	–	–	–	–
P245GH	1.0352	$t_R \leq 50$ $50 < t_R \leq 160$	195 180	185 175	175 165	160 155	145 135	135 130	125 120	–	–	–	–
P250GH [c]	1.0460	$t_R \leq 60$ $60 < t_R \leq 105$ $105 < t_R \leq 225$ $225 < t_R \leq 375$ $375 < t_R \leq 750$	237 230 220 200 190	216 210 200 180 170	190 185 175 160 155	170 165 155 140 135	150 145 135 125 115	130 125 115 105 100	110 100 90 85 80	90c 80c 70c 65c 60c	–	–	–
P265GH	1.0425	$t_R \leq 60$ $60 < t_R \leq 100$	215 195	205 185	195 175	175 160	155 140	140 135	130 125	–	–	–	–
P280GH	1.0426	$t_R \leq 50$ $50 < t_R \leq 160$	250 210	235 200	225 195	205 185	185 170	170 155	155 135	–	–	–	–
P295GH	1.0481	$t_R \leq 60$ $60 < t_R \leq 100$	250 230	235 220	225 210	205 195	185 180	170 165	155 145	–	–	–	–
P305GH	1.0436	$t_R \leq 50$ 50 < tR ≤ 160	270 250	255 240	240 230	220 210	200 195	190 175	165 155	–	–	–	–
16Mo3	1.5415	$t_R \leq 60$ $60 < t_R \leq 90$ $90 < t_R \leq 150$ $150 < t_R \leq 375$ $375 < t_R \leq 500$	264 250 240 235 220	245 230 220 210 200	225 210 200 190 180	205 195 185 175 165	180 170 160 150 145	170 160 155 145 140	160 150 145 140 135	155 145 140 135 130	150 140 135 130 125	–	–
13CrMo4–5	1.7335	$t_R \leq 60$ $60 < t_R \leq 90$ $90 < t_R \leq 150$ $150 < t_R \leq 375$ $375 < t_R \leq 500$	260 250 250 240 220	245 240 235 225 210	240 230 220 210 200	230 220 210 200 190	215 205 195 185 175	200 190 180 175 165	190 180 170 165 160	180 170 160 155 150	175 165 155 150 145	–	–
15MnMoV4–5	1.5402	$t_R \leq 250$	–	–	309	294	284	265	235	218	–	–	–

This standard was downloaded from the normsplash.com

Steel designation		Thickness of the ruling section t_R, mm	$R_{p0,2}$ min. in MPa at a temperature of:										
Name	Number		100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C	600 °C
18MnMoNi5–5	1.6308	$t_R \leq 200$	375	370	360	350	340	330	310	–	–	–	–
14MoV6–3	1.7715	$t_R \leq 500$	282	276	267	241	225	216	209	203	200	197	164
15MnCrMoNiV5–3	1.6920	$t_R \leq 100$	341	330	322	312	306	298	288	282	269	255	221
11CrMo9–10	1.7383	$t_R \leq 200$ $200 < t_R \leq 500$	265 245	250 230	235 215	230 210	220 200	205 185	195 175	185 165	175 155	–	–
X16CrMo5–1 [a]	1.7366	$t_R \leq 300$	345	335	327	323	322	316	306	285	256	–	–
X16CrMo5–1 [b]	1.7366	$t_R \leq 300$	156	150	148	147	145	142	137	129	116	–	–
X10CrMoVNb9–1	1.4903	$t_R \leq 130$	410	395	380	370	360	350	340	320	300	270	215
X20CrMoV11–1	1.4922	$t_R \leq 330$	460	445	430	415	390	380	360	330	290	250	–

[a] Normalized and tempered or quenched and tempered.

[b] Annealed.

[c] These values are valid for 420 °C.

This standard was downloaded from the normsplash.com

Annex A
(informative)

Reference data for stress rupture properties and 1 % creep limit properties

A1 Table A.1a — Stress rupture properties (for temperatures from 380 °C to 500 °C)

Steel designation		Time h	Average stress in MPa for rupture at a temperature of: [a]												
Name	Number		380 °C	390 °C	400 °C	410 °C	420 °C	430 °C	440 °C	450 °C	460 °C	470 °C	480 °C	490 °C	500 °C
P235 GH P245GH P250GHd) P265 GH	1.0345 1.0352 1.0460 1.0425	10 000 100 000 200 000	229 165 145	211 148 129	191 132 115	174 118 101	158 103 89	142 91 78	127 79 67	113 69 57	100 59 48	86 50 40	75 42 33	– – –	– – –
P280GH, P295 GH P305GH	1.0426, 1.0481 1.0436	10 000 100 000 200 000	291 227 206	266 203 181	243 179 157	221 157 135	200 136 115	180 117 97	161 100 82	143 85 70	126 73 60	110 63 52	96 55 44	– – –	– – –
16Mo3	1.5415	10 000 100 000 200 000	– – –	– – –	– – –	– – –	– – –	– – –	– – –	298 245 228	273 209 189	247 174 153	222 143 121	196 117 96	171 93 75
13CrMo4–5	1.7335	10 000 100 000 200 000	– – –	– – –	– – –	– – –	– – –	– – –	– – –	370 285 260	348 251 226	328 220 195	304 190 167	273 163 139	239 137 115
15MnMoV4–5	1.5402	10 000 100 000	– –	– –	– –	– –	– –	353 265	323 231	294 198	262 168	229 143	196 118	170 98	144 78
14MoV6–3	1.7715	10 000 100 000 200 000	– – –	– – –	– – –	– – –	– – –	– – –	– – –	380 321 301	353 294 274	328 268 247	304 242 221	280 217 196	257 193 172
15MnCrMoNiV5–3	1.6920	10 000 100 000 200 000	– – –	– – –	454 417 399	445 405 385	432 388 368	415 367 346	394 341 318	371 309 287	346 272 249	321 235 208	294 201 171	265 168 141	234 139 113

This standard was downloaded from the normsplash.com

Steel designation		Time h	Average stress in MPa for rupture at a temperature of: [a]												
Name	Number		380 °C	390 °C	400 °C	410 °C	420 °C	430 °C	440 °C	450 °C	460 °C	470 °C	480 °C	490 °C	500 °C
11CrMo9–10	1.7383	10 000	–	–	–	–	–	–	–	306	286	264	241	219	196
		100 000	–	–	–	–	–	–	–	221	205	188	170	152	135
		200 000	–	–	–	–	–	–	–	201	186	169	152	136	120
X16CrMo5–1 [b]	1.7366	10 000	–	–	–	–	–	–	–	–	–	226	220	190	164
		100 000	–	–	–	–	–	–	–	276	218	181	153	132	113
		200 000	–	–	–	–	–	–	–	237	192	158	135	114	96
X16CrMo5–1 [c]	1.7366	10 000	–	–	–	–	–	–	–	205	190	175	160	145	130
		100 000	–	–	–	–	–	–	–	158	143	128	113	100	90
		200 000	–	–	–	–	–	–	–	145	129	115	102	89	79
X10CrMoVNb9–1	1.4903	10 000	–	–	–	–	–	–	–	–	–	–	–	–	289
		100 000	–	–	–	–	–	–	–	–	–	–	–	–	258
		200 000	–	–	–	–	–	–	–	–	–	–	–	–	245
X20CrMoV11–1	1.4922	10 000	–	–	–	–	–	–	–	–	–	–	348	319	292
		100 000	–	–	–	–	–	–	–	–	–	–	289	263	236
		200 000	–	–	–	–	–	–	–	–	–	–	270	242	218

a Some values in Table A.1a have been obtained by extrapolation.

b Normalized and tempered or quenched and tempered.

c Annealed.

d for P250GH (1.0460) only stress rupture properties up to 420 °C to be applied.

NOTE 1 The values given in Table A.1a mean values of the scatter band considered until now.

NOTE 2 The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperature listed in Table A.1a do not mean that the steels can be used in continues 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.

A1

This standard was downloaded from the normsplash.com

Table A.1b — Stress rupture properties (for temperatures from 510 °C to 670 °C)

Steel designation		Rupture time h	Average stress in MPa for rupture at a temperature of:[a]															
Name	Number		510 °C	520 °C	530 °C	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C	660 °C	670 °C
P235 GH P245GH P250GH P265 GH	1.0345 1.0352 1.0460 1.0425	10 000 100 000 200 000	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
P280GH, P295 GH P305GH	1.0426, 1.0481 1.0436	10 000 100 000 200 000	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
16Mo3	1.5415	10 000 100 000 200 000	147 74 57	125 59 45	102 47 36	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
13CrMo4–5	1.7335	10 000 100 000 200 000	209 116 96	179 94 76	154 78 62	129 61 50	109 49 39	91 40 32	76 33 26	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
15MnMoV4–5	1.5402	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
14MoV6–3	1.7715	10 000 100 000 200 000	234 170 150	212 149 130	190 130 113	170 113 98	151 99 85	133 86 71	118 73 –	104 – –	92 – –	81 – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
15MnCrMoNiV 5–3	1.6920	10 000 100 000 200 000	205 113 88	A1 17 7 A1 90 66	150 70 50	125 53 34	102 39 23	83 – –	69 – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –	– – –
11CrMo9–10	1.7383	10 000 100 000 200 000	176 118 105	156 103 91	138 90 79	122 78 68	108 68 58	96 58 50	85 51 43	75 44 37	68 38 32	61 34 28	– – –	– – –	– – –	– – –	– – –	– – –	– – –
X16CrMo5–1[b]	1.7366	10 000 100 000	145 96	129 81	114 70	100 59	88 50	77 43	68 37	60 –	53 –	46 –	– –	– –	– –	– –	– –	– –	– –

This standard was downloaded from the normsplash.com

Steel designation		Rupture time h	Average stress in MPa for rupture at a temperature of:[a]															
Name	Number		510 °C	520 °C	530 °C	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C	660 °C	670 °C
		200 000	80	68	57	47	40	–	–	–	–	–	–	–	–	–	–	–	–
X16CrMo5–1[c]	1.7366	10 000 100 000 200 000	119 81 70	108 73 63	98 65 56	88 57 49	79 50 42	71 44 35	64 38 30	57 33 26	50 28 23	43 24 20	– – –	– – –	– – –	– – –	– – –	– – –	– – –
X10CrMoVNb9–1	1.4903	10 000 100 000 200 000	271 239 225	252 220 206	234 201 188	216 183 170	199 166 153	182 150 136	166 134 121	151 120 106	136 106 93	123 94 81	110 83 71	99 73 63	89 65 57	79 56 49	70 49 42	62 42 35	55 36 -
X20CrMoV11–1	1.4922	10 000 100 000 200 000	269 212 194	247 188 170	225 167 149	205 147 129	184 128 112	165 111 96	147 95 81	130 81 68	113 69 58	97 59 49	84 51 42	72 43 36	61 36 30	52 31 –	44 26 –	- - -	- - -

a Some values in Table A.1b have been obtained by exploration.

b Normalized and tempered or quenched and tempered.

c Annealed.

NOTE 1 The values given in Table A.1b mean values of the scatter band considered until now.

NOTE 2 The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperature listed in Table A.1b do not mean that the steels can be used in continues 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.

This standard was downloaded from the normsplash.com

A1 Table A.2a — 1 % creep limit properties (for temperatures from 380 °C to 500 °C)

Steel designation		Time h	1 % creep limit in MPa at a temperature of: [a]												
Name	Number		380 °C	390 °C	400 °C	410 °C	420 °C	430 °C	440 °C	450 °C	460 °C	470 °C	480 °C	490 °C	500 °C
P235 GH P245GH P250GH [e] P265 GH	1.0345 1.0352 1.0460 1.0425	10 000 100 000	164 118	150 106	136 95	124 84	113 73	101 65	91 57	80 49	72 42	62 35	53 30	– –	– –
P280GH, P295 GH P305GH	1.0426 , 1.0481 1.0436	10 000 100 000	195 153	182 137	167 118	150 105	135 92	120 80	107 69	93 59	83 51	71 44	63 38	– –	– –
16Mo3	1.5415	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	216 167	199 146	182 126	166 107	149 89	132 73
13CrMo4–5	1.7335	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	245 191	228 172	210 152	193 133	173 116	157 98
15MnMoV4–5	1.5402	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	333 240	302 209	271 177	224 150	208 126	177 103
14MoV6–3 [b]	1.7715	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	231 172	210 152	191 134
11CrMo9–10	1.7383	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	240 166	219 155	200 145	180 130	163 116	147 103
X16CrMo5–1	1.7366	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	c	c
X16CrMo5–1 [d]	1.7366	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	131 99	123 91	115 82	107 75	99 70	91 65
X20CrMoV11–1	1.4922	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	324 260	299 236	269 213	247 190

This standard was downloaded from the normsplash.com

Steel designation		Time h	1 % creep limit in MPa at a temperature of: [a]											
Name	Number		380 °C	390 °C	400 °C	410 °C	420 °C	430 °C	440 °C	450 °C	460 °C	470 °C	480 °C	490 °C	500 °C

a Some values in Table A.2a have been obtained by extrapolation.

b These data are based on “High temperature design data for ferritic pressure vessel steels” published by the Creep of Steels Working Party of the Institute of Mechanical Engineers, Great Britain.

c Normalized and tempered or quenched and tempered. Values to be agreed at the time of enquiry and order.

d Annealed.

e For P250GH (1.0460) only stress rupture properties up to 420 °C to be applied.

NOTE 1 The values given in Table A.2a mean values of the scatter band considered until now.

NOTE 2 The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperature listed in Table A.2a do not mean that the steels can be used in continues 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.

This standard was downloaded from the normsplash.com

Table A.2b — 1 % creep limit properties (for temperatures from 510 °C to 650 °C)

Steel designation		Time h	1 % creep limit in MPa at a temperature of: [a]														
Name	Number		510 °C	520 °C	530 °C	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C
P235 GH P245GH P250GH P265 GH P280GH, P295 GH P305GH	1.0345 1.0352 1.0460 1.0425 1.0426, 1.0481 1.0436	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
16Mo3	1.5415	10 000 100 000	115 59	99 46	84 36	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
13CrMo4–5	1.7335	10 000 100 000	139 83	122 70	106 57	90 46	76 36	64 30	53 24	– –	– –	– –	– –	– –	– –	– –	– –
15MnMoV4–5	1.5402	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
14MoV6–3 [b]	1.7715	10 000 100 000	170 118	154 103	139 90	126 78	114 66	102 57	93 48	82 –	73 --	65 –	– –	– –	– –	– –	– –
11CrMo9–10	1.7383	10 000 100 000	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
X16CrMo5–1 [c]	1.7366	10 000 100 000	76 54	67 47	60 42	55 37	49 32	43 30	37 26	– –	– –	– –	– –	– –	– –	– –	– –
X16CrMo5–1 [d]	1.7366	10	83	75	67	59	52	46	41	36	32	28	–	–	–	–	–

This standard was downloaded from the normsplash.com

Steel designation		Time h	1 % creep limit in MPa at a temperature of: [a]														
Name	Number		510 °C	520 °C	530 °C	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C
		000 100 000	60	55	50	45	40	35	30	25	20	17	–	–	–	–	–
X20CrMoV11–1	1.4922	10 000 100 000	227 169	207 147	187 130	170 114	151 98	135 85	118 72	103 61	90 52	75 43	64 36	53 30	44 25	36 20	29 17

a Some values in Table A.2b have been obtained by extrapolation.

b These data are based on “High temperature design data for ferritic pressure vessel steels” published by the Creep of Steels Working Party of the Institute of Mechanical Engineers, Great Britain.

c Normalized and tempered or quenched and tempered.

d Annealed.

NOTE 1 The values given in Table A.2b mean values of the scatter band considered until now.

NOTE 2 The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperature listed in Table A.2b do not mean that the steels can be used in continues 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.

A1

This standard was downloaded from the normsplash.com

Annex B
(informative)

Significant technical changes to the version EN 10222-2:1999

Some significant changes to the previous version EN 10222-2:1999 are listed below:

1) Updating of the normative references;

2) Generally alignment of the requirements with EN 10222-1;

3) Updating of the ordering information's in chapter 5;

4) Table 1 containing values and statements on the heat treatment of the steels updated;

5) New steel grade P250GH inserted in the standard;

6) Updating of the values for the chemical composition and mechanical properties for the steel grades covered by this part of the EN 10222 series;

7) New sub Clause 6.7 "Resistance to hydrogen induced cracking" inserted in the standard;

8) Previous contents of Annexes A and B updated in the new Annex ZA in relationship with EU Directive 2014/68/EU.

This standard was downloaded from the normsplash.com

A1

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/071 to provide one voluntary means of conforming to Essential Requirements of Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative 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 Directive 2014/68/EU, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

Requirements of Directive 2014/68/EU	Clause(s)/subclause(s) of this EN	Remarks/Notes
4.1a	6.4	Appropriate material properties
4.1d	6.2, 6.5, 6.6	Suitable for the processing procedures
4.3	Clause 7 (EN 10222-1:2017, 7.1)	Inspection documentation

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard. A1

This standard was downloaded from the normsplash.com

Bibliography

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

[2] EN 10229, *Evaluation of resistance of steel products to hydrogen induced cracking (HIC)*

[3] EN 10028-2:2017, *Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties.*

This standard was downloaded from the normsplash.com