UDC 629.14.018.29-41 : 621.642-98 April 1993

Flat products made from steel for pressure purposes

Weldable, normalized, fine grain steels

English version of DIN EN 10028 Part 3

DIN
EN 10 028
Part 3

Flacherzeugnisse aus Druckbehälterstählen;
schweißgeeignete Feinkornbaustähle, normalgeglüht

This standard, together with DIN EN 10028 Part 1 and DIN EN 10113 Parts 1 and 2, supersedes DIN 17 102, October 1983 edition.

European Standard EN 10028-3 : 1992 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 22.

The responsible German body involved in its preparation was the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee), Technical Committee *Stähle für den Druckbehälterbau.*

This standard is largely based on the June 1989 draft of DIN 17 102 Part 10 (cf. Amendments).

DIN 50601 corresponds to EURONORM 103 referred to in clause 2 of the EN.

Continued on pages 2 and 3.
EN comprises 7 pages.

Standards referred to

(and not included in **Normative references**)

DIN 50601 Determination of grain size of ferrite or austenite in ferrous materials by metallographic methods

Previous edition

DIN 17102: 10.83.

Amendments

In comparison with the October 1983 edition of DIN 17102, the following amendments have been made.

a) The specifications are now covered in EN 10028 Parts 1 and 3, and have been editorially revised.

b) The present standard does not apply to weldable fine grain structural steels (cf. DIN 10113 Parts 1 and 2, at present at the stage of draft).

c) Steels with a minimum yield strength of 255, 315, 380, 420 and 500 N/mm² have been dropped, and those with a minimum yield strength of 275 N/mm² (in place of 285 N/mm²), are included for the first time.

d) Some of the requirements for chemical composition and mechanical properties have been amended.

e) The material designations have been changed in accordance with the table below.

Steel grade as specified in DIN EN 10028 Part 3	Equivalent steel grade as specified in DIN 17102, October 1983 edition	Material number
P275N	StE 285	1.0486
P275NH	WStE 285	1.0487
P275NL1	TStE 285	1.0488
P275NL2	EStE 285	1.1104
P355N	StE 355	1.0562
P355NH	WStE 355	1.0565
P355NL1	TStE 355	1.0566
P355NL2	EStE 355	1.1106
P460N	StE 460	1.8905
P460NH	WStE 460	1.8935
P460NL1	TStE 460	1.8915
P460NL2	EStE 460	1.8918

International Patent Classification

C 22 C 38/00
C 21 D 1/55
G 01 N 33/20

Editor's note

This Standard reproduces the official text of the English version of EN 10028-3 as issued by CEN. In its preparation for publication as DIN EN 10028 Part 3 (English version), certain points have been noted which we consider to be in need of correction. These have been marked +). The suggested amendments are given below and will be forwarded to the responsible CEN Secretariat for its consideration.

In presentation, orthography, punctuation and hyphenation, the aim has been to implement the PNE Rules consistently. Obvious errors (e.g. redundancies and omissions) have been rectified without further reference.

Suggested amendments

1 *For the sake of consistency (cf. Scope), the subtitle of the EN should be amended to read: 'Weldable, normalized, fine grain steels'.*

2 *In subclause 7.1, item c) does not reflect the German text and should read: 'the series with low temperature toughness', and item d), 'the special series with low temperature toughness' (since these are the more commonly used technical terms). Subclauses 8.4.2 and 9.5.2 should then be amended accordingly.*

3 *To avoid confusion, the term 'delivery condition' should be replaced by 'heat treatment condition' in subclause 8.2, the Note to subclause 8.4.1, and table 4.*

4 *For ease of reading, the last paragraph of subclause 8.2.3 should be amended to read: 'In this case, samples shall be treated to the usual condition prior to testing (cf. table 4).'*

5 *To facilitate comprehension, the Note to subclause 8.2.3 should be amended to read: 'In the case of samples treated as described above, the party responsible for further processing is still to provide proof that the properties of the finished product comply with the relevant requirements.'*

6 *In the Note to subclause 8.2.4, the term 'stress relief annealing' should be replaced by 'stress-relieving', which is the more common technical term.*

7 *For the sake of clarity, the title of table 2 should be amended to read: 'Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for cast analysis (cf. table 1)'.*

8 *For the purpose of elaboration, footnote [1]) to table 3 should be amended to read: 'The carbon equivalent, CEV, shall be calculated from the following equation:'.*

9 *By way of correction, the title of subclause 9.3 should read: 'Scope of testing'.*

10 *For the sake of clarity, subclause 9.5.2 should be amended to read: 'The values of impact energy shall be in compliance with table 6.'*

11 *For the sake of comprehension, footnote [1]) to table 4 should be amended to read: 'Until the values of yield strength are harmonized among the various national codes of practice, it shall be permitted to determine the 0,2 % proof strength, $R_{p0,2}$, instead of R_{eH}. In the case of R_{eH} values up to 355 N/mm^2, the values of $R_{p0,2}$ shall be reduced by 10 N/mm^2 and, in the case of R_{eH} values over 355 N/mm^2, the values of $R_{p0,2}$ shall be reduced by 15 N/mm^2.'*

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10 028-3

December 1992

UDC 629.14.018.29-41 : 621.642-98

Descriptors: Iron and steel products, metal plate, steel strip, steels, welded constructions, pressure equipment, designation, specifications, heat treatment condition, tests, marking.

English version

Flat products made of steels for pressure purposes

Part 3: Weldable fine grain steels, normalized +)

Produits plats en aciers pour appareils à pression. Partie 3: Aciers soudables à grains fins, normalisés

Flacherzeugnisse aus Druckbehälterstählen. Teil 3: Schweißgeeignete Feinkornbaustähle, normalgeglüht

This European Standard was approved by CEN on 1992-12-21.

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 bibliographic references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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

Ref. No. EN 10 028-3 : 1992 E

Contents

NOTE: The clauses marked ● contain information relating to agreements which are to be made at the time of ordering. The clauses marked ●● contain information relating to agreements which may be made at the time of ordering.

Foreword

This European Standard was prepared by ECISS/TC 22 'Steels for pressure purposes; qualities', the Secretariat of which is held by DIN.

Within the framework of the ECISS (European Committee for Iron and Steel Standardization) programme, ECISS/TC 22 was allocated the task of revising EURONORM 28-85 'Steel plate, sheet and strip with elevated temperature properties; technical delivery conditions' and (where relevant to pressure vessel construction) EURONORM 113-72 'Weldable fine grain structural steels' and replacing them with a European Standard.

At its meeting in January 1991, ECISS/TC 22 approved the present document. The following ECISS members were represented at the meeting: Austria, Belgium, Finland, France, Germany, Italy, Norway, Sweden, United Kingdom.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by June 1993 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This Part of EN 10028 specifies requirements for flat products, used for the construction of pressure vessels, made from the weldable fine grain steels specified in table 1.

NOTE: 'Fine grain steels' are understood to be steels which have a ferritic grain size of 6 or finer when tested in accordance with EURONORM 103.

1.2 The requirements specified in EN 10028-1 shall also apply.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 10020	Definition and classification of grades of steel
EN 10028-1	Flat products made from steels for pressure purposes. Part 1: General requirements
ISO 2605-1:1976	Steel products for pressure purposes; derivation and verification of elevated temperature properties; yield or proof stress of carbon and low alloy steel products
EU 103-71[1])	Microscopic determination of the ferritic and austenitic grain size of steel

3 Definitions

See EN 10028-1.

4 Dimensions and tolerances on dimensions

See EN 10028-1.

5 Calculation of mass

See EN 10028-1.

6 Designation and ordering

See EN 10028-1.

7 Classification into grades

7.1 This European Standard covers the steel grades given in table 4, in four series:

a) the basic series (P . . . N);
b) the elevated temperature series (P . . . NH);
c) the low temperature series (P . . . NL1);+)
d) the special low temperature series (P . . . NL2).+)

7.2 In accordance with EN 10020, grades P275N, P275NH, P275NL1, P355N, P355NH, P355NL1 are unalloyed quality steels, grades P275NL2 and P355NL2 are unalloyed special steels, and the other grades are alloy special steels.

8 Requirements

8.1 Steelmaking process

See EN 10028-1.

8.2 Delivery condition+)

8.2.1 ●● Unless otherwise agreed at the time of ordering, the products covered by this European Standard shall be supplied in the normalized condition.

In the case of steels with a minimum yield strength $\geq 460\ N/mm^2$, delayed cooling or additional tempering may be necessary for small product thicknesses and in special cases.

8.2.2 Normalizing rolling may be carried out instead of normalizing. This means that the requirements are still to be met even after subsequent normalizing.

8.2.3 ●● Subject to agreement, the products covered by this European Standard may also be supplied in the untreated condition.

In these cases, testing shall be carried out on test pieces in the usual delivery condition as indicated in table 4.+)

NOTE: This testing of test pieces in the simulated heat treated condition does not discharge the processor from the obligation of providing proof of the specified properties in the finished product.+)

8.2.4 Information on processing is given in Information Circular No. 2 'Weldable fine grain steels; information for processing, particularly for welding'. This document is currently being revised by CEN/TC 121 and will be published under a different number.

NOTE: An Information Circular on stress relief annealing+) is currently in preparation.

8.3 Chemical composition

8.3.1 The chemical composition, as determined by cast analysis, shall be in compliance with table 1.

8.3.2 Where a product analysis is to be carried out, the results may deviate from the values given in table 1 by the amounts listed in table 2.

8.3.3 ●● A maximum value for the carbon equivalent, in accordance with table 3, may be agreed at the time of ordering.

8.4 Mechanical properties

8.4.1 Tables 4 to 6 shall apply for the mechanical properties (cf. EN 10028-1).

NOTE: It should be noted that the values specified for the carbon equivalent apply for the mechanical properties specified for the relevant delivery condition.+)

[1]) ●● Prior to adoption as a European Standard, this EURONORM or a corresponding national standard may be applied, depending on the agreement reached at the time of ordering.

8.4.2 ●● Subject to agreement, the minimum elevated temperature 0,2 % proof strength values given in table 5 may also apply for the low temperature series and special low temperature series.+)

8.5 Surface condition

See EN 10028-1.

8.6 Internal soundness

See EN 10028-1.

9 Testing

See EN 10028-1.

9.1 Type and content of inspection documents

See EN 10028-1.

9.2 Tests to be carried out

See EN 10028-1.

9.3 Number of tests+)

See EN 10028-1.

9.4 Sampling and sample preparation

9.4.1 See EN 10028-1.

9.4.2 ●● As a deviation from EN 10028-1, it may be agreed that impact testing be carried out on longitudinal test pieces instead of transverse test pieces.

9.5 Test procedures

9.5.1 See EN 10028-1.

9.5.2 Proof of the impact values given in table 6 may be obtained at the temperatures given in the table.+)

●● Impact testing shall be carried out at a temperature to be agreed upon at the time of ordering and for one type of test piece (transverse, unless otherwise agreed). Unless otherwise agreed, the impact energy shall be determined at − 20 °C for the basic and the elevated temperature series, and at − 50 °C for the low temperature and special low temperature series.+)

9.6 Retests

See EN 10028-1.

10 ●● Marking

See EN 10028-1.

Table 1: Chemical composition as determined by cast analysis

Material designation	Material number	Classification[1]	Percentage by mass C max.	Si max.	Mn	P max.	S max.	$Al_{ges.}$ min.	Cr max.	Cu max.	Mo max.	N max.	Nb max.	Ni max.	Ti max.	V max.	Nb + Ti + V max.
P275N	1.0486	UQ	0,18	0,40	0,50 to 1,40	0,030	0,025	0,020[2]	0,30[3]	0,30[3]	0,08[3]	0,020	0,05	0,50	0,03	0,05	0,05
P275NH	1.0487	UQ															
P275NL1	1.0488	UQ	0,16		0,50 to 1,50	0,030	0,020										
P275NL2	1.1104	UE				0,025	0,015										
P355N	1.0562	UQ	0,20	0,50	0,90 to 1,70	0,030	0,025	0,020[2]	0,30[3]	0,30[3]	0,08[3]	0,020	0,05	0,50	0,03	0,10	0,12
P355NH	1.0565	UQ															
P355NL1	1.0566	UQ	0,18			0,030	0,020										
P355NL2	1.1106	UE				0,025	0,015										
P460N	1.8905	LE	0,20	0,60	1,00 to 1,70	0,030	0,025	0,020[2]	0,30	0,70[4]	0,10	0,025	0,05	0,80	0,03	0,20	0,22
P460NH	1.8935	LE															
P460NL1	1.8915	LE				0,030	0,020										
P460NL2	1.8918	LE				0,025	0,015										

[1]) UQ = unalloyed quality steel; UE = unalloyed special steel; LE = alloy special steel.

[2]) Where nitrogen is additionally fixed by niobium, titanium or vanadium, the minimum aluminium content specified does not apply.

[3]) The sum of the contents of chromium, copper and molybdenum shall not exceed 0,45 % by mass.

[4]) If the content of copper exceeds 0,30 % by mass, that of nickel shall be at least half that value, by mass.

Table 2: Permissible deviations in the results of the product analysis from specified values applicable to the cast analysis (see table 1)+)

Element	Content as determined by cast analysis, according to table 1 Percentage by mass	Limit deviations[1]) in the product analysis from the limiting values specified in table 1 for the cast analysis Percentage by mass		Element	Content as determined by cast analysis, according to table 1 Percentage by mass	Limit deviations[1]) in the product analysis from the limiting values specified in table 1 for the cast analysis Percentage by mass
C	≤ 0,20	+ 0,02		Cu	≤ 0,30 > 0,30 to ≤ 0,70	+ 0,05 + 0,07
Si	≤ 0,60	+ 0,05		Mo	≤ 0,10	+ 0,03
Mn	≤ 1,70	+ 0,10 − 0,05		N	≤ 0,025	+ 0,002
P	≤ 0,030	+ 0,005		Nb	≤ 0,05	+ 0,01
S	≤ 0,015 > 0,015 to ≤ 0,025	+ 0,003 + 0,005		Ni	≤ 0,80	+ 0,05
Al	≥ 0,020	− 0,005		Ti	≤ 0,03	+ 0,01
Cr	≤ 0,30	+ 0,05		V	≤ 0,20	+ 0,02

[1]) If several product analyses are carried out for one cast and if the values established for an individual element fall outside the permitted range, then the values shall either exceed the maximum permitted value or be lower than the minimum permitted value, but not both at the same time.

Table 3: ●● Maximum value of carbon equivalent
(subject to agreement, see 8.3.3 and the note to 8.4.1)

Material designation	Max. carbon equivalent[1]), *CEV*, for a nominal thickness, in mm		
	≤ 63	> 63 to ≤ 100	> 100 to ≤ 150
P275N P275NH P275NL1 P275NL2	0,40	0,40	0,42
P355N P355NH P355NL1 P355NL2	0,43	0,45	0,45
P460N[2]) P460NH[2]) P460NL1[2]) P460NL2[2])	-	-	-

[1]) Carbon equivalent:+)

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

[2]) ●● Subject to agreement, the following conditions may be substituted for a specific carbon equivalent:
V + Nb + Ti ≤ 0,22 %; Mo + Cr ≤ 0,30 %.

Table 4: Mechanical properties at ambient temperature

Material designation	Material number	Usual delivery condition *)	Yield strength, R_{eH} [1]), for a product thickness, in mm, of ≤16	>16 to ≤35	>35 to ≤50	>50 to ≤70	>70 to ≤100	>100 to ≤150	>150	Tensile strength, R_m, for a product thickness, in mm ≤70	>70 to ≤100	>100 to ≤150	>150	Elongation at fracture, A ($L_0 = 5{,}65 \cdot \sqrt{S_0}$), for a product thickness, in mm ≤70	>70 to ≤150	>150
			N/mm² min.							N/mm²				% min.		
P275N P275NH P275NL1 P275NL2	1.0486 1.0487 1.0488 1.1104	Normalized [2])	275	275	265	255	235	225	[3])	390 to 510	370 to 490	350 to 470	[3])	24	23	[3])
P355N P355NH P355NL1 P355NL2	1.0562 1.0565 1.0566 1.1106	Normalized [2])	355	355	345	325	315	295	[3])	490 to 630	470 to 610	450 to 590	[3])	22	21	[3])
P460N P460NH P460NL1 P460NL2	1.8905 1.8935 1.8915 1.8918	Normalized [4])	460	450	440	420	400	380	[3])	570 to 720 [5])	540 to 710	520 to 690	[3])	17	16	[3])

[1]) 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, the $R_{p0,2}$ values are 10 N/mm² for R_{eH} values up to 355 N/mm² and 15 N/mm² lower for R_{eH} values greater than 355 N/mm². +)

[2]) See 8.2.2.

[3]) ●● Subject to agreement.

[4]) See 8.2.1.

[5]) For thicknesses up to 16 mm, a maximum value of 730 N/mm² shall be permitted.

Table 5: Elevated temperature 0,2 % proof strength [1])

Material designation	Product thickness mm	0,2 % proof strength at a temperature, in °C, of 50	100	150	200	250	300	350	400
		N/mm² min.							
P275NH	≤ 35	264	245	226	196	177	147	127	108
	> 35 to ≤ 70	247	235	216					
	> 70 to ≤ 100	229	216	196	176	157	127	108	88
	> 100 to ≤ 150	214	196	176	157	137	108	88	69
P355NH	≤ 35	336	304	284	245	226	216	196	167
	> 35 to ≤ 70	313	294	275					
	> 70 to ≤ 100	300	275	255	235	216	196	177	147
	> 100 to ≤ 150	280	255	235	216	196	177	157	127
P460NH	≤ 35	–	402	373	333	314	294	265	235
	> 35 to ≤ 70	–	392	363					
	> 70 to ≤ 100	–	373	343	324	294	275	245	216
	> 100 to ≤ 150	–	353	324	304	275	255	226	196

[1]) The values given in this table have not been derived from the method given in ISO 2605-1.

Table 6: Minimum impact values (applicable to V-notch test pieces)

Series	Heat treatment condition	Product thickness	Minimum impact energy values, KV, in J[1]), determined on									
			longitudinal test pieces					transverse test pieces				
			at a test temperature, in °C, of									
		mm	− 50	− 40	− 20	0	+ 20	− 50	− 40	− 20	0	+ 20
P...N P...NH	Normalized[2])	5 to 150[3])	-	-	40	47	55	-	-	20	27	31
P...NL1			27	34	47	55	63	16	20	27	34	40
P...NL2			30	40	65	90	100	27	30	40	60	70

[1]) See EN 10028-1, 9.5.3.
[2]) See 8.2.1 and 8.2.2.
[3]) For product thicknesses up to 10 mm, see EN 10028-1.