

Flat products made of steels for pressure purposes —

Part 5: Weldable fine grain steels, thermomechanically rolled

The European Standard EN 10028-5:2003 has the status of a
British Standard

ICS 77.140.30; 77.140.50

National foreword

This British Standard is the official English language version of EN 10028-5:2003. It supersedes BS EN 10028-5:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/73/2, Steel plates and bars for pressure purposes, which has the responsibility to:

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EUROPEAN STANDARD

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English version

Flat products made of steels for pressure purposes - Part 5: Weldable fine grain steels, thermomechanically rolled

Produits plats en aciers pour appareils à pression - Partie
5: Aciers soudables à grains fins, laminés
thermomécaniquement

Flacherzeugnisse aus Druckbehälterstählen - Teil 5:
Schweißgeeignete Feinkornbaustähle, thermomechanisch
gewalzt

This European Standard was approved by CEN on 17 January 2003.

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Foreword

This document EN 10028-5:2003 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of an identical text or by endorsement, at the latest by December 2003, and conflicting national standards shall be withdrawn at the latest by December 2003.

This document supersedes EN 10028-5:1996.

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(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

This European Standard consists of the following parts, under the general title *Flat products made of steels for pressure purposes*:

- Part 1: General requirements
- Part 2: Non-alloy and alloy steels with specified elevated temperature properties
- Part 3: Weldable fine grain steels, normalized
- Part 4: Nickel alloy steels with specified low temperature properties
- Part 5: Weldable fine grain steels, thermomechanically rolled
- Part 6: Weldable fine grain steels, quenched and tempered
- Part 7: Stainless steels

NOTE The clauses marked by two points (••) contain information relating to agreements that may be made at the time of enquiry and order.

This document includes a Bibliography.

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, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the requirements for flat products for pressure equipments made of thermomechanically rolled steels as specified in Table 1.

The steels are not suitable for hot forming.

NOTE Until now no sufficient data for the standardization of the elevated temperature properties of these steels are available. If their use at such temperatures is intended the conditions for this should be specially agreed between the interested parties.

The requirements of EN 10028-1 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 (including amendments).

EN 10020, *Definition and classification of grades of steels*.

EN 10028-1:2000 + A1:2002, *Flat products made of steels for pressure purposes – Part 1: General requirements*.

EN 10204, *Metallic products – Types of inspection documents*.

3 Terms and definitions

For the purposes of this European Standard the terms and definitions given in EN 10028-1 apply.

4 Dimension and tolerances

See EN 10028-1.

5 Calculation of mass

See EN 10028-1.

6 Classification and designation

6.1 Classification

6.1.1 This standard covers the steel grades given in Table 1 in three qualities:

- a) the basic series (P...M)
- b) series with low temperature properties down to -40 °C (P...ML1);
- c) series with low temperature properties down to -50 °C (P...ML2).

6.1.2 In accordance with EN 10020 all the steels specified in this standard are alloy special steels.

6.2 Designation

See EN 10028-1.

7 Information to be supplied by the purchaser

7.1 Mandatory information

See EN 10028-1.

7.2 Options

Two options are specified in this standard and listed below. Additionally the relevant options of EN 10028-1 apply. If the purchaser does not indicate a wish 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 10028-1).

- a) maximum carbon equivalent (see 8.3.3);
- b) mid thickness test pieces for the impact test (see clause 10).

7.3 Example for ordering

10 plates with nominal dimensions, thickness = 50 mm, width = 2 000 mm, length = 10 000 mm, made of a steel grade with the name P355ML2 and the number 1.8833 as specified in EN 10028-5, inspection certificate 3.1B as specified in EN 10204:

10 plates – 50 x 2 000 x 10 000 – EN 10028-5 P355ML2 – Inspection certificate 3.1.B

or

10 plates – 50 x 2 000 x 10 000 – EN 10028-5 1.8833 - Inspection certificate 3.1.B

8 Requirements

8.1 Steelmaking process

See EN 10028-1.

8.2 Delivery condition

8.2.1 The products covered by this standard shall be supplied in the thermomechanically rolled condition.

8.2.2 The steels specified in this standard are suitable for welding processes in current use (see notes 1 to 3 to 8.2.3).

8.2.3 The manufacturer shall, if requested, provide the purchaser with data on suitable welding conditions determined on the basis of weld procedure tests.

NOTE 1 With increasing product thickness and strength level cold cracking can occur. Cold cracking is caused by the following factors in combination:

- the amount of diffusible hydrogen in the weld metal;
- brittle structure of the heat affected zone;
- tensile stress concentrations in the welded joint.

NOTE 2 When using recommendations as laid down, for example in EN 1011-1 and EN 1011-2, the recommended welding conditions and the various welding ranges of the steel grades can be determined depending on the product thickness, the applied welding energy, the design requirements, the electrode efficiency, the welding process and the weld metal properties.

NOTE 3 Excessive post weld heat-treatment (PWHT) conditions can decrease the mechanical properties. Where in stress relieving the intended time temperature parameter

$$P = T_s (20 + \lg t) \times 10^{-3}$$

where

T_s is the stress relieving temperature in K and

t is holding time in hours

is exceeding the critical value of $P_{crit.} = 17,3$ the purchaser should in his enquiry and order inform the manufacturer accordingly and, where appropriate, tests on simulated post weld heat treated samples can be agreed to check whether after such a treatment the properties specified in this standard can still be regarded as valid.

8.3 Chemical composition

8.3.1 The requirements of Table 1 apply for the chemical composition according to the cast analysis.

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

8.3.3 •• A maximum value for the carbon equivalent in accordance with Table 3 may be agreed upon at the time of enquiry and order.

8.4 Mechanical properties

The values given in Tables 4 and 5 (see also EN 10028-1 and clause 10) shall apply.

8.5 Surface condition

See EN 10028-1.

8.6 Internal soundness

See EN 10028-1.

For possible verification, see also EN 10028-1.

9 Inspection

9.1 Types of inspection and inspection documents

See EN 10028-1.

9.2 Tests to be carried out

See EN 10028-1.

9.3 Retests

See EN 10028-1.

10 Sampling

See EN 10028-1.

For the impact test, deviating from EN 10028-1:2000 + A1:2002, Figure 2, footnote f, the preparation of test pieces taken from the mid thickness may be agreed at the time of enquiry and order. In this case, test temperatures and minimum impact energy values shall also be agreed.

11 Test methods

See EN 10028-1.

12 Marking

See EN 10028-1.

EN 10028-5:2003 (E)

Table 1 — Chemical composition (cast analysis)^a

Steel grade		Content, % by mass												
name	number	C max.	Si max.	Mn max.	P max.	S max.	Al _{total} ^b min.	N max.	Mo ^d max.	Nb ^e max.	Ni max.	Ti ^e max.	V ^e max.	Other
P355M	1.8821	0,14	0,50	1,60	0,025	0,020	0,020 ^c	0,015	0,20	0,05	0,50	0,05	0,10	d
P355ML1	0,020				0,015									
P355ML2	0,025				0,020									
P420M	1.8824	0,16	0,50	1,70	0,025	0,020	0,020 ^c	0,020	0,20	0,05	0,50	0,05	0,10	d
P420ML1	0,020				0,015									
P420ML2	0,025				0,020									
P460M	1.8826	0,16	0,60	1,70	0,025	0,020	0,020 ^c	0,020	0,20	0,05	0,50	0,05	0,10	d
P460ML1	0,020				0,015									
P460ML2	0,025				0,020									

^a Elements not listed in this table shall not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate measures shall be taken to prevent the addition from scrap and other materials used in steelmaking of these elements which may adversely affect the mechanical properties and usability.

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

^c The minimum value for Al_{total} does not apply if adequate contents of other nitrogen-fixing elements are present.

^d (Cr + Cu + Mo) ≤ 0,60 %

^e The total of V + Nb + Ti shall not exceed a value of 0,15 %.

Table 2 — Permissible deviations of the chemical composition in the results of the product analysis from the specified values applicable to the cast analysis

Element	Specified value in the cast analysis according to Table 1 % by mass	Permissible deviation ^a of the product analysis % by mass
C	≤ 0,16	+ 0,02
Si	≤ 0,60	+ 0,06
Mn	≤ 1,70	+ 0,10
P	≤ 0,025	+ 0,005
S	≤ 0,015	+ 0,003
	>0,015 to ≤ 0,020	+ 0,005
Al	≥ 0,020	- 0,005
N	≤ 0,020	+ 0,002
Mo	≤ 0,20	+ 0,03
Nb	≤ 0,05	+ 0,01
Ni	≤ 0,50	+ 0,05
Ti	≤ 0,05	+ 0,01
V	≤ 0,10	+ 0,01
Cr+Cu+Mo	≤ 0,60	+ 0,10
V+Nb+Ti	≤ 0,15	+ 0,03
^a If several product analyses are carried out on one cast, and then contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis then it is only allowed to exceed the permissible maximum value or fall short of the permissible minimum value, but not both for one cast.		

**Table 3 — Maximum values for the carbon equivalent (CEV) based on cast analysis
(if agreed at the time of enquiry and order)^a**

Steel grade	CEV ^b max. for product thickness <i>t</i> in mm		
	$t \leq 16$	$16 < t \leq 40$	$40 < t \leq 63$
P355M/ML1/ML2	0,39	0,39	0,40
P420M/ML1/ML2	0,43	0,45	0,46
P460M/ML1/ML2	0,45	0,46	0,47
^a See 8.3.3. ^b $CEV = C + \frac{Mn}{6} + \frac{Cr}{5} + \frac{Mo}{5} + \frac{V}{15} + \frac{Cu}{15} + \frac{Ni}{15}$			

Table 4— Mechanical properties at room temperature

Steel grade		Yield strength ^a R_{eH} for product thickness t in mm		Tensile strength R_m	Elongation after fracture A
name	number	$t \leq 16$	$16 < t \leq 40$ $40 < t \leq 63$	MPa	% min.
P355M	1.8821	355	345	450 to 610	22
P355ML1	1.8832				
P355ML2	1.8833				
P420 M	1.8824	420	390	500 to 660	19
P420ML1	1.8835				
P420ML2	1.8828				
P460M	1.8826	460	430	530 to 720	17
P460ML1	1.8837				
P460ML2	1.8831				

^a The yield strength to be determined shall be the upper yield strength R_{eH} or, if this is not pronounced, the 0,2 % proof strength $R_{p0.2}$.

Table 5 — Minimum impact energy values (valid for transverse test pieces)

Steel grades	Product thickness mm	Impact energy <i>KV</i> J min. at a temperature in °C of				
		- 50	- 40	- 20	0	+ 20
P...M	5 ^a to 63	-		27	40	60
P...ML1		-	27	40	60	-
P...ML2		27	40	60	80	-
^a See EN 10028-1.						

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

Table ZA.1 – Correspondence between this European Standard and Directive 97/23/EC

Clause(s)/sub-clause(s) of EN 10028-5	Essential Requirements (ERs) of Directive 97/23/EC
All normative clauses	Annex 1, section 4

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

Bibliography

EN 1011-1, *Welding - Recommendations for welding of metallic materials – Part 1: General guidance for arc welding.*

EN 1011-2, *Welding - Recommendations for welding of metallic materials – Part 2: Arc welding of ferritic steels.*

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