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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Gas meters - Rotary displacement gas meters

Compteurs de gaz - Compteurs de gaz à déplacement
rotatif

Gaszähler - Drehkolbengaszähler

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 237.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CEN 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.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 12480:2023) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12480:2018.

prEN 12480:2023 includes the following significant technical changes with respect to EN 12480:2018:

- Clause 2 normative references updated;
- Clause 6 reworded;
- Annex ZB reworked.

The main goal of this revision was to be harmonized with 2014/32/EU (Measuring Instruments Directive) and 2014/68/EU Pressure Equipment Directive.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annexes ZA and ZB, which is an integral part of this document.

EN 12480:2018 was published and assessed by a HAS Consultant on PED and could not be cited in the OJEU.

1 Scope

This document specifies ranges, construction, performances, output characteristics and testing of rotary displacement gas meters (hereinafter referred to as RD meters or simply meters) for gas volume measurement.

This document applies to rotary displacement gas meters used to measure the volume of fuel gases of at least the 1st, 2nd and 3rd gas families, the composition of which is specified in EN 437:2021, at a maximum working pressure up to and including 20 bar over an ambient and gas temperature range of at least $-10\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

This document applies to meters that are installed in locations with vibration and shocks of low significance (class M1) and in

- closed locations (indoor or outdoor with protection as specified by the manufacturer) with condensing or with non-condensing humidity

or, if specified by the manufacturer,

- open locations (outdoor without any covering) with condensing humidity or with non-condensing humidity,

and in locations with electromagnetic disturbances (class E1 and E2). The standards apply to mechanical meters with mechanical index, electronic devices are not covered by this document.

Unless otherwise specified in this document:

- all pressures used are gauge;
- all influence quantities, except the one under test, are kept relatively constant at their reference value.

This document applies to meters with a maximum allowable pressure PS and the volume V of less than $6\,000\text{ bar} \cdot \text{L}$ or with a product of PS and DN of less than $3\,000\text{ bar}$.

This document can be used for both pattern approval and individual meter testing. Cross-reference tables are given in:

- Annex A for the tests that need to be undertaken for pattern approval;
- Annex B for individual meter testing.

Some parts of this document cover meters with mechanical index only.

The risk philosophy adopted in this document is based on the analysis of hazards including pressure. The document applies principles to eliminate or reduce hazards. Where these hazards cannot be eliminated appropriate protection measures are specified.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1092-1:2018, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1092-2:1997, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 1092-3:2003,¹ *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1092-4:2002, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 4: Aluminium alloy flanges*

EN 1759-1:2004, *Flanges and their joint — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 1: Steel flanges, NPS 1/2 to 24*

EN 1759-3:2003, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 3: Copper alloy flanges*

EN 1759-4:2003, *Flanges and their joint — Circular flanges for pipes, valves, fittings and accessories, class designated — Part 4: Aluminium alloy flanges*

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

EN 12516-2:2014+A1:2021, *Industrial valves — Shell design strength — Part 2: Calculation method for steel valve shells*

EN 12516-3:2003, *Valves — Shell design strength — Part 3: Experimental method*

EN 12516-4:2014+A1:2018, *Industrial valves — Shell design strength — Part 4: Calculation method for valve shells manufactured in metallic materials other than steel*

EN 60529:1992, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN IEC 60079-0:2018,² *Explosive atmospheres — Part 0: Equipment - General requirements (IEC 60079-0:2017)*

EN 60079-11:2012, *Explosive atmospheres — Equipment protection by intrinsic safety “i” (IEC 60079-11:2011)*

EN 60730-1:2000,³ *Automatic electrical controls for household and similar use — Part 1: General requirements (IEC 60730-1:1999)*

EN IEC 61000-6-1:2019, *Electromagnetic compatibility (EMC) — Part 6-1: Generic standards — Immunity standard for residential, commercial and light-industrial environments (IEC 61000-6-1:2016)*

EN IEC 61000-6-2:2019, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments (IEC 61000-6-2:2016)*

¹ As impacted by EN 1092-3:2003/AC:2007.

² As impacted by EN 60079-0:2018/AC:2020-02.

³ As impacted by EN 60730-1:2000/A1:2019 and EN 60730-1:2000/A2:2022.

EN IEC 61000-6-3:2021, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for equipment in residential environments (IEC 61000-6-3:2020)*

EN IEC 61000-6-4:2019, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:2018)*

EN 61000-6-5:2016, *Electromagnetic compatibility (EMC) — Part 6-5: Generic standards — Immunity for equipment used in power station and substation environment*

EN 61000-6-7:2015, *Electromagnetic compatibility (EMC) — Part 6-7: Generic standards — Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

EN IEC 61000-6-8:2020, *Electromagnetic compatibility (EMC) — Part 6-8: Generic standards — Emission standard for professional equipment in commercial and light industrial locations (IEC 61000-6-8:2020)*

EN ISO 1518-2:2011, *Paints and varnishes — Determination of scratch resistance — Part 2: Variable-loading method (ISO 1518-2:2011)*

EN ISO 2409:2020, *Paints and varnishes— Cross-cut test (ISO 2409:2020)*

EN ISO 6270-2:2018, *Paints and varnishes — Determination of resistance to humidity — Part 2: Procedure for exposing test specimens in condensation-water atmospheres (ISO 6270-2:2018)*

EN ISO 9606-1:2017, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012 & Cor 2:2013)*

EN ISO 9606-2:2004, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 9712:2022, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2022)*

EN ISO 14732:2013, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

EN ISO 15607:2019, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2019)*

EN ISO 15609-1:2019, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2019)*

EN ISO 15614-1:2017, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2017)*

EN ISO 15614-2:2005,⁴ *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)*

⁴ As impacted by EN ISO 15614-2:2005/AC:2009.

ISO 834-1:1999+A2:2021, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 7005-1:2011, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges*

ISO 14782:2021, *Plastics — Determination of haze for transparent materials*

ISO 17663:2009, *Welding — Quality requirements for heat treatment in connection with welding and allied processes*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

accuracy class 1,0

accuracy achieved by a meter, which has an error of indication between -2% and $+2\%$ for flow rates Q , where $Q_{\min} \leq Q < Q_t$ and an error of indication between -1% and $+1\%$ for flow rates Q , where $Q_t \leq Q \leq Q_{\max}$

3.1.2

cyclic volume

volume of the gas measured by one complete revolution of the element(s)

3.1.3

density of gas

mass of gas divided by the volume

3.1.4

allowable design temperature range

range of gas temperatures (minimum to maximum) for which the meter is designed as declared and marked on the meter

3.1.5

diameter

DN

nominal size of diameter

3.1.6

error of indication

value which shows the relationship in percentage terms of the difference between the volume indicated by the meter and the volume which has actually flowed through the meter, to the latter value:

$$E = \frac{V_i - V_c}{V_c} \cdot 100$$

where

V_i is the indicated volume and V_c is the volume which has actually flowed through the meter

3.1.7

maximum allowable pressure

PS

maximum pressure for which the meter is designed as specified by the manufacturer

3.1.8

minimum flow rate

lowest flow rate at which the gas meter provides indications that satisfy the requirements regarding maximum permissible error (MPE)

3.1.9

maximum flow rate

highest flow rate at which the gas meter provides indications that satisfy the requirements regarding maximum permissible error (MPE)

3.1.10

meter family

group of meters of different sizes but with similar construction (see Annex H)

Note 1 to entry: By specifying a meter family it is possible to reduce the number of tests and documents during assessment.

3.1.11

metering condition

condition of the gas prevailing at the point of measurement

3.1.12

metering pressure

absolute pressure at which the volume of the gas is measured

3.1.13

normal conditions of use

conditions referring to the meter operating:

- within the range of working pressure;
- within the operational temperature and gas temperature range;
- with the distributed gas

3.1.14

operating pressure range

limits of working pressure, as declared by the manufacturer, for which the meter will continue to operate within its metrological characteristics

3.1.15**operating temperature range**

range of gas and ambient temperatures for which the meter satisfies the metrological requirements of this document

3.1.16**overload flow rate**

Q_r

highest flow rate at which the meter operates for a short period of time without deteriorating

3.1.17**pressure loss**

non-recoverable pressure drop caused by the presence of the meter in the pipeline

3.1.18**rotary displacement meter**

gas volume meter in which a rigid measuring compartment is formed between the walls of a stationary chamber and rotating element or elements

Note 1 to entry: Each rotation of the element(s) displaces a fixed volume of gas which is cumulatively registered and indicated by an indicating device. It is designed to measure, memorize and display the volume of a fuel gas that has passed through it.

3.1.19**storage temperature range**

range of temperatures at which the meter can be stored without being adversely affected

3.1.20**transitional flow rate**

flow rate occurring between the maximum and minimum flow rates at which the flow rate range is divided into two zones, the upper zone and the lower zone, each zone having a characteristic MPE

3.1.21**volume of meter**

internal volume of meter excluding the volume of internal parts

3.1.22**working pressure**

pressure of the gas at the inlet of the meter

3.1.23**limit pressure**

pressure at which yielding becomes apparent in any component of the meter or its fixtures

3.1.24**safety factor body**

ratio of the limit pressure p_l to the maximum allowable pressure P_S applied to the meter body

3.1.25**safety factor others**

ratio of the limit pressure p_l to the maximum allowable pressure P_S applied to other pressure containing parts of the meter

3.2 Symbols and abbreviations

For the purposes of this document, the symbols and subscripts given in Table 1 apply.

Table 1 — Symbols

Symbol	Represented quantity	Unit
V_{cyc}	Cyclic volume	dm^3
ρ	Density of gas	$kg \cdot m^{-3}$
TS	Allowable design temperature range	$^{\circ}C$
DN	Diameter	Dimensionless
E	Error of indication	%
MPE	Maximum permissible error	%
WME	Weighted mean error	%
PS	Maximum allowable pressure	Pa, bar
Q	Flow rate	m^3/h
p_m	Metering pressure	Pa, bar
p	Operating pressure range	Pa, bar
t	Operating temperature range	$^{\circ}C$
Q_r	Overload flow rate	m^3/h
ts	Storage temperature range	$^{\circ}C$
Q_t	Transitional flow rate	m^3/h
V	Volume of meter in litres	L
pl	Limit pressure	bar
S_b	Safety factor body	Dimensionless
S	Safety factor others	Dimensionless
tr	Revolution	Dimensionless
Subscripts		
m	Metering conditions of the gas	
min	Minimum	
max	Maximum	
i	Indicated	
t	Transitional	

4 Operating range

4.1 General

Gas meters shall be classified according to accuracy class 1,0. The values of maximum flow rates and the corresponding values of the upper limits of the minimum flow rates shall be one of those given in 4.2, when the meter is tested with air of density approximately $1,2 \text{ kg/m}^3$.

4.2 Flow rate range

Unless covered in the EU type examination certificate, the values of the maximum and minimum flow rates of rotary displacement gas meters shall be decimal multiples and sub-multiples of these values, with $Q_{\max} \geq 20 Q_{\min}$. For example for one decade:

$Q_{\max} (\text{m}^3/\text{h})$: 100, 160, 250, 400, 650

$Q_{\min} (\text{m}^3/\text{h})$: 10, 13, 16, 20, 25, 32, 40, 50, 65, 80

4.3 Operating pressure range

The upper limit of the operating pressure range shall not exceed the maximum allowable pressure PS. The operating pressure range stated by manufacturer shall be marked on the meter.

4.4 Operating temperature range

All meters shall be capable of meeting the requirements in 5.6 for the following: gas; ambient; storage; design temperature ranges:

- a minimum ambient temperature range of $-10 \text{ }^{\circ}\text{C}$ to $40 \text{ }^{\circ}\text{C}$;
If a wider ambient temperature range is required, then these values shall be chosen using a maximum temperature of $40 \text{ }^{\circ}\text{C}$, $55 \text{ }^{\circ}\text{C}$, or $70 \text{ }^{\circ}\text{C}$ and a lower temperature limit of $-10 \text{ }^{\circ}\text{C}$, $-25 \text{ }^{\circ}\text{C}$, or $-40 \text{ }^{\circ}\text{C}$;
- a minimum gas temperature range of 40 K (the gas temperature range shall be within the ambient temperature range);
- a minimum storage temperature range of $-20 \text{ }^{\circ}\text{C}$ to $60 \text{ }^{\circ}\text{C}$ (see 5.6) (the storage temperature range may be wider than or equal to the ambient temperature range).

The operating temperature range shall be inside the limits of the allowable design temperature range. The operating temperature range stated by manufacturer shall be marked on the meter.

5 Metrological performance

5.1 General

The uncertainty of the test rig (best measurement capability) shall be at a maximum of $1/5$ of the MPE for the initial pattern approval test and at a maximum of $1/3$ of the MPE for the individual meter testing.

Meters family shall be applied according to Annex H.

5.2 Error of indication

5.2.1 Requirements

When tested in accordance with 5.2.2, the meter error of indication shall be within the limits specified in Table 2.

Table 2 — Limits of maximum permissible errors

Flow rate Q m^3/h	Maximum permissible errors
$Q_{\min} \leq Q < Q_t$	$\pm 2 \%$
$Q_t \leq Q \leq Q_{\max}$	$\pm 1 \%$

Transitional flow rate values, Q_t , shall be taken from Table 3.

Table 3 — Transitional flow rate values

$Q_{\max} / Q_{\min}$	Q_t
$20 \leq Q_{\max} / Q_{\min} \leq 30$	$0,20 Q_{\max}$
$Q_{\max} / Q_{\min} > 30$	$\leq 0,10 Q_{\max}$

Each meter shall be adjusted so that the weighted mean error (*WME*) is as close to zero as the adjustment and the maximum permissible errors allow, without systematically favouring any party.

The *WME* shall have a value between $-0,4 \%$ and $+0,4 \%$.

The *WME* is calculated as follows:

$$WME = \frac{\sum(Q_i / Q_{\max}) \cdot E_i}{\sum(Q_i / Q_{\max})}$$

where

$Q_i / Q_{\max}$ is a weighting factor;

E_i is the error of indication at the flow rate Q_i given as a percentage.

When $Q_i = Q_{\max}$, a weighting factor of 0,4 instead of 1 shall be used.

5.2.2 Test

The test is carried out using air (density $1,2 \text{ kg m}^{-3}$), or gas specified in the scope, at normal ambient conditions. The meter is tested at the following flow rates ($\pm 10 \%$):

a) pattern approval:

1) For meters with flow rate range between 1:20 to 1:30:

$Q_{\min}$; $0,05 Q_{\max}$ (when this value is larger than $Q_{\min}$); $0,1 Q_{\max}$; $0,2 Q_{\max}$; $0,4 Q_{\max}$; $0,7 Q_{\max}$; $Q_{\max}$

2) for meters with a flow rate range $\geq 1:50$:

$Q_{\min}$; $0,05 Q_{\max}$; $0,10 Q_{\max}$; $0,25 Q_{\max}$; $0,40 Q_{\max}$; $0,70 Q_{\max}$; $Q_{\max}$

- b) individual factory testing for error of indication (every meter shall be tested) at the flow rates indicated in Table 4.

When requested by the customer, the error of indication test can be carried out at specified conditions (close to the expected operational conditions).

If the test point is equal to Q_t , the tighter limit of the error of indication has to be applied.

Table 4 — Test points for individual meter testing

$Q_{\max} / Q_{\min}$	$Q_{\min}$	$0,015 Q_{\max}$	$0,1 Q_{\max}$	$0,2 Q_{\max}$	$Q_{\max}$
$20 \leq Q_{\max} / Q_{\min} \leq 30$	X			X	X
$30 < Q_{\max} / Q_{\min} < 160$	X		X	X	X
$Q_{\max} / Q_{\min} \geq 160$	X	X	X	X	X

5.3 Pressure loss

5.3.1 Requirements

When tested in accordance with 5.3.2, the maximum pressure loss at $Q_{\max}$, when using air with density $1,2 \text{ kg} \cdot \text{m}^{-3}$, shall be declared by the manufacturer.

5.3.2 Test

The pressure loss shall be measured between a point 1 DN upstream and a point 1 DN downstream of the meter, on piping of the same DN as the meter.

Care shall be taken on selection and manufacturing of the pressure tapings to ensure that flow pattern distortions do not affect the pressure readings.

5.4 Metrological repeatability

5.4.1 Requirements

When tested in accordance with 5.4.2, in the flow range $Q_{\min} - Q_{\max}$ the variation of error of indication at each flow rate shall stay within the range:

$Q_{\min} \leq Q < Q_t$: $1/3 \text{ MPE}$;

$Q_t \leq Q \leq Q_{\max}$: $1/5 \text{ MPE}$.

5.4.2 Test

The error of indication of the meter shall be determined at $Q_{\min}$, the flow shall then be increased to at least Q_t and then returned to $Q_{\min}$ and the error of indication determined.

This process shall be repeated and the error of indication at $Q_{\min}$ determined again.

Check that the three successive errors of indication at $Q_{\min}$ are within the MPE given in 5.4.1.

This test may be combined with the test described below for determining the repeatability from Q_t to $Q_{\max}$.

The error of indication of the meter is determined at two flow rates in the following order: Q_t , $Q_{\max}$, where the change from Q_t to $Q_{\max}$ is done via $1,10 Q_{\max}$, in order to approach $Q_{\max}$ from a higher flow rate.

The cycle is repeated six times. The test shall be carried out with air, or gas, at atmospheric conditions (± 100 mbar).

Check that the six resulting errors of indication at each flow rate are within a span of 0,2 %, excluding any interaction between the meter and the test bench.

5.5 Operating pressure

5.5.1 General

The manufacturer shall declare the maximum operating pressure for which the meter can be used without additional high-pressure calibration. Above this declared pressure, additional high pressure calibration shall be undertaken.

5.5.2 Requirements

- a) For pattern approval, when tested in accordance with 5.5.3 a), the meter shall comply with 5.2.1.
- b) Using the same meter as in a) above, when tested in accordance with 5.5.3 b), at the manufacturer's declared maximum operating pressure it shall be confirmed that the meter complies with 5.2.1.
- c) For individual test, when tested in accordance with 5.5.4, the manufacturer's declared maximum operating pressure shall be confirmed.

5.5.3 Pattern approval test

- a) One meter of each meter family is tested following 5.2.2 a).
- b) Test the meter at 10 different flow rates equally distributed between Q_t and $Q_{\max}$ at the declared maximum operating pressure.

5.5.4 Individual test

No additional test is required when the meter is used within the declared maximum operating pressure.

Above this declared maximum operating pressure, an error of indication test is carried out at the specified conditions (close to the operational conditions).

When requested by the customer, the error of indication test can be carried out at specified conditions (close to the operational conditions) even where the pressure is inside of the pressure range for this meter type.

5.6 Temperature ranges

5.6.1 General

5.6.1.1 Requirement

A meter of a meter family with the highest expected temperature dependency shall be tested in accordance with 5.6.1.2, the measured errors of indications shall be within the MPE given in 5.2.1.

For all test flow rates above Q_t , the variations in the measured errors of indication at the different temperatures shall be calculated. These differences shall not vary by more than 0,2 % at each flow rate.

If during the examination flow points are excluded (at 0,7 $Q_{\max}$ and/or $Q_{\max}$), the following procedure is applied for the examination of those excluded flow points:

For the examined flow points the maximum difference is determined (see above). A check is made whether the accuracy measurements at the excluded flow points (0,7 $Q_{\max}$ and/or $Q_{\max}$) at normal ambient temperature plus the absolute value of the maximum difference remains within the MPE.

5.6.1.2 Test

Test the meter at the upper specified gas temperature and at the lower specified gas temperature ensuring that the temperatures do not differ by more than 2 °K from the specified temperatures. Determine the error of indication at both temperatures for the flow rates which are specified in 5.2.2 a).

5.6.2 Minimum operational temperature

5.6.2.1 Requirement

When tested in accordance with 5.6.2.2, the meter shall start to rotate at a flow rate not exceeding $Q_{\min}$, and continue to rotate for not less than one complete revolution with a pressure loss not exceeding 0,1 mbar.

5.6.2.2 Test

- Cool the meter down to minimum operational temperature, until stabilized;
- start the meter at a flow rate not exceeding $Q_{\min}$ with air (or equivalent medium) at ambient temperature.

5.6.3 Maximum operational temperature

5.6.3.1 Requirement

When tested in accordance with 5.6.3.2, the meter shall start to rotate at a flow rate not exceeding $Q_{\min}$, and continue to rotate for not less of one complete revolution with a pressure loss not exceeding 0,1 mbar.

5.6.3.2 Test

- Heat the meter at maximum operational temperature, until stabilized;
- start the meter at a flow rate not exceeding $Q_{\min}$ with air (or equivalent medium) at ambient temperature.

5.6.4 Storage temperature range

5.6.4.1 Requirement

When tested in accordance with 5.6.4.2 a), the error of indication shall be within the maximum permissible error and the meter shall not display a shift in excess of 0,4 % and not show signs of deterioration.

When tested in accordance with 5.6.4.2 b), the error of indication shall be within the maximum permissible error and the meter shall not show signs of deterioration.

5.6.4.2 Test

- a)
- Cool the meter to the minimum storage temperature, until stabilized;
 - take the meter back to ambient temperature, until stabilized;
 - perform again the error of indication test as indicated in 5.2.2 a) and carry out a visual inspection.
- b)
- Heat the meter to the maximum storage temperature, until stabilized;
 - take the meter back to ambient temperature, until stabilized;
 - perform again the error of indication test as indicated in 5.2.2 a) and carry out a visual inspection.

5.7 Condensing ambient conditions

5.7.1 Requirements

After testing in accordance with 5.7.2, the error of indication shall remain within the initial maximum permissible error limits specified in Table 2 and the index and markings shall remain legible.

5.7.2 Test

Test one meter for error of indication in accordance with 5.2.2 a) and then test in accordance with EN ISO 6270-2:2018 for a duration of 340 hours. Re-test the meter for error of indication in accordance with 5.2.2 a) and visually inspect for legibility of the index and the markings.

5.8 Bidirectional meters

5.8.1 Requirements

When tested in accordance with 5.8.2, meters designed for both flow directions shall conform to the metrological performances described in 5.2.1 for both directions.

5.8.2 Test

The test meter is tested following 5.2.2 a), adjusted following 5.2.1. The meter is turned in the opposite flow direction and tested again following 5.2.2 a).

5.9 Influence of oil filling

5.9.1 Requirements

Where the meter is designed for operating with oil filling, after testing in accordance with 5.9.2 the influence of oil filling is lower than $1/3$ of MPE. For meters meeting this requirement, the individual meter calibration, 5.2.2 b), shall be performed without oil filling.

5.9.2 Tests

At least one meter from each meter family shall be tested for error of indication in accordance with 5.2.2 a) with oil filling. The same meter shall be tested with the oil drained: Check that the MPE differences between the two tests doesn't exceed $1/3$ of the MPE for each tested flow rate.

6 Design and manufacturing

6.1 General

A gas meter shall be designed, manufactured and checked to ensure it meets the requirements of this standard. The manufacturer shall provide instructions, covering installation, commissioning and maintenance to ensure its safety and correct functionality in service under all reasonably foreseeable conditions.

A gas meter shall be tested according to Annex A as far as pattern testing is concerned and according to Annex B as far as testing of each individual meter is concerned.

Manufacturers shall comply with Annex D.

Materials for the pressurized parts of the meter shall not be significantly affected by ageing during the expected life of the meter and be suitable for its intended purpose.

The design shall take in account the following:

- operating pressure range;
- operating temperature range;
- protection against corrosion;
- penetration resistance;
- reaction forces on bodies and flanges.

The gas meter shall be constructed in such a way that any mechanical interference, capable of affecting the meter error of indication, results in permanently visible damage to the meter, or its sealing or protection marks.

For use in open location, the meters shall fulfil the specification in Annex G.

A sealing drawing is part of the documentation for type pattern approval. It shall include the metrological sealing as well as the sealing of all metrological relevant removable accessories.

6.2 Material

6.2.1 General

The meter body and the internal mechanism shall be manufactured of materials suitable for the service conditions, and resistant to attack from the fluids which may pass through the meter.

Exterior surfaces of the meter shall be protected, if necessary, against corrosion.

The meter body and all other parts shall be constructed of sound materials designed to handle the pressure and temperatures for which they are rated.

6.2.2 Design method

The gas meter shall be designed for adequate strength based on a calculation method according to EN 12516-2:2014+A1:2021 (steel) or EN 12516-4:2014+A1:2018 (non-steel), supplemented by an experimental design method, or an experimental design method without calculation according to EN 12516-3:2002.

6.2.3 Resistance to external corrosion

All parts of the meter shall be able to resist any corrosive substances contained in the external atmosphere with which they may be in contact during normal conditions of use.

Where necessary, meters shall be provided with a suitable coating to protect against corrosion. Any such protective coating shall meet the requirements of 6.2.4 and 6.2.5.

6.2.4 Penetration resistance

6.2.4.1 Requirements

When tested in accordance with 6.2.4.2, the base material shall not be exposed.

6.2.4.2 Test

The penetration resistance of the protective coating shall be assessed as described in EN ISO 1518-2:2011, 5.1.

The following parameters apply:

- a loading of 29,4 N;
- a speed of $30 \text{ mm} \cdot \text{s}^{-1}$ to $40 \text{ mm} \cdot \text{s}^{-1}$;
- penetration specified to the substrate.

An alternative apparatus to that given in EN ISO 1518-2:2011, 5.1 is shown in Figure 1.

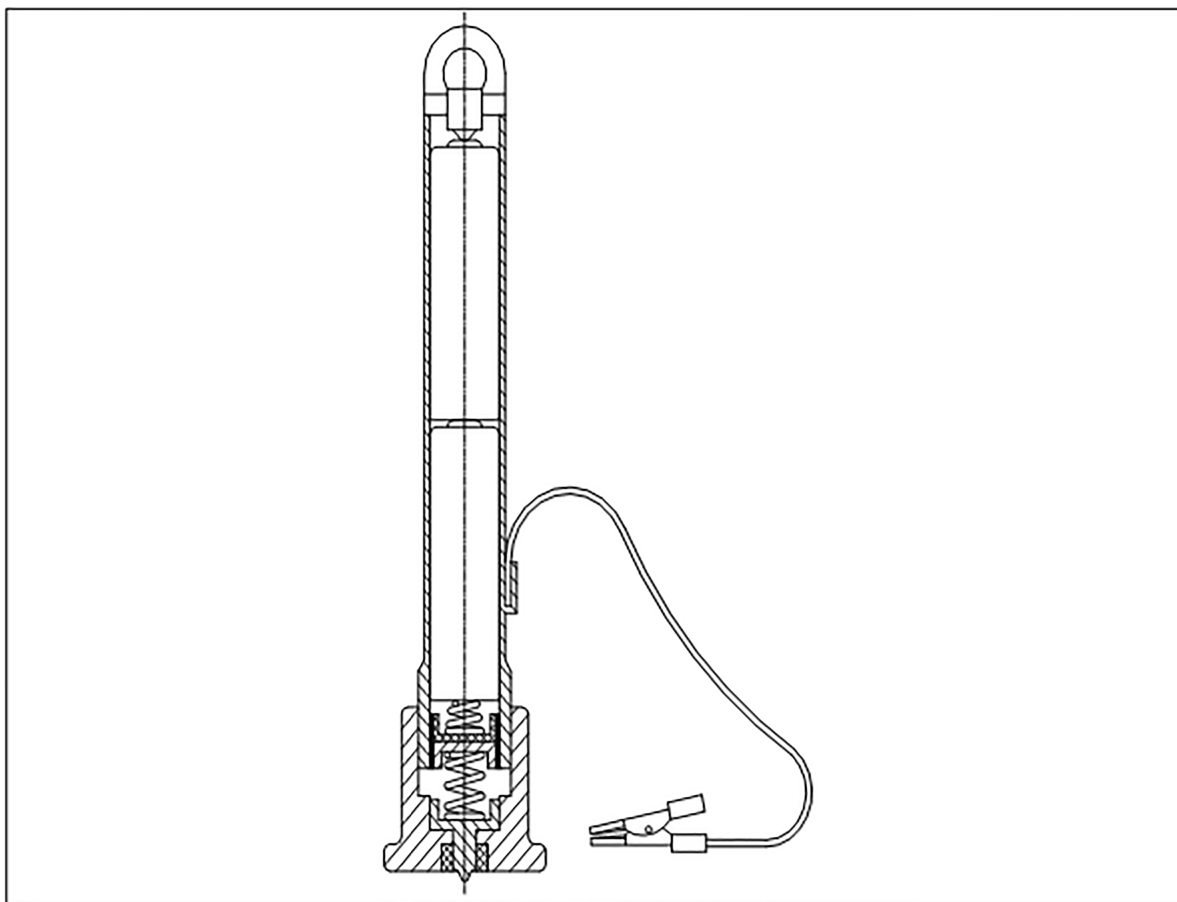


Figure 1 — Alternative to the penetration resistance test apparatus

6.2.5 Adhesion of the protective coating

6.2.5.1 Requirements

When tested in accordance with 6.2.5.2, there shall be no detachment of any complete protective coated square.

6.2.5.2 Test

The protective coated surface of the meter or representative sample shall be tested in accordance with EN ISO 2409:2020.

6.2.6 Materials for pressurized parts

6.2.6.1 General

Pressure containing parts shall be constructed with materials suitable for the scheduled lifetime of the meter unless replacement is foreseen. Such materials shall be verified according to the following requirements:

- materials shall be covered by a European approval of pressure equipment materials; **or**
- materials shall be subject of a particular material appraisal.

Materials may comply with harmonized standards (see Table F.1).

In all cases, the safety factors in Table 5 shall be met.

For a steel to be considered sufficiently ductile, when tested in a tensile test using a standard procedure the elongation after rupture shall be no less than 14 % and its bending rupture energy shall be no less than 27 J when measured on an ISO V test-piece. The test shall be undertaken at a temperature not exceeding the lowest scheduled operating temperature, but with a maximum temperature of 20 °C. For other than steel materials, refer to relevant standards or construction codes. Materials used in similar applications under similar operating conditions, which have been recognized as being safe to use before 29 November 1999 are also regarded as suitable. The safety of gas meters using such materials shall be verified in combination with the design assessment. Pressurized parts shall be designed for loadings appropriate to their intended use and other reasonable foreseen operating conditions.

Pressurized parts shall meet the requirements of 6.2.6.3.1.

NOTE For a list of materials used for the construction of pressure equipment and recognized as being safe to use before 29 November 1999, see Table F.2.

6.2.6.2 Non-destructive testing (NDT)

Meter bodies which are to be non-destructively tested shall be in accordance with Annex E.

6.2.6.3 Strength of housings

6.2.6.3.1 Body

The limit pressure p_l and maximum allowable pressure PS shall be as follows:

$$p_l \geq S_b \cdot PS$$

The design shall also take in account the possible stress during transportation and handling (minimum thickness and geometry...).

6.2.6.3.2 Flanges

The maximum allowable operating pressure for flanges in accordance with the relevant parts of ISO 7005-1:2011 and ISO 7005-2:1988 shall not be less than maximum allowable pressure PS . Flanges shall be in accordance with following appropriate standards: EN 1092-1:2018; EN 1092-2:1997; EN 1092-3:2003; EN 1092-4:2002; EN 1759-1:2004; EN 1759-3:2003; EN 1759-4:2003.

6.2.6.3.3 Other pressure containing parts for rotary piston meters

Those parts subjected to pressure under normal operating conditions, or those that become pressure containing parts in the event of a failure, shall have a limit pressure p_l and a maximum allowable pressure PS , complying with the following requirement: $p_l \geq S \cdot PS$.

6.2.6.3.4 Minimum values of safety factor

The values listed in Table 5 shall be used to limit the stresses in the walls of pressure containing parts at the maximum allowable pressure.