

Gas meters — Turbine gas meters

This European Standard EN 12261:2002, with the incorporation of Amendment A1:2006 has the status of a British Standard

ICS 17.120.10

National foreword

This British Standard is the official English language version of EN 12261:2002, including Corrigendum September 2003 and Amendment A1:2006. It together with BS EN 12480:2002, supersedes BS 4161-6:1987 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN Amendment 1:2006 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GSE/25, Gas meters, which has the responsibility to:

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- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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English version

Gas meters - Turbine gas meters

Compteurs de gaz - Compteurs de gaz à turbine

Gaszähler - Turbinenradgaszähler

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Foreword to Amendment A1

This document (EN 12261:2002/A1:2006) has been prepared by Technical Committee CEN/TC 237 "Gas meters", the secretariat of which is held by BSI.

This Amendment to the European Standard EN 12261:2002 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

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 2004/22, Measuring Instruments Directive (MID).

For relationship with EU Directive, 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, 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 United Kingdom.

1 Scope

A1 This European Standard specifies the measuring conditions, requirements and tests for the construction, performance and safety of class 1,0 axial and radial turbine gas meters with mechanical indicating devices, herein after referred to as a meter(s), having in-line pipe connections for gas flow measurement.

This European Standard applies to turbine gas meters used to measure the volume of fuel gases of the 1st and 2nd gas families, the composition of which is specified in EN 437, at maximum working pressures up to 420 bar, actual flow rates up to 25 000 m³/h over a gas temperature range of at least 40 K and for a climatic environmental temperature range of at least 50 K.

This standard applies to meters that are installed in locations with vibration and shocks of low significance 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.

Unless otherwise specified in this standard:

- all pressures used are gauge;
- all influence quantities, except the one under test, are kept relatively constant at their reference value. $\sqrt{A_1}$

2 Normative references

This European Standard incorporates by dated or undated references 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 437, *Test gases — Test pressures — Appliance categories*

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

EN 50014, *Electrical apparatus for potentially explosive atmospheres — General requirements*

EN 50020, *Electrical apparatus for potentially explosive atmospheres — Intrinsic safety "I"*

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

EN 60947-5-6, *Low-voltage switchgear and controlgear — Part 5-6: Control circuit devices and switching elements — DC interface for proximity sensors and switching amplifier (NAMUR) (IEC 60947-5-6:1999)*

EN ISO 5167-1:1995, *Measurement of fluid flow by means of pressure differential devices — Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full (ISO 5167-1:1991)*

EN ISO 9001, *Quality management systems — Requirements (ISO 9001:2000)*

ISO 3, *Preferred numbers — Series of preferred numbers*

ISO 2768-1:1989, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO *guide to the expression of uncertainty in measurement*

EN 119000, *Generic specification — Dry and mercury wetted reed contact units*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply

3.1.1

turbine gas meter

measuring device in which the dynamic forces of the flowing gas cause a turbine wheel to rotate with a speed as a function of the volume flow rate. The number of revolutions of the turbine wheel is the basis for the indication of the volume passed through the meter

A1 It is designed to measure, memorize and display the volume of a fuel gas that has passed through it **A1**

3.1.2

measured quantity

volume in cubic metres, at metering conditions

3.1.3

volume flow rate

volume at metering conditions divided by time

3.1.4

rangeability

the ratio between Q_{mi} and Q_{max} , i.e. the minimum and maximum flow rate respectively for which the meter performs within the maximum permissible errors

3.1.5

average velocity

volume flow rate divided by the cross-sectional area of the meter connections

3.1.6

casing

pressure containing structure of the meter

3.1.7 pressures and temperatures

3.1.7.1

metering pressure (p_m)

absolute gas pressure to which the indicated volume of gas is related

3.1.7.2

operating pressure

gas pressure within the piping containing the meter

3.1.7.3

working pressure range

allowable pressure range over which the meter is calibrated and performs within the metrological requirements

3.1.7.4

A1 operating temperature range A1

range of metering temperatures over which the meter operates within the metrological requirements

3.1.7.5

maximum design pressure (p_{max})

pressure on which design calculations are based

3.1.8 designation

3.1.8.1

DN-designation

numerical designation of size for components of a pipework system, which is used for reference purposes. It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

3.1.8.2

PN-designation

alphanumeric term used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system with regard to pressure. It comprises the letters PN followed by a dimensionless whole number

3.1.9

metering conditions

conditions of the gas prevailing at the point of the measurement (e.g.: temperature and pressure of the measured gas in the meter)

3.1.10

Reynolds number (*Re*)

number referring to the flow conditions:

$$Re = 0,3537 \times \frac{Q}{D \times v}$$

where the value of *D* is given by the internal pipe diameter. The parameters (variables) in the above equation and their units are defined in Table 1

3.1.11

error of indication

indication of a turbine meter minus the reference value of the measurand

Errors (*E*) are expressed as relative values (as a percentage) by the ratio of the difference between the indicated volume (*V_i*) and a reference volume (*V_c*) of the gas which has passed through the gas meter to this latter value:

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

3.1.12

pressure loss

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

3.1.13

pulse value

number of pulses per cubic metre indicated

3.1.14 gas families

3.1.14.1

1st family

a gas having a Wobbe index between:

23,8 MJ · m⁻³ and 31,4 MJ · m⁻³

according to EN 437 related on gross calorific value

3.1.14.2**2nd family**

a gas having a Wobbe index between:

41,3 MJ · m⁻³ and 57,9 MJ · m⁻³

according to EN 437 related on gross calorific value

A1 3.1.15 class 1,0 meter

meter which has an error of indication between -2% and + 2% for flow rates Q where $Q_{\min} \leq Q < Q_t$, -1% and +1 % for flow rates Q where $Q_t \leq Q \leq Q_{\max}$ and when the errors between Q_t and $Q_{\max}$ all have the same sign, they do all not exceed 0,5 %

3.1.16 $Q_{\min}$

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

3.1.17 $Q_{\max}$

highest flowrate at which the gas meter provides indications that satisfy the requirements regarding MPE

3.1.18 Q_t

transitional flowrate, the flowrate occurring between the maximum and minimum flowrates at which the flowrate range is divided into two zones, the 'upper zone' and the 'lower zone'. Each zone has a characteristic MPE

3.1.19 Q_r

overload flowrate, the highest flowrate at which the meter operates for a short period of time without deteriorating A1

3.2 Symbols

The symbols and subscripts used hereafter in this European Standard are specified in Table 1.

Table 1 — Symbols

Symbols	Represented quantity	Unit
c	Pressure loss coefficient depending on meter type	mm^{-4}
d	Relative density of the gas (air = 1)	-
D	Inside diameter meter outlet/inlet	mm
D_1	Inside diameter pipe	mm
E	Error	%
F	Force (bending moment)	N
F'	Force (torsional moment)	N
I	Current	A
L	Length of the lever arm (bending moment)	mm
L'	Length of the lever arm (torsional moment)	mm
M	Torque	N·m
p	Pressure	Pa, bar
Q	Volume flow rate	m^3/h
Re	Reynolds number	-
t	Temperature	°C
U_B	Battery voltage	V
V	Volume	m^3
ν	Kinematic viscosity	$\text{m}^2 \cdot \text{s}^{-1}$
ρ	Density of the gas	$\text{kg} \cdot \text{m}^{-3}$
Subscripts:		
i	Summation index	
m	Metering conditions of the gas	
max	Maximum value	
min	Minimum value	
s	Specified conditions	
t	Transitional	

4 Meter classification

4.1 Flange pressure ratings

Flanges shall be designed according to PN Designation or ANSI class rating (see Table 2).

Table 2 — Flange pressure ratings

PN Designation	ANSI class rating
10	125
16	-
20	150
25	-
40	-
50	300
64	-
100	-
110	600
150	900
250	-
260	1500
420	2500
This table is based on EN 1333 resp. ISO 7005-1.	

The use of the following pressure ratings is recommended:

10 - 16 - 20 - 25 - 40 - 50 - 100 - 150 - 250 - 420.

4.2 Gas meter sizes, rangeability and connection diameter sizes

A1 Gas meters shall be classified as class 1,0 with the maximum and minimum flow rates and nominal diameters as shown in table 3. **A1**

The maximum and minimum flow rates shall be specified for the gas density for which the meter will operate within the specifications of meter performance defined in clause 5.

NOTE The maximum flow rate in cubic meters per hour (m³/h) is a number in R 5 of the sets of preferred numbers listed in ISO 3 (the value of 63 has been rounded to 65).

Table 3 — Authorized values of maximum flow rates, corresponding minimum flow rates and nominal diameters

Q_{max} (m³/h)	Rangeability			Nominal diameters DN		
	1:20 Q_{min} (m³/h)	1:30	1:50	A	B	C
40	2	1,3	0,8	25		50
65	3	2	1,3		50	
100	5	3	2		50	80
160	8	5	3	50	80	100
250	13	8	5		80	100
400	20	13	8	80	100	150
650	32	20	13	100	150	
1 000	50	32	20		150	200
1 600	80	50	32	150	200	250
2 500	130	80	50	200	250	300
4 000	200	130	80	250	300	400
6 500	320	200	130	300	400	
10 000	500	320	200	400	500	
16 000	800	500	320	500	600	
25 000	1 300	800	500	600	750	
A high speed version B normal speed version (preferred) C low speed version						

A1

4.3 Connections and dimensions

The inlet and outlet of the meter shall have the same nominal diameter and connection type.

The preferred overall length in millimetres of the meter between inlet and outlet connections is 3 DN. Tolerances are given in ISO 2768-1:1989, "Designation C".

The preferred length in millimetres of 3 DN for the meter shall not be exceeded. For shorter meters the manufacturer shall be able to provide a "make up spool piece" to bring their body lengths up to the preferred length, where requested.

The maximum overall distance in millimetres measured from the extremity of the protruding parts to the meter axis should not exceed 150 plus 1,5 DN.

For flange connections refer to Table 2.

4.4 Temperature ranges

The gas and the ambient temperature ranges for which the meter is designed to perform within the standard performance specification shall be stated.

A1 4.5 Climatic environment

The climatic environment ranges for which the meter is designed to perform within the standard performance specification shall be stated. **A1**

5 Metrological performance requirements

5.1 General

Each type of meter shall be subjected to the series of tests specified in 5.2 to establish the metrological performance of the type of meter. If one type of meter comprises a range of sizes of the same basic design and a range of metering conditions, the type test may be performed on a limited number of sample meters (1 to 6 samples irrespective of size) being representative for that range of meter sizes and metering conditions.

Each meter conforming to an approved type shall be tested individually according to annex E. The results of the tests obtained in 5.2 and annex E shall be available on request together with a statement of the conditions under which the test took place.

The meter shall be fitted with all components which may affect the metrological performance.

General requirements for the test facility to be used for the type test are given in annex A.

Where the text refers to a gas for flow tests this means air or a gas from the 1st or 2nd gas family or any other gas provided it is yielding similar metrological results at a Reynolds number within $\pm 5\%$ of the Reynolds number at the foreseen metering conditions.

The total uncertainty of the equipment used to measure the error of indication shall be calculated according to ISO Guide.

5.2 Type testing

5.2.1 Error of indication

5.2.1.1 Requirements

The error of indication of the meter shall be in absolute values less than the maximum permissible errors specified in Table 4, taking account of Table 5.

Table 4 — Maximum permissible errors

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

Table 5 — Transitional flow rate Q_t

Rangeability	Q_t
1 : 20	$0,20 \cdot Q_{\max}$
1 : 30	$0,15 \cdot Q_{\max}$
$\geq 1 : 50$	$0,10 \cdot Q_{\max}$

A1 When the errors between Q_t and $Q_{\max}$ all have the same sign, they shall all not exceed $0,5\%$. **A1**

A1

If tests at more than one pressure are carried out, the difference between the results of the tests between $0,25 \cdot Q_{\max}$ and $Q_{\max}$ shall not exceed 0,5 % for meters with $DN > 100$ or 1,0 % for meters with $DN \leq 100$.

If a meter has been certified for one working pressure range it is deemed to be certified for any smaller working pressure range.

If a meter is certified for one rangeability it is deemed to be certified for any lower rangeability.

5.2.1.2 Test

Before type testing, a meter shall undergo a run-in-period of 50 hours at a flow rate of at least $0,5 \cdot Q_{\max}$.

The test consists of determining the error of indication of the complete meter at the flow rates given in Table 6.

For a meter type specified for measurement in a pressure range below or equal to 4 bar the error of indication test shall be carried out with a gas at atmospheric conditions (± 100 mbar).

For a meter type specified for measurement in a pressure range extended above 4 bar the error of indication test shall be carried out with a gas in the range of the specified metering conditions. The tests shall be carried out at least at the lowest and the highest working pressure specified by the manufacturer. However, for specified maximum pressures above 50 bar a test at 50 bar is deemed acceptable.

Table 6 — Test flow rates in % of $Q_{\max}$

A1	Rangeability		
	1 : 20	1 : 30	1 : 50
			2
		3	
	5	5	5
	10	10	
			15
	25	25	25
	40	40	40
	70	70	70
	100	100	100

A1

5.2.2 A1 Metrological Stability A1

5.2.2.1 Requirements

In the flow rate range from $0,25 \cdot Q_{\max}$ to $Q_{\max}$ the variation of the error of indication of the meter at each flow rate shall stay within a span of 0,2 %.

5.2.2.2 Test

The error of indication of the meter shall be determined at various flow rates in the following order: $0,25 \cdot Q_{\max}$, $0,70 \cdot Q_{\max}$, $0,40 \cdot Q_{\max}$, $Q_{\max}$, where the change from $0,4 \cdot Q_{\max}$ to $Q_{\max}$ is done via $1,10 \cdot Q_{\max}$, in order to approach $Q_{\max}$ from a higher flow rate. At each flow rate the error shall be determined three times without changing the flow rate. The cycle shall be repeated three times. The test shall be carried out with a gas at atmospheric conditions (± 100 mbar) or at the lowest pressure designated on the meter.

The nine resulting errors of indication at each flow rate shall be within a span of 0,2 %.

5.2.3 Linearity

5.2.3.1 Requirements

For the test flow rates from $0,25 \cdot Q_{\max}$ to $Q_{\max}$ at each test pressure the differences between the highest and the lowest error of indication shall not exceed the values specified in Table 7.

Table 7 — Allowable differences between the highest and lowest error of indication at each test pressure

Size	Pressure	
	≤ 4 bar	> 4 bar
$\leq$ DN 100	1,0 %	0,5 %
$>$ DN 100	1,0 %	0,3 %

5.2.3.2 Test

In order to determine if the linearity requirement is fulfilled the value of the errors found at each flow rate according to 5.2.1.2 shall be taken.

5.2.4 Endurance

5.2.4.1 Requirements

Meters shall retain the accuracy of their metrological characteristics, within defined limits, over their expected life. To prove this the meters shall undergo an endurance test.

The difference in error of indication between the start and end of the test shall be less than one third of the maximum permissible error given in Table 4.

A1 After the test, the error of indication shall not exceed the maximum permissible error given in Table 4. **A1**

5.2.4.2 Test

One to six sample meters of each type irrespective of size shall be used for the endurance test.

Meters shall be tested with their indicating devices fitted.

The duration of the test shall be such that each meter measures a volume corresponding to 1 000 h of operation of the meter at the maximum flow rate; the test shall be completed within 2 months.

For a meter type intended for operation in a pressure range below or equal to 4 bar the test shall be carried out with a gas at a pressure of 4 bar or its maximum working pressure whichever is the lower. For a meter type intended for operation in a pressure range extended above 4 bar, the test shall be carried out with a gas at a minimum pressure of 8 bar or at its maximum working pressure whichever is lower.

At the start of the test all meters shall conform to 5.2.1.1 and 5.2.2.1.

At the end of the test the error of indication of the meters shall be determined again under the same conditions and at the same test facility as at the start of the test.

5.2.5 Meter position

5.2.5.1 Requirements

Unless it is specified on the meter that it is to be used only for certain mounting positions in the line, for each type of meter it shall be established whether the position of the meter influences the measuring behaviour of the meter. The following positions shall be considered: horizontal, vertical flow-up, vertical flow-down.

5.2.5.2 Test

The test consists of 2 parts.

- a) The meter shall be tested in each position to be considered according to the procedure in 5.2.1. The test shall take place at the lowest working pressure of the meter. The difference in test results shall be less than one third of the maximum permissible error limits for the flow rates above and below Q_t .
- b) A sample meter shall be subjected to the endurance test specified in 5.2.4 in each position.

NOTE Different sample meters may be used for each test position.

5.2.6 Temporary overload

5.2.6.1 Requirements

The meter shall be designed to be capable of occasionally running 20 % above the maximum flow rate within the range of pressure and temperature for which it is rated without influence on the error of indication of the meter.

5.2.6.2 Test

The meter shall run at a flow rate of $1,2 Q_{\max}$ for a time period of 1 h. The test shall be carried out at the same pressures as the error of indication test in 5.2.1.

After this 1 hour test, the error of indication in the flow rate range from $0,25 Q_{\max}$ to $Q_{\max}$ shall remain within the span specified for the stability test in 5.2.2.

5.2.7 Temperature range

5.2.7.1 Requirements

 The gas and the environmental (climatic) temperature ranges over which the meter is designed to perform within the standard performance specification shall be stated by the manufacturer. These shall be a minimum temperature range of 40 K for the gas temperature and 50 K for the environmental temperature.

The upper temperatures (gas and climatic) shall be either 40 °C, 55 °C or 70 °C. The lower temperatures (gas and climatic) shall be either -10 °C, -25 °C or -40 °C. 

5.2.7.2 Test

The test consists of three parts.

a) Materials

The manufacturer shall demonstrate that all materials of which the meter is designed are capable of withstanding the extreme temperatures of the specified temperature range.

b) Test on the indicating device

The indicating device, including as many parts of the gear train as possible from the design of the meter, shall be taken from the meter and placed in a temperature cabinet. It shall be connected to a drive unit capable of operating the indicating device.

The indicating device shall then be exposed to a 24 hour cyclic temperature variation between the upper and lower temperature limit, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phase.

NOTE Condensation will occur during the temperature rise.

The 24 hour cycle consists of:

- temperature rise during 3 hours;
- temperature maintained at the upper value until 12 hours from the start of the cycle;
- temperature lowered to lower value within 3 hours;
- temperature maintained at the lower value until 24 hour cycle is completed.

During and after the temperature cycle the indicating device shall operate without problems.

c) Test of the complete meter

The error of indication of the meter shall be determined at least at one gas temperature differing by a minimum of 15 K higher and one differing by a minimum of 15 K lower from the gas temperature at which the test given in 5.2.1.2 took place. Care shall be taken that the meter temperature has been stabilized at this test temperature. The difference between the errors of indication from this test and from the test given in 5.2.1.2 shall be less than one half the maximum permissible error given in Table 4.

The test shall be carried out at the flow rates $Q_{\min}$ or $0,05 \cdot Q_{\max}$, whichever is greater, and at $0,40 \cdot Q_{\max}$.

Two sample meters of each type, the size of which does not exceed DN 150, shall be used for the test.

The test shall be carried out at atmospheric conditions (± 100 mbar).

5.2.8 Installation conditions

5.2.8.1 Requirements

In order to assess the sensitivity of the meter performance to upstream installation conditions, each type of meter shall be subjected to the standard tests described in annex B „Perturbation testing“.

The errors of indication obtained during disturbed flow conditions downstream of the perturbation units shall not differ by more than one third of the maximum permissible error limits given in Table 4, from the error of indication obtained with an undisturbed upstream flow condition as obtained in 5.2.1.

Any additional pipe inlet lengths and/or flow conditioners necessary to meet this requirement shall be specified by the manufacturer. These components together with the meter constitute a “meter package”.