

Flat products made of steels for pressure purposes

Part 5: Weldable fine grain steels,
thermomechanically rolled

ICS 77.140.30; 77.140.50

National foreword

This British Standard is the UK implementation of EN 10028-5:2009. It supersedes BS EN 10028-5:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/73/2, Steel plates and bars for pressure purposes.

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

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Produits plats en acier 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 14 May 2009.

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Foreword

This document (EN 10028-5:2009) 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of an identical text or by endorsement, at the latest by December 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

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

This document supersedes EN 10028-5:2003.

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 has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and 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 1 At the time of publication of this European Standard, no sufficient data for the standardization of the elevated temperature properties of these steels was 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 10028-1:2007 + A1:2009 also apply.

NOTE 2 Once this European Standard is published in the EU Official Journal (OJEU) under Directive 97/23/EC, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 97/23/EC is limited to technical data of materials in this European Standard (Part 1 and this Part 5 of the series) 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 97/23/EC are satisfied, needs to be done.

2 Normative references

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

EN 10028-1:2007 + A1:2009, *Flat products made of steels for pressure purposes – Part 1: General requirements*

EN 10204:2004, *Metallic products – Types of inspection documents*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10028-1:2007 + A1:2009 apply.

4 Dimension and tolerances

See EN 10028-1:2007 + A1:2009.

5 Calculation of mass

See EN 10028-1:2007 + A1:2009.

6 Classification and designation

6.1 Classification

6.1.1 This European 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 document are alloy special steels.

6.2 Designation

See EN 10028-1:2007 + A1:2009.

7 Information to be supplied by the purchaser

7.1 Mandatory information

See EN 10028-1:2007 + A1:2009.

7.2 Options

A number of options are specified in this document and listed below. Additionally the relevant options of EN 10028-1:2007 + A1:2009 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 10028-1:2007 + A1:2009).

- 1) providing data on suitable welding conditions (see 8.2.3) ;
- 2) maximum carbon equivalent (see 8.3.3);
- 3) specification of a minimum impact energy of 40 J (see Note to 8.4 and Table 5);
- 4) 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 3.1 as specified in EN 10204:

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

or

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

8 Requirements

8.1 Steelmaking process

See EN 10028-1:2007 + A1:2009.

8.2 Delivery condition

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

8.2.2 The steels specified in this European 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:

9.2 Tests to be carried out

See EN 10028-1:2007 + A1:2009.

9.3 Retests

See EN 10028-1:2007 + A1:2009.

10 Sampling

See EN 10028-1:2007 + A1:2009.

For the impact test, deviating from EN 10028-1:2007 + A1:2009, Table 3, 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 10028-1:2007 + A1:2009.

12 Marking

See EN 10028-1:2007 + A1:2009.

9.2 Tests to be carried out

See EN 10028-1:2007 + A1:2009.

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See EN 10028-1:2007 + A1:2009.

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See EN 10028-1:2007 + A1:2009.

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11 Test methods

See EN 10028-1:2007 + A1:2009.

12 Marking

See EN 10028-1:2007 + A1:2009.

Table 1 — Chemical composition (cast analysis)^a

Steel grade		Content, % by mass																									
Steel name	Steel number	C max.	Si max.	Mn ^b max.	P max.	S max.	Al _{total} ^c min.	N max.	Mo ^e max.	Nb ^f max.	Ni max.	Ti ^f max.	V ^f max.	Other													
P355M	1.8821	0,14	0,50	1,60	0,025	0,010	0,020 ^d	0,015	0,20	0,05 ^g	0,50	0,05	0,10	e													
P355ML1	1.8832				0,020	0,008																					
P355ML2	1.8833				0,020	0,005																					
P420M	1.8824	0,16	0,50	1,70	0,025	0,010		0,020							0,020	0,20	0,05 ^g	0,50	0,05	0,10	e						
P420ML1	1.8835				0,020	0,008																					
P420ML2	1.8828				0,020	0,005																					
P460M	1.8826	0,16	0,60	1,70	0,025	0,010		0,020							0,020							0,20	0,05 ^g	0,50	0,05	0,10	e
P460ML1	1.8837				0,020	0,005																					
P460ML2	1.8831				0,020	0,005																					

^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 For each reduction of 0,02 % below the maximum carbon content, an increase of 0,05 % Mn above the specified maximum value is permitted, up to a maximum of 2,00 % Mn.

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

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

^e (Cr + Cu + Mo) ≤ 0,60 %

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

^g If the carbon content is restricted to ≤ 0,07 %, a maximum niobium content of 0,10 % is permitted. In this case, special care shall be taken to avoid problems in the heat affected zone at operation temperatures of -40 °C and below or after PWHT.

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	≤ 2,00	+ 0,10
P	≤ 0,025	+ 0,005
S	≤ 0,010	+ 0,003
Al	≥ 0,020	- 0,005
N	≤ 0,020	+ 0,002
Mo	≤ 0,20	+ 0,03
Nb	≤ 0,10	+ 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		
	<i>t</i> ≤ 16	16 < <i>t</i> ≤ 40	40 < <i>t</i> ≤ 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 $CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$

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
Steel name	Steel number	$t \leq 16$	$16 < t \leq 40$	$40 < t \leq 63$	MPa	% min.
P355M	1.8821	355			450 to 610	22
P355ML1	1.8832					
P355ML2	1.8833					
P420 M	1.8824	420	400	390	500 to 660	19
P420ML1	1.8835					
P420ML2	1.8828					
P460M	1.8826	460	440	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 grade	Product thickness mm	Impact energy KV J min. at a temperature in °C of				
		-50	-40	-20	0	+20
P...M	≤ 63	–	–	27 ^a	40	60
P...ML1		–	27 ^a	40	60	–
P...ML2		27 ^a	40	60	80	–
^a ●● A minimum impact energy value of 40 J may be agreed at the time of enquiry and order.						

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

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

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

Clauses/sub-clauses of this European Standard	Essential Requirements (ERs) of Directive 97/23/EC, Annex I	Qualifying remarks/ Notes
8.4	4.1a	Appropriate material properties
8.2	4.1c	Ageing
8.2 and 8.6	4.1d	Suitable for the processing procedures
9.1	4.3	Documentation

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

Bibliography

- [1] EN 1011-1, *Welding - Recommendations for welding of metallic materials – Part 1: General guidance for arc welding*
- [2] EN 1011-2, *Welding - Recommendations for welding of metallic materials – Part 2: Arc welding of ferritic steels*
- [3] EN 10020, *Definition and classification of grades of steel*

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