BS EN 10222-4:2017

BSI Standards Publication

Steel forgings for pressure purposes

Part 4: Weldable fine grain steels with high proof strength

bsi.

National foreword

This British Standard is the UK implementation of EN 10222-4:2017. It supersedes BS EN 10222-4:1999, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Steel forgings for pressure purposes - Part 4: Weldable fine grain steels with high proof strength

Pièces forgées en acier pour appareils à pression - Partie 4: Aciers soudables à grains fins avec limite d'élasticité élevée

Schmiedestücke aus Stahl für Druckbehälter - Teil 4: Schweißgeeignete Feinkornbausstähle mit hoher Dehngrenze

This European Standard was approved by CEN on 25 December 2016.

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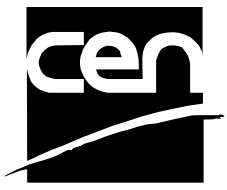

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European foreword

This document (EN 10222-4:2017) has been prepared by Technical Committee ECISS/TC 111 “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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

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

This document supersedes EN 10222-4:1998.

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*.

Annex A provides details about significant technical changes to EN 10222-4:1998.

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.

1 Scope

This European Standard specifies the technical delivery conditions for forgings for pressure purposes, made of weldable fine grain steels with high proof strength.

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 conditions 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 the classification system in EN 10020, the steel grades specified in this document are non-alloy quality steels (P285NH, P285QH, P355NH, P355QH1, P355NL1), non-alloy special steel (P355NL2) and alloy special steels (P355QL1, P355QL2, P420NH, P420QH, P460QH, P460QL1, P460QL2).

4.2 Designation

See EN 10222-1:2017.

5 Information to be supplied by the purchaser

5.1 Mandatory information

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

5.2 Options

A number of options are specified in this document and listed below. Additionally, the relevant options of EN 10222-1:2017 apply.

1) test temperature for the tensile test at elevated temperature, if applicable (see 6.4);
2) carbon equivalent for non-alloy steels (see Table 2, footnote b);
3) higher Al content (see Table 2, footnote c);
4) higher sulphur content (see Table 2, footnote f);
5) mechanical properties for grades type P460 in normalized condition (see Table 4 footnote f and Table 6, footnote a);
6) different test temperature for the min. impact energy (see Table 5, footnote c);
7) minimum impact energy values (see Table 5 footnote d);
8) test to evaluate the resistance to hydrogen induced cracking (see 6.7).

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 in Table 1.

6.3 Chemical composition

6.3.1 Cast analysis

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

6.3.2 Product analysis

The product analysis shall not deviate from the specified cast analysis (see Table 2) by more than the values specified in Table 3.

6.4 Mechanical properties

When heat treated in accordance with Table 1, the mechanical properties shall conform to the requirements of Tables 4 and 5.

Elevated temperature proof strength ($R_{P0,2}$) values shall conform to the requirements of Table 6.

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.

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

Steels covered by this standard 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.

Table 1 — Heat treatment

Steel grade		Heat treatment[a]	Austenitizing or normalizing		Tempering
Steel name	Steel number		Temperature °C	Cooling in[b]	Temperature °C
P285NH	1.0477	+N	880 to 960	a	–
P285QH	1.0478	+QT	860 to 940	o, w	600 to 700
P355NH	1.0565	+N	880 to 960	a	–
P355NL1[c]	1.0566	+N	880 to 960	a	–
P355NL2[c]	1.1106	+N	880 to 960	a	–
P355QH1	1.0571	+QT	860 to 940	o, w	600 to 700
P355QL1	1.8868	+QT	860 to 940	o, w	600 to 700
P355QL2	1.8869	+QT	860 to 940	o, w	600 to 700
P420NH[c]	1.8932	+N	880 to 960	a	–
P420QH	1.8936	+QT	860 to 940	o, w	600 to 700
P460QH	1.8871	+QT	860 to 940	o, w	600 to 700
P460QL1	1.8872	+QT	860 to 940	o, w	600 to 700
P460 QL2	1.8864	+QT	860 to 940	o, w	600 to 700

a +*N* = normalized, +QT = quenched and tempered.

b a = air, o = oil, w = water or water based medium.

c Limited to teq < 40 mm (see prEN 10222–1:2015, Table A.1)

Table 2 — Chemical composition (cast analysis)

Steel designation		% by mass[a]														Carbon equivalent value[b] % by mass
Steel name	Steel number	C max.	Si max.	Mn	P max.	S[f] max.	Al_{total}	N max.	Cr max.	Cu max.	Mo max.	Nb max.	Ni max.	V max.	Nb + V max.	
P285NH	1.0477	0,18	0,40	0,80 to 1,50	0,025	0,010	≥ 0,020[c]	0,020	0,30	0,20	0,08	0,03	0,30	0,05	0,05	0,41
P285QH	1.0478															
P355NH	1.0565	0,18	0,50	1,10 to 1,70	0,025	0,010	≥ 0,020[c]	0,015	0,30[d]	0,30[d]	0,08[d]	0,05	0,50	0,10	0,12	0,47
P355NL1	1.0566					0,008										
P355NL2	1.1106				0,020											
P355QH1	1.0571	0,18	0,40	0,90 to 1,50	0,025	0,010	≥ 0,020[c]	0,015	0,30	0,30	0,25	0,05[e]	0,50	0,10[e]	0,12	
P355QL1	1.8868				0,020	0,008										
P355QL2	1.8869															
P420NH	1.8932	0,20	0,60	1,10 to 1,70	0,025	0,010	≥ 0,020[c]	0,020	0,30	0,20	0,10	0,05	1,00	0,20	0,22	0,51
P420QH	1.8936				0,020	0,008								0,15	- [e]	
P460QH	1.8871	0,18	0,50	1,10 to 1,70	0,025	0,010	≥ 0,020[c]	0,015	0,50	0,30	0,50	0,05	1,00	0,15	- [e]	0,51
P460QL1	1.8872				0,020	0,008										
P460QL2	1.8834															

[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 adversely affect the mechanical properties and usability.

[b] If agreed at the time of enquiry and order (see also EN 10222–1:2017, 6.4.1.5).

[c] A maximum value of 0,050 should be agreed at time of enquiry and order. If only aluminium is used for nitrogen binding, a ratio Al/N ≥ 2 shall apply.

[d] The sum of the percentages by mass of the three elements chromium, copper and molybdenum shall not exceed 0,45 %.

[e] Ti and Zr may also be added: Ti ≤ 0,03 %, Zr ≤ 0,05 %The percentage of grain refining elements shall be at least 0,15 %.

[f] A maximum sulphur content up to 0,015 % may be agreed at time of enquiry and order. In this case the mechanical properties stated in the according tables are also valid and shall be fulfilled.

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

Element	Specified range %	Permissible deviations[a] %
C	≤ 0,20	+0,02
Si	≤ 0,60	+ 0,05
Mn	≤ 1,00	+0,05
	> 1,00 to ≤ 1,70	±0,10
P	≤ 0,025	+ 0,005
S	≤ 0,010	+ 0,003
Al	≥ 0,020 to ≤ 0,050	±0,005
N	< 0,025	+ 0,002
Cr	≤ 0,50	+ 0,05
Mo	≤ 0,10	+ 0,03
Cu	≤ 0,20	+ 0,05
Nb	≤ 0,05	+ 0,01
Ni	≤ 1,00	+ 0,05
Ti	≤ 0,03	+ 0,01
V	≤ 0,20	+ 0,01
Nb +V	≤ 0,22	+0,02

[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.

Table 4 — Mechanical properties at room temperature

Steel grade		Heat treatment[a]	Thickness of the ruling section t_R[b] mm	Yield strength R_{eH}[c] MPa min.	Tensile strength R_m MPa	Elongation after fracture A[d] % min	
Steel name	Steel number					l	tr, t
P285NH	1.0477	+N	$t_R \leq 16$	285	390 to 510	24	23
			$16 < t_R \leq 35$	275			
			$35 < t_R \leq 70$	260			
P285QH[e]	1.0478	+QT	$70 < t_R \leq 100$	245	370 to 510	22	21
			$100 < t_R \leq 250$	225			
			$250 < t_R \leq 400$	205			
P355NH	1.0565	+N	$t_R \leq 16$	355	490 to 630	23	21
P355NL1	1.0566		$16 < t_R \leq 35$	345			
P355NL2	1.1106		$35 < t_R \leq 70$	330			
P355QH1[e]	1.0571	+QT	$70 < t_R \leq 100$	315	470 to 630	21	19
P355QL1[e]	1.8872		$100 < t_R \leq 250$	295			
P355QL2[e]	1.8864		$250 < t_R \leq 400$	275			
P420NH	1.8932	+N	$t_R \leq 16$	420	530 to 680	20	19
			$16 < t_R \leq 35$	410			
			$35 < t_R \leq 70$	390			
P420QH[e]	1.8936	+QT	$70 < t_R \leq 100$	375	510 to 670	18	17
			$100 < t_R \leq 250$	345			
			$250 < t_R \leq 400$	325			
P460QH[e,f]	1.8871	+QT	$t_R \leq 100$	420	520 to 710	18	16
P460QL1[e,f]	1.8872		$100 < t_R \leq 250$	400			
P460QL2[e,f]	1.8864		$250 < t_R \leq 400$	380			

a +A annealed; +N normalized; +QT quenched and tempered; +NT normalized and tempered.

b 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 ≥ 2 and a length to thickness ratio ≥ 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.

c 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.

d l = longitudinal, t = tangential, tr = transverse.

e For thickness less than 70 mm the tensile strength values for QT grades are the same as for normalized grades

f For the three grades P460QH, P460QL1, and P460QL2 in normalized conditions the values for the mechanical properties should be agreed at the time of enquiry and order.

Table 5 — Minimum impact energy

Steel designation	Heat Treatment condition[a,b]	Thickness of the ruling section t_R mm	Impact energy KV_2 in J[c] min at a test temperature in °C of:									
			longitudinal					Transversal and tangential				
			+20	0	-20	-40	-50	+20	0	-20	-40	-50
P285NH P355NH P420NH	+N	≤ 70	55	47	40	27[d]	-	40	34	27[d]	-	-
P285QH P355QH1 P420QH P460QH	+QT	≤ 400	63	55	47	34	-	40	34	27[d]	-	-
P355NL1	+N	≤ 70	55	47	40	27[d]	-	47	40	34	27[d]	-
P355QL1 P420QL1 P460QL1	+QT	≤ 400	63	55	47	34	-	47	40	34	27[d]	-
P355NL2	+N	≤ 70	55	47	40	30	27[d]	47	40	34	30	27[d]
P355QL2 P460QL2	+QT	≤ 400	63	55	47	34	27[d]	47	40	34	30	27[d]

a +*N* = normalized; +QT = quenched and tempered.

b For temperatures and cooling conditions, see Table 1.

c Where minimum impact energy values are specified for several temperatures, verification of the impact energy, unless otherwise agreed, shall be carried out at the temperature for which the value of 27 J is specified. Where the minimum impact energy value specified at the lowest temperature is higher than 27 J, this higher value shall be verified

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

Table 6 — Minimum 0,2 % proof strength $R_{p0,2}$ values at elevated temperatures

Steel grade		Thickness of the ruling section t_R	$R_{p0,2,\,min.}$ in MPa at a Temperature in °C of							
Steel name	Steel number		50	100	150	200	250	300	350	400
P285NH	1.0477	$t_R \leq 16$	276	259	240	221	202	166	153	144
		$16 < t_R \leq 35$	266	250	232	213	195	160	148	139
		$35 < t_R \leq 70$	251	237	219	201	184	151	140	131
P285QH	1.0478	$70 < t_R \leq 100$	237	223	206	190	174	143	132	124
		$100 < t_R \leq 250$	218	205	190	174	160	131	121	114
		$250 < t_R \leq 400$	198	187	173	159	145	119	110	104
P355NH	1.0565	$t_R \leq 16$	343	323	299	275	252	232	214	202
		$16 < t_R \leq 35$	334	314	291	267	245	225	208	196
		$35 < t_R \leq 70$	319	300	278	256	234	215	199	187
P355QH1	1.0571	$70 < t_R \leq 100$	305	287	265	244	224	206	190	179
		$100 < t_R \leq 250$	285	268	249	228	209	192	178	167
		$250 < t_R \leq 400$	266	250	232	213	195	179	166	156
P420NH	1.8932	$t_R \leq 16$	406	382	354	325	298	274	254	238
		$16 < t_R \leq 35$	396	373	346	318	291	267	248	233
		$35 < t_R \leq 70$	377	355	329	302	277	254	236	221
P420QH	1.8936	$70 < t_R \leq 100$	363	341	316	290	266	245	227	213
		$100 < t_R \leq 250$	334	314	291	267	245	225	208	196
		$250 < t_R \leq 400$	314	296	274	252	231	212	196	185
P460QH[a]	1.8871	$t_R \leq 100$	402	392	363	343	314	294	265	235
		$100 < t_R \leq 250$	382	363	333	314	284	265	235	206
		$250 < t_R \leq 400$	373	353	324	304	275	255	226	196

[a] For the three grades P460 in normalized conditions the values for the mechanical properties should be agreed at the time of enquiry and order.

Annex A
(informative)

Significant technical changes to the version EN 10222-4:1998

Significant technical changes to the previous version EN 10222-4:1998 are listed below:

1) Updating of the normative references;
2) Generally alignment of the requirements with EN 10222−1;
3) Updating of the optional information's in chapter 5.2;
4) Table 1 containing values and statements on the heat treatment of the steels updated;
5) New Table 4 containing values for the mechanical properties at room temperature;
6) New steel grades added: P355NL1 and NL2; P355QL1 and QL2; P460QL1 and QL2;
7) Updating of the values for the chemical composition and mechanical properties for the steel grades covered by this part of the EN 10222 series;
8) New sub Clause 6.7 "Resistance to hydrogen induced cracking" inserted in the standard;
9) Updating of Annex ZA in relationship with EU Directive 2014/68/EU.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU

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.

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)*

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.