BRITISH STANDARD

BS EN 14236:2007

Ultrasonic domestic gas meters

The European Standard EN 14236:2007 has the status of a British Standard

ICS 91.140.40

British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 14236:2007. It supersedes DD ENV 14236:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/25, Gas meters.

A list of organizations represented on GSE/25 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EN 14236

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English Version

Ultrasonic domestic gas meters

Compteurs de gaz domestiques à ultrasons

Ultraschall-Haushaltsgaszähler

This European Standard was approved by CEN on 13 December 2006.

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 bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

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Foreword

This document (EN 14236:2007) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by July 2007, and conflicting national standards shall be withdrawn at the latest by July 2007

This document supersedes ENV 14236:2002.

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/EC.

For relationship with EU Directive 2004/22/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 United Kingdom.

1 Scope

This European Standard specifies requirements and tests for the construction, performance and safety of class 1,0 and class 1,5 battery powered ultrasonic gas meters (hereinafter referred to as meters), having co-axial single pipe, or two pipe connections, used to measure volumes of distributed fuel gases of the second and/or third family, as given in EN 437, at maximum working pressures not exceeding 0,5 bar[1)] and maximum actual flow rates of up to 10 m^3/h over a minimum ambient temperature range of -10 °C to +40 °C, and minimum gas temperature span of 40 K, for domestic applications. This European Standard applies to meters where the measuring element and the register(s) are enclosed in the same case.

This European Standard applies to meters with and without built-in temperature conversion, 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 stated, all pressures given in this European Standard are gauge pressures.

When more than one meter type is submitted for testing, then each meter type is required to be tested against this European Standard.

Clauses 1 to 15 and Annex C are for design and type testing only.

NOTE See Annex A for production requirements.

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 55022, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement (CISPR 22:1997, modified)*

EN 60068-2-5, *Environmental testing — Part 2: Tests — Test Sa: Simulated solar radiation at ground level (IEC 60068-2-5:1975)*

EN 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 + 12 h cycle) (IEC 60068-2-30:2005)*

EN 60079-0:2004, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements (IEC 60079-0:2004, modified)*

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1) 1 bar = 1 000 mbar = 10^5 Pa.

EN 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:1995)*

prEN 60079-11, IEC 60079-11, Ed. 5.0: *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"*

EN 60079-15, *Electrical apparatus for explosive gas atmospheres — Part 15: Construction, test and marking of type of protection "n" electrical apparatus (IEC 60079-15:2005)*

EN 60086-1, *Primary batteries — Part 1: General (IEC 60086-1:2000)*

EN 60086-4, *Primary batteries — Part 4: Safety standard for lithium batteries (IEC 60086-4:2000)*

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

EN 60695-11-5, *Fire hazard testing — Part 11-5: Test flames — Needle-flame test method — Apparatus, confirmatory test arrangement and guidance (IEC 60695-11-5:2004)*

EN 60707, *Flammability of solid non-metallic materials when exposed to flame sources — List of test methods (IEC 60707:1999)*

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

EN 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication (IEC 61000-4-2:1995)*

EN 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio frequency, electromagnetic field immunity test — (IEC 61000-4-3:2006)*

EN 61000-4-8, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 8: Power frequency magnetic field immunity test — Basic EMC publication (IEC 61000-4-8:1993)*

EN 61000-4-9, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 9: Pulse magnetic field immunity test — Basic EMC publication (IEC 61000-4-9:1993)*

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

EN 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards – Immunity for industrial environments (IEC 61006-2-2:2005)*

EN 62056-21:2002, *Electricity metering — Data exchange for meter reading, tariff and load control — Part 21: Direct local data exchange (IEC 62056-21:2002)*

EN ISO 2409, *Paints and varnishes — Cross-cut test (ISO 2409:1992)*

EN ISO 2812-1:1994, *Paints and varnishes — Determination of resistance to liquids — Part 1: General methods (ISO 2812-1:1993)*

EN ISO 4628-2:2003, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering (ISO 4628-2:2003)*

EN ISO 4628-3:2003, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 3: Assessment of degree of rusting (ISO 4628-3:2003)*

EN ISO 4892-3, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps (ISO 4892-3-2006)*

EN ISO 6270-1, *Paints and varnishes — Determination of resistance to humidity — Part 1: Continuous condensation (ISO 6270-1:1998)*

EN ISO 6272-1, *Paints and varnishes — Rapid-deformation (impact resistance) tests — Part 1: Falling-weight test, large-area indenter (ISO 6272-1:2002)*

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

EN ISO 9227, Corrosion tests in artificial atmospheres – *Salt spray tests (ISO 9227:2006)*

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

ISO 1518, *Paints and varnishes — Scratch test*

ISO 7724-3, *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*

ASTM D471, *Standard Test Method for Rubber Property — Effect of Liquids*

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*

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
actual flow rate
flow rate at the gas pressure and gas temperature conditions prevailing in the gas distribution line in which the meter is fitted, at the meter inlet

3.1.2
base conditions
fixed conditions to which a volume of gas is converted (i.e. base gas temperature 15 °C, base gas pressure 1 013,25 mbar)

3.1.3
contaminants
gas borne dust, vapour and other substances that could affect the operation of the meter

3.1.4
communications port
galvanic or optical serial data port

3.1.5
display
device (e.g. liquid crystal display) which shows the contents of a memory (e.g. registered volume or flags)

3.1.6
distributed gas
gas locally available

3.1.7
error of indication (ϵ)
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 volume:

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

where

V_i is the indicated volume in cubic metres (m^3);

V_c is the volume in cubic metres (m^3) that has actually flowed through the meter

3.1.8
external leak tightness
leak tightness of the gas carrying components of the gas meter with respect to the atmosphere

3.1.9
flag
single alphabetic character on the index giving a visual signal of significant events and/or change(s) in the operation of the meter

3.1.10
galvanic connection/interface
hard wired serial connection or pulse output from the meter

3.1.11
index
all that which is viewed through the index window, including the display

3.1.12
index window(s)
area(s) of transparent material through which the index can be read

3.1.13
maximum error shift
maximum mean error shift at any of the tested flow rates

3.1.14
maximum working pressure
upper limit of the working pressure for which the meter has been designed, as declared by the manufacturer and marked on the index or the data plate

3.1.15
mean error
arithmetic mean of consecutive errors of indication at a flow rate

3.1.16
measuring element
part of the meter which produces an electrical signal proportional to the gas flow rate

3.1.17
memory
element which stores digital information

3.1.18
meter case
complete meter, not casing only

3.1.19
meter class
class to which a meter belongs, according to the metrological requirements of this European Standard, i.e. class 1,5 or class 1,0.

3.1.20
meter cover
rigid enclosure on the front of the meter made either wholly of transparent material, or of opaque material provided with index window(s)

3.1.21
normal conditions of operation
conditions referring to the meter operating:

— at a pressure up to the maximum working pressure (with or without a flow of gas);

— within the range of flow rates;

— within the ambient temperature range;

— within the gas temperature range;

— with the distributed gas

3.1.22
operating mode
method (sample frequency and timing) of obtaining volume flow measurements

3.1.23
optical port
serial data port using an infra-red transmitter and receiver

3.1.24
pressure absorption
difference between the pressure measured at the inlet and outlet connections of the meter whilst the meter is operating

3.1.25
pressure measuring point
permanent fitting on the meter outlet enabling a direct measurement of the outlet pressure to be obtained

3.1.26
range of mean errors
difference between the minimum and maximum mean errors over a specified flow range

3.1.27
regression line
straight line, generated using a statistical method, to give a graphical representation of a set of results

3.1.28
register
electronic device comprising both memory and display, which stores and displays information

3.1.29
segment
individual part of a display which is able to show a portion of a character

3.1.30
starting flow rate
lowest flow rate at which the meter is able to indicate a volume of gas passed

3.1.31
temperature conversion device
device which converts the measured volume to a corresponding volume at base gas temperature

3.1.32
test house
organisation used to perform prescribed tests on meters, in accordance with this standard

3.1.33
thermal cut-off valve
heat sensitive valve used to cut off the flow of gas to the meter if the ambient temperature rises above a predetermined level for a specified time

3.1.34
ultrasonic gas meter
gas meter that uses ultrasound and that is designed to measure, memorise and display the fuel gas volume that has passed through it

3.1.35
ultrasonic transducer
device used to generate and detect the ultrasound signals within the meter

3.1.36
working pressure
pressure of the gas at the inlet of the meter

3.2 Symbols

3.2.1
D
outside diameter of the pipe in millimetres (mm)

3.2.2
g
acceleration due to gravity, in metres per square second ($m \cdot s^{-2}$)

3.2.3
MPE
maximum permissible error, in percent (%)

3.2.4
p_{max}
maximum working pressure

3.2.5
$Q_{\mathbf{max}}$
maximum flow rate, specified in cubic metres per hour (m^3/h) for which the meter has been designed

3.2.6
Q_{min}
minimum flow rate, specified in cubic metres per hour (m^3/h) for which the meter has been designed

3.2.7
Q_r
overload flow rate, the highest flow rate at which the meter operates for a short period of time without deteriorating

3.2.8
Q_{start}
lowest flow rate at which the meter is capable of registering the passage of gas, as declared by the manufacturer

3.2.9
$Q_{\mathbf{t}}$
transitional 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'

NOTE Each zone has a characteristic maximum permissible error

3.2.10
$t_{\mathbf{b}}$
base gas temperature

3.2.11
$t_{b,i}$
base gas temperature for meters declared suitable for differential temperature and intermittent operation

3.2.12
$T_{\mathbf{i}}$
temperature at meter inlet

3.2.13
$t_{\mathbf{m}}$
ambient temperature of the meter

3.2.14
$t_{\mathbf{g}}$
gas temperature range of the meter

3.2.15
$t_{\mathbf{sp}}$
specified centre temperature for a temperature converted meter

4 Normal operating conditions

4.1 Flow range

The values of maximum flow rates and those corresponding values of the upper limits of the minimum flow rates shall be those given in Table 1.

Table 1 — Flow range

Q_{max} m^3/h	Upper limits of Q_{min} m^3/h
2,5	0,016
4	0,025
6	0,040
10	0,060

The definitions of the meter classifications applicable in this European Standard are given in Table 2.

Table 2 — Flow rate ranges by meter classification

Class	Q_{max}/Q_{min}	Q_{max}/Q_t	Q_r/Q_{max}
1,5	≥ 150	≥ 10	≥ 1,2
1,0	≥ 150	≥ 5	≥ 1,2

4.2 Maximum working pressure

The manufacturer shall declare the maximum working pressure of the meter and this pressure shall be marked on the index or data plate of the meter. This pressure shall not exceed 0,5 bar.

4.3 Temperature range

Unless otherwise stated, all temperatures given in this document shall be measured to within ± 1 °C.

All meters shall be capable of meeting the requirements for a minimum ambient temperature range of -10 °C to +40 °C (see 5.14), a minimum gas temperature span of 40 K and a storage temperature of ≤ -20 °C to ≥ +60 °C. The gas temperature range shall be within the ambient temperature range.

The manufacturer shall declare the gas temperature range and the ambient temperature range.

The manufacturer can declare a wider ambient temperature range using a minimum temperature of -10 °C, -25 °C or -40 °C and a maximum temperature of 40 °C, 55 °C or 70 °C and/or a wider storage temperature range. The meter shall be capable of meeting the requirements over this declared wider range.

If the manufacturer declares that the meter is resistant to high ambient temperatures, the meter shall also be capable of meeting the requirements of the heat resistance test and shall be marked accordingly (see 7.2.1 and 9.1).

4.4 Range of gases

4.4.1 Test gases

The manufacturer shall specify the range of gases for which the meter is suitable, from Table 3.

Table 3 — Gas groups from EN 437

Second family	Groups	H	L	E
Third family	Groups	P/B	P	B
Additional	Air			

Meters suitable for:

— second family gases shall be tested with air and 99,5 % CH_4.

— third family gases shall be tested with air and 99,5 % Propane and/or 99,5 % Butane, as appropriate.

By agreement with the Test House any other test gas can be included. The additional gases shall be marked on the meter as defined in 9.1.

NOTE For further information on test gases see Annex A.

4.5 Orientation

Where meters can be installed in orientations other than with the connection ports vertical, meters shall be tested in those other orientations, for durability and as agreed with the Test House.

5 Metrological performance

5.1 General

Provision shall be made for synchronizing the start and finish of test periods with test equipment, either via a galvanic connection or optical port.

The test equipment shall generate an event that starts the test. The measured response (volume reading) from the meter shall be synchronous with its sampling instant. To achieve this, the meter shall delay its measured response until the next sample period after it has received a start command.

The sampling instant shall be synchronous with the start of the data transmission string.

NOTE This is used to start/stop an independent timer of sufficient resolution to accurately time the period between successive measure periods.

If it is intended to use the meter in two directions (forward and reverse flow) then all tests shall be performed in both directions.

5.2 Mode comparison

5.2.1 General

If the meter has a normal operating (sampling) mode and one or more test (fast sampling) modes then, provided that the requirement in 5.2.2 is met, all subsequent tests in this European Standard shall be carried out in the test-mode. If the requirement is not satisfied then all subsequent tests shall be performed in the normal operating mode.

5.2.2 Requirements

The accuracy of the measurements shall not be influenced by different sampling modes.

The difference of the mean errors of the standard mode and the test-mode shall not exceed 0,3 % for $Q_t \leq Q \leq Q_{max}$ and 0,6 % for $Q_{min} \leq Q < Q_t$.

If this requirement is not satisfied, subsequent tests shall be undertaken in the normal operating mode.

5.2.3 Test

Test the meter in the standard mode and in the test-mode in accordance with 5.3.2 a).

Calculate the difference in mean error at each flow rate.

5.3 Permissible errors

5.3.1 Requirements

When tested in accordance with 5.3.2 a) the mean error shall be within the maximum permissible errors specified in Table 4 and the range of mean errors shall be within the limits specified in Table 5.

When the errors between Q_t and Q_{max} all have the same sign, they shall not exceed 1 % for class 1,5 and 0,5 % for class 1,0.

When tested in accordance with 5.3.2 b) the mean error shall be within the maximum permissible errors specified in Table 4 and the range of mean errors shall be within the limits specified in Table 5 for each individual test gas at each test temperature.

If the manufacturer has declared a wider ambient and gas temperature range, then the extreme temperatures declared shall be substituted for -10 °C and +40 °C, as appropriate.

After the meter has been subjected to other influences, given by the individual clauses of this European Standard, the mean errors shall be within the error limits specified within those clauses when tested by the methods given in 5.3.2 a) or 5.3.2 b).

5.3.2 Test

a) Error on air

Thermally stabilize the meter to be tested to the temperature of the test laboratory.

Pass a volume of air at 20 °C, the actual volume of which is measured by a reference standard, through the meter and note the volume indicated by the meter. This indicated volume can be obtained via the communication port. The minimum volume of air to be passed through the meter is specified by the manufacturer and agreed with the Test House.

Carry out six consecutive tests at each of the following flow rates in ascending or descending order Q_{min}, 3 Q_{min}, 5 Q_{min}, 10 Q_{min}, 0,1 Q_{max}, 0,2 Q_{max}, 0,4 Q_{max}, 0,7 Q_{max}, Q_{max}.

Calculate the six errors of indication (see 3.1.7) at each of the flow rates, the mean of the six errors and note it as a point on the error curve. Then, calculate the difference of the arithmetic mean of the errors of indication at each of the flow rates.

b) Error on gas (excluding air)

Carry out the test as described in 5.3.2 a) and additionally at –10 °C and +40 °C (or that wider temperature range declared by the manufacturer) using the test gases in turn specified in 4.4.1 and any other test gas by agreement with the Test House, which shall be marked on the meter (see 9.1).

Table 4 — Maximum permissible errors, class 1,5 and class 1,0

Flow rate m^3/h	**Maximum permissible errors**	
	Class 1,5	Class 1,0
$Q_{min} \leq Q < Q_t$	± 3 %	± 2 %
$Q_t \leq Q \leq Q_{max}$	± 1,5 %	± 1 %

Table 5 — Maximum difference between errors

Flow rate range m^3/h	**Maximum range of mean errors**	
	Class 1,5	Class 1,0
$Q_{min} \leq Q < Q_t$.	4 %	$1^1/_3$ %
$Q_t \leq Q < Q_{max}$	2 %	$^2/_3$ %

5.4 Gas — air relationship

5.4.1 General

Where meters satisfy the requirements in 5.4.2, air shall be used for subsequent tests as the test medium.

5.4.2 Requirements

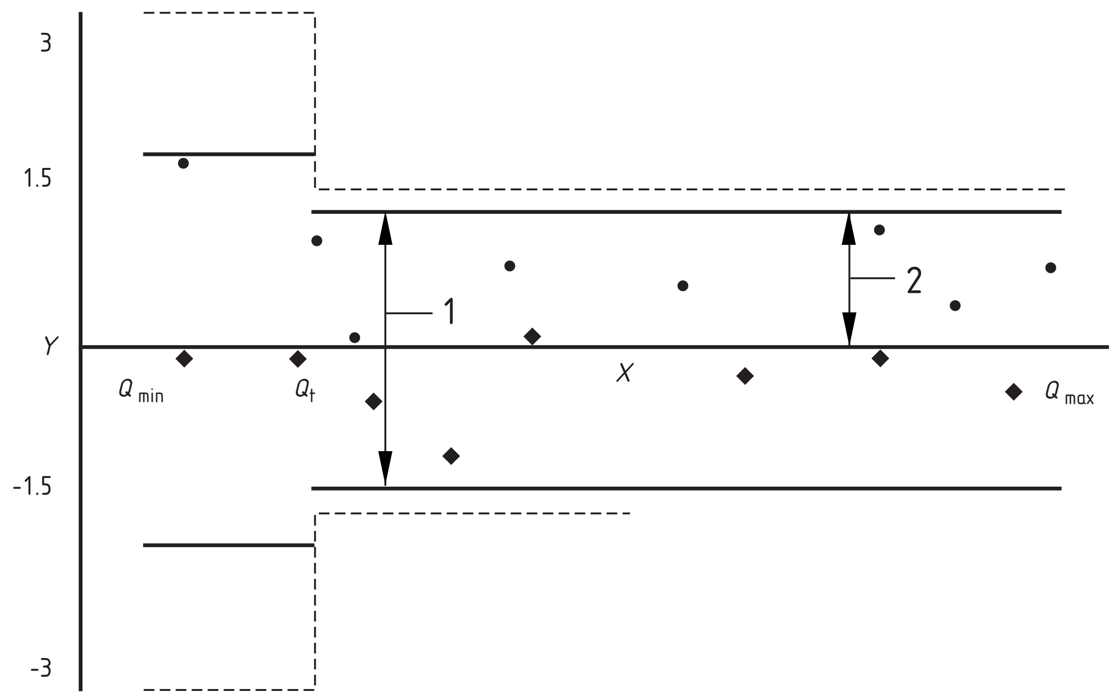
When tested in accordance with 5.4.3 the range of mean errors on all test gases combined (including air) shall be within the limits specified in Table 5 (see X in Figure 1).

The difference between the mean error on the test gases and that on air at each flow rate shall satisfy the limits specified in Table 6 (see Y in Figure 1).

Table 6 — Mean error difference between gas and air

Flow rate m^3/h	**Maximum mean error difference**	
	Class 1,5	Class 1,0
$Q_{min} \leq Q < Q_t$	± 3 %	2 %
$Q_t \leq Q \leq Q_{max}$	± 1,5 %	1 %

NOTE Figure 1 represents a graphical explanation of the requirements given in 5.3 and 5.4.



Key

1 error %

2 flow rate *Q*

● error on gas

◆ error on air

NOTE All points are the mean of at least 3 measurements.

Figure 1 — Relationship between defined errors

5.4.3 Test

Apply the requirements of 5.4.2 to the results from testing the meter in accordance with 5.3.2 a) and 5.3.2 b).

5.5 Pressure absorption

5.5.1 Requirements

The pressure absorption of the meter with a flow of air of density 1,2 kg/m^3, at a flow rate equal to Q_{max}, shall not exceed 2,0 mbar.

5.5.2 Test

Pass air through the meter with a flow of air of density 1,2 kg/m^3, at a flow rate equal to Q_{max}, and measure the differential pressure across the meter with a suitable measuring instrument.

5.6 Metrological stability

5.6.1 Requirements

The difference between any two of the six errors of indication at each flow rate greater than or equal to Q_t shall not exceed 0,6 % and at each flow rate less than Q_t the difference shall not exceed 1,0 %.

5.6.2 Test

Apply the requirements of 5.6.1 to the results from testing the meter in accordance with 5.3.2 a).

5.7 Immunity to contaminants in gas stream

5.7.1 Requirements

When meters are tested in accordance with 5.7.2, the errors of these meters shall not exceed the following:

— Class 1,5 Mean error: 2 *MPE*; Error shift: 2 % between Q_t to Q_{max}.

— Class 1,0 Mean error: *MPE*; Error shift: one third of the *MPE* in Table 4.

After the test in 5.7.2, the pressure absorption tested in accordance with 5.3.2 a) shall not exceed 2,2 mbar.

5.7.2 Test

Test a minimum of 6 meters. Where more than one installation orientation is specified by the manufacturer, test a minimum of 3 m in each orientation.

The test equipment used for this test need not have absolute traceability provided that each meter is calibrated on equipment that does have such traceability prior to commencing the test.

Test the meter in accordance with 5.3.2 a).

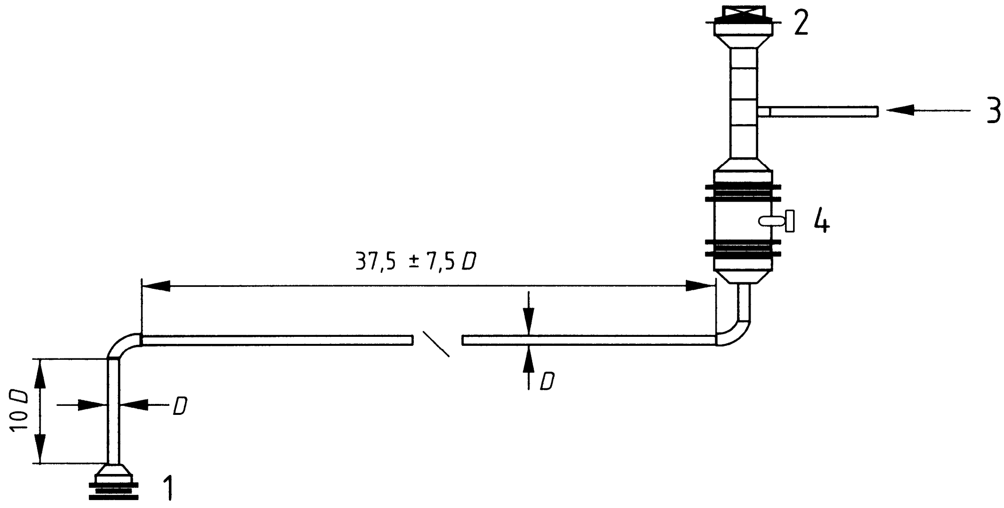
Attach the meter to a dust rig that has 10 *D* of vertical pipe before the meter and pass air through the meter for 5 min at Q_{max}. Stop the air supply and add 5 g of 300 to 400 grade dust to the rig inlet. Start the air supply and maintain a flow of Q_{max} for a further 5 min.

Repeat this procedure with 5 g of each dust grade in the order 200 to 300, 100 to 200 and 0 to 100.

Test the meter in accordance with 5.3.2 a).

For meters covered by this European Standard, *D* = 15 mm.

Dimensions in millimetres



Key

1 meter connection
2 dust inlet (screwed plug)
3 air supply (fan)
4 fast acting full bore valve

Figure 2 — Example of a typical test rig for the addition of dust

Referring to Figure 2, the apparatus consists of the following components:

a) 10 *D* of vertical parallel bore pipe, to connect to the meter inlet;

b) a removable screwed plug, for the addition of dust;

c) a ball valve, to release the dust;

d) a length of straight pipe 30 *D* to 45 *D* in length, to ensure that all dust is airborne before entering the meter;

e) copper pipework with soldered or compression fittings is preferred. Steel pipe fittings are not recommended as the dust will adhere to the screw threads.

Other designs of test rig can be used, at the discretion of the Test House. Check the effectiveness of a test rig design on a regular basis, using a test box. This is to ensure that when 20 g of dust is added using the procedure mentioned above at least 18 g is deposited inside the test box fitted to the rig outlet. Ensure that the test box has a similar volume and shape to the meter to be tested and fitted with a filter on the outlet to minimize the dust passing through the outlet.

5.7.3 Specification of contamination dust

Four separate batches of dust shall be used with 95 % of the particles in each batch in the appropriate size range given below:

a) 0 µm to 100 µm Average size (50 ± 10) µm;

b) 100 µm to 200 µm Average size (150 ± 10) µm;

c) 200 µm to 300 µm Average size (250 ± 10) µm;

d) 300 µm to 400 µm Average size (350 ± 10) µm.

Each of the above batches shall have a composition by mass of:

Black iron oxide (Fe_3O_4)	79 %
Red iron oxide (FeO)	12 %
Mineral silica flour (SiO)	8 %
Paint residual flake	1 %

5.8 Installation effects

5.8.1 Requirements

When tested in accordance with 5.8.2, the mean errors at all flow rates shall remain within the *MPE* and the mean error difference at each flow rate shall not exceed one third of the *MPE* specified in Table 4. The meter shall recover from the flow disturbance to be within the *MPE*, specified in Table 4.

5.8.2 Test

Test the meter in accordance with 5.3.2 a) with a straight pipe of length no less than 10 *D* connected to the meter inlet.

Repeat the test, with a pipe of the same diameter as the nominal connection diameter of the meter, but with two 90° elbows with their planes at right angles and not more than 2 *D* apart. Connect this to the meter inlet with the first bend not more than 2 *D* from the inlet.

Repeat the test in accordance with 5.3.2 a) with a straight pipe of length not less than 10 *D* connected to the meter inlet.

5.9 Zero flow

5.9.1 Requirements

Neither the meter display nor the internal register shall change in value (increase or decrease) when the meter is tested by the method given in 5.9.2.

5.9.2 Test

This test is carried out at -10 °C, +20 °C and +40 °C. If the manufacturer has declared a wider ambient and gas temperature range, then the extreme temperatures declared are substituted for -10 °C and +40 °C above as appropriate.

Record the meter display and the internal register of the meter. Fill the meter with dry pure methane at atmospheric pressure and seal the inlet and outlet ports of the meter with gas tight fittings. Allow the meter to stabilize at the test temperature and then store for 24 h at the test temperature. Record the meter display and internal register and subtract the respective first readings from the second readings to indicate any registration change. Repeat the test at each test temperature.

5.10 Reverse flow

5.10.1 Requirements

If the meter has been designed to only be used in one direction, then when tested in accordance with 5.10.2 the register shall neither increase nor decrease. Where an additional reverse flow register is fitted, this shall indicate the passage of the test volume during the test described in 5.10.2.

5.10.2 Test

A test volume of 0,2 Q_{max} is passed through the meter in the reverse direction at a nominal flow rate of Q_{max}. The index reading is recorded before and after the test.

5.11 Low flow registration

5.11.1 Requirement

When tested by the method given in 5.11.2, the starting flow rate shall not be greater than 0,25 Q_{min}.

The meter shall also register the passage of gas.

5.11.2 Test

Test the meter in accordance with 5.3.2 a), except that the test shall be carried out at 1,2 Q_{start} with a test volume of 0,01 m^3.

5.12 High flow registration

5.12.1 Requirement

When tested in accordance with 5.12.2 the mean error shall not exceed the *MPE,* specified in Table 4.

5.12.2 Test

Test the meter in accordance with 5.3.2 a) but at 1,2 Q_{max}.

5.13 Pulsed (unsteady) flow

5.13.1 General

The normal operating mode of the meter shall have a sample period (*T*) that does not exceed 2 s, randomised to ± 2 s, unless the manufacturer can demonstrate that a proposed longer sampling rate will not cause the metrological characteristics of the meter to be significantly impaired by pulsed or unsteady flow. Where the mean sample period is longer than 2 s, the tests of 5.13.3 shall still be applied.

5.13.2 Requirements

The difference between the cumulative volume at the ends of test runs 2 and 6, (see Table 7), and the cumulative volume at runs 1 and 5 respectively, shall not exceed two thirds of the total *MPE* range specified in Table 4.

The difference between the cumulative volume at the ends of test runs 3, 4, 7 and 8, (see Table 7), and the cumulative volume at runs 1 and 5 respectively shall not exceed one third of the total *MPE* range specified in Table 4.

The observed standard deviation of the error with stepping flow shall be within a range of 0,75 to 1,25 times the calculated standard deviation of the error.

Test 5.13.3 shall be performed with the meter in its normal operating mode.

5.13.3 Test

Subject the meter to flow conditions specified in Table 7 with either continuous or square wave airflow at the on/off timings and flow rates, for a duration of 24 h, recording the start and end index volumes of each test.

Table 7 — Unsteady flow runs

Run	**Flow rate**	**Flow (wave form)** where *T* = sampling period
1	0,375 Q_{max}	Continuous
2	0,375 Q_{max}	1,05 *T* on, 1,05 *T* off
3	0,375 Q_{max}	5,25 *T* on, 5,25 *T* off
4	0,375 Q_{max}	10,5 *T* on, 10,5 *T* off
5	0,07 Q_{max}	Continuous
6	0,07 Q_{max}	1,05 *T* on, 1,05 *T* off
7	0,07 Q_{max}	5,25 *T* on, 5,25 *T* off
8	0,07 Q_{max}	10,5 *T* on, 10,5 *T* off

The following formula is used to calculate the standard deviation (s_d) as a percentage of the total volume of gas passed during a test:

$$s_d = \frac{50 \cdot T}{S \cdot N^{1/2}}$$

where

T is the sampling period, in seconds (s);

S is the duration of each 'on period', in seconds (s);

N is the number of 'on periods' during the test.

5.14 Temperature sensitivity

5.14.1 Requirements

When tested in accordance with 5.14.2 the meter shall meet the following requirements:

— that all results shall be within the errors shown in Table 4;

— that no error of indication shall differ from its regression line by more than 1 % for class 1,5 and $^{2}/_{3}$ % for class 1,0.

5.14.2 Test

Install the meter on an appropriate test rig, see Figure C.1, and stabilize the meter at the starting temperature of the test for a period of 3 h prior to commencing the change of temperature at the rate specified below.

Test the meter in accordance with 5.3.2 b) at a flow rate of 0,05 Q_{max} using test gas as specified in 4.4.1, according to meter type. Repeat this test at a frequency of three or four tests per hour while changing the ambient temperature from –10 °C to +40 °C at a rate of 2 °C/h with the relative humidity not exceeding 50 %.

Calculate the regression lines of the errors of indication over temperature.

6 Construction and materials

6.1 General

The gas meter shall be constructed in such a way that any mechanical interference capable of affecting the measuring accuracy results in permanently visible damage to the gas meter or the verification or protection marks.

Any means of adjusting the performance characteristics of the meter shall be effectively secured and protected against unauthorized interference.

Electronic seals shall comply with the following requirements:

— access shall only be obtained by using a password or a code that can be updated, or by using a specific device;

— the last intervention, at least, shall be registered in the memory, including date and time of intervention and a specific element to identify the intervention;

— it shall be possible to have access to the intervention(s) registered in the memory for a minimum period of two years.

The meter connections shall be fitted with suitable non-sealing caps or covers to protect any threads and to prevent the entry of foreign matter during transit and storage.

A sealing drawing shall be part of the documentation for type approval. It shall include the metrological sealing as well as all other tamper evident seals.

6.2 Robustness of meter case

6.2.1 General

Parts of the meter case in direct contact with the ambient air on the outside and with the gas on the inside shall be of sufficient thickness to meet the requirements of 6.2.

The meter case shall be constructed and arranged so that any non-permanent deformation cannot prevent the satisfactory operation of the meter.

The meter shall have a meter case that can be sealed in such a way that the internal parts of the meter are accessible only after breaking the metrological seal(s) or causing clear evidence of interference.

6.2.2 Protection against penetration of dust and water

6.2.2.1 Requirements

The meter shall be designed in such a way that it gives protection against the ingress of dust and water so that it conforms, as a minimum, to the IP 54 degree of protection, in accordance with EN 60529.

6.2.2.2 Test

Test the meter (including the battery compartment) in accordance with EN 60529.

6.2.3 Resistance to internal pressure

6.2.3.1 Requirements

After testing in accordance with 6.2.3.2, the meter shall not leak and there shall be no permanent deformation of the meter.

6.2.3.2 Test

Subject the meter to 2 000 cycles at 30 cycles per hour, at internal pressures varying from 0 mbar to 1,5 times the maximum working pressure or 350 mbar whichever is the greater. The rate of change of pressure shall not exceed 20 mbar $\cdot$ s^{-1}.

6.2.4 External leak tightness

6.2.4.1 Requirements

The meter shall be leak tight under normal conditions of use. When tested in accordance with 6.2.4.2, the meter shall not leak.

6.2.4.2 Test

Pressurize the meter, at normal laboratory temperature, with air to 1,5 times the declared maximum working pressure and check for leaks.

Carry out the test by:

a) immersing the meter in water and observing for leakage for 30 s after any external trapped air has been dispersed, or

b) any equivalent procedure.

6.2.5 Heat resistance

6.2.5.1 Requirement

Following the test specified in 6.2.5.2, the meter shall satisfy the requirements of 6.2.4.1.

6.2.5.2 Test

Suspend the meter in an ambient temperature of (120 ± 2) °C for 15 min. For safety reasons, any battery fitted to the meter shall be removed during the heating period.

6.2.6 Connections

6.2.6.1 Orientation

6.2.6.1.1 Requirements

The connections of meters having top mounted two pipe connections shall have the centrelines of these connections within 2° of the vertical, with respect to the horizontal plane of the meter.

The distance between the centrelines of the connections, measured at the free end of the connections, shall be within ± 0,5 mm of the nominal distance between the centrelines, or within ± 0,25 % of the nominal distance between centrelines, whichever is the greater, and the centrelines shall be within 2° of being parallel.

The free ends of the connections shall be level within 2 mm, or within 1 % of the nominal distance between the centrelines of the connections, whichever is the greater, with respect to the horizontal plane of the meter.

6.2.6.1.2 Test

Take the measurements.

6.2.6.2 Nominal connection diameters for single and two pipe meters

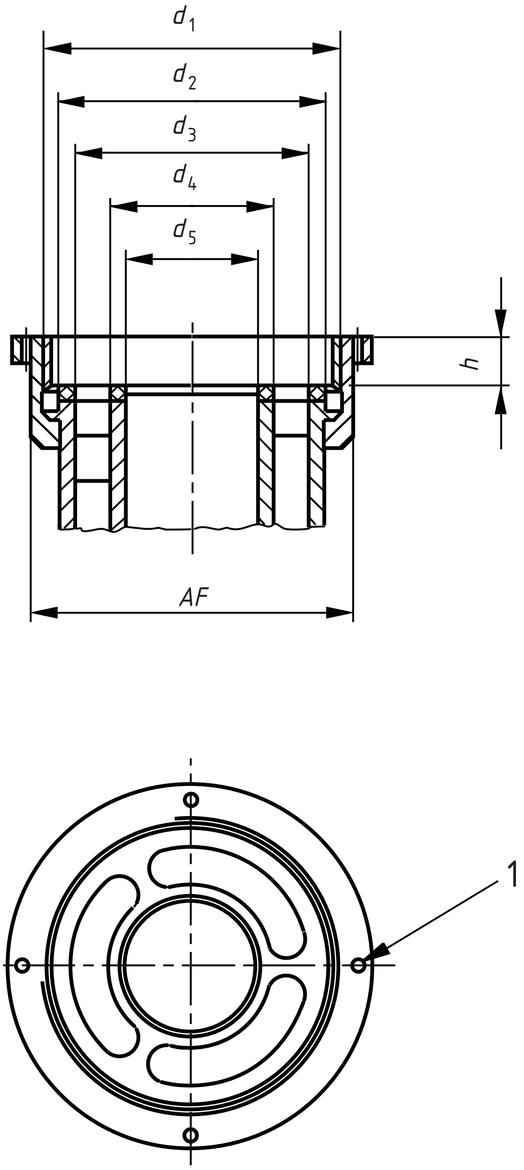
6.2.6.2.1 Requirements

The nominal connection diameters shall be as specified by the meter manufacturer.

The connections of meters having a co-axial single pipe connection shall be in accordance with Figure 3.

6.2.6.2.2 Test

Take the measurements.



Dimensions in millimetres

Q_{MAX}(m³/h)	*d*₁	*d*₂	*d*₃	*d*₄	*d*₅	*h*	*SW*
≤ 10	G2	54	46	32	26	9^{+3}_{0}	65
16/25	G2¾	76,5	63	48	41	10^{+4}_{0}	90

Key

1 sealing hole
AF across flats

Figure 3 — Co-axial single pipe screw connections

6.2.6.3 Torque

6.2.6.3.1 Requirements

The meter connection shall be subjected to the appropriate torque specified in Table 8, in accordance with 6.2.6.3.2 and shall then comply with the following:

— external leak tightness (see 6.2.4.1);

— any residual rotational deformation of the meter connection shall not exceed 2°.

6.2.6.3.2 Test

Firmly support the case of the meter and apply the appropriate torque value to each connection in turn using a torque wrench.

Table 8 — Torque and bending moment

Nominal connection diameter		Torque value	Bending moment
inches	DN	N · m	N · m
½	15	50	10
¾	20	80	20
1	25	110	40
1¼	32	110	40
1½	40	140	60

6.2.6.4 Bending moment

6.2.6.4.1 Requirements

When tested in accordance with 6.2.6.4.2, the meter shall remain leak tight after this test in accordance with 6.2.4.1.

The mean errors of the meter shall remain within the *MPE* specified in Table 4, before and after being subjected to the test described in 6.2.6.4.2.

After the test, the residual deformation of the connections shall not exceed 5°.

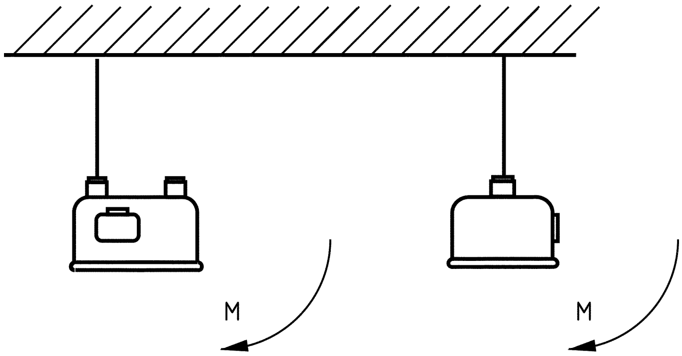
6.2.6.4.2 Test

Test the meter in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max}.

Rigidly support the meter by one of its connections and subject it to the appropriate bending moment, see Table 8, for a period of 2 min. Different meters are used for the lateral test(s) and the fore and aft test (see Figure 4).

In the case of the meter being of two pipe construction, repeat the lateral bending moment test on the other meter connection, but for the fore and aft test support the meter by both connections.

Test the meter in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max}.



Key

M Bending moment

Figure 4 — Arrangement for bending moment test

6.2.7 Resistance to vibration

6.2.7.1 Requirements

The meter shall remain leak tight and its mean errors shall be within the *MPE* specified in Table 4 before and after being subjected to the vibration test described in 6.2.7.2.

6.2.7.2 Test

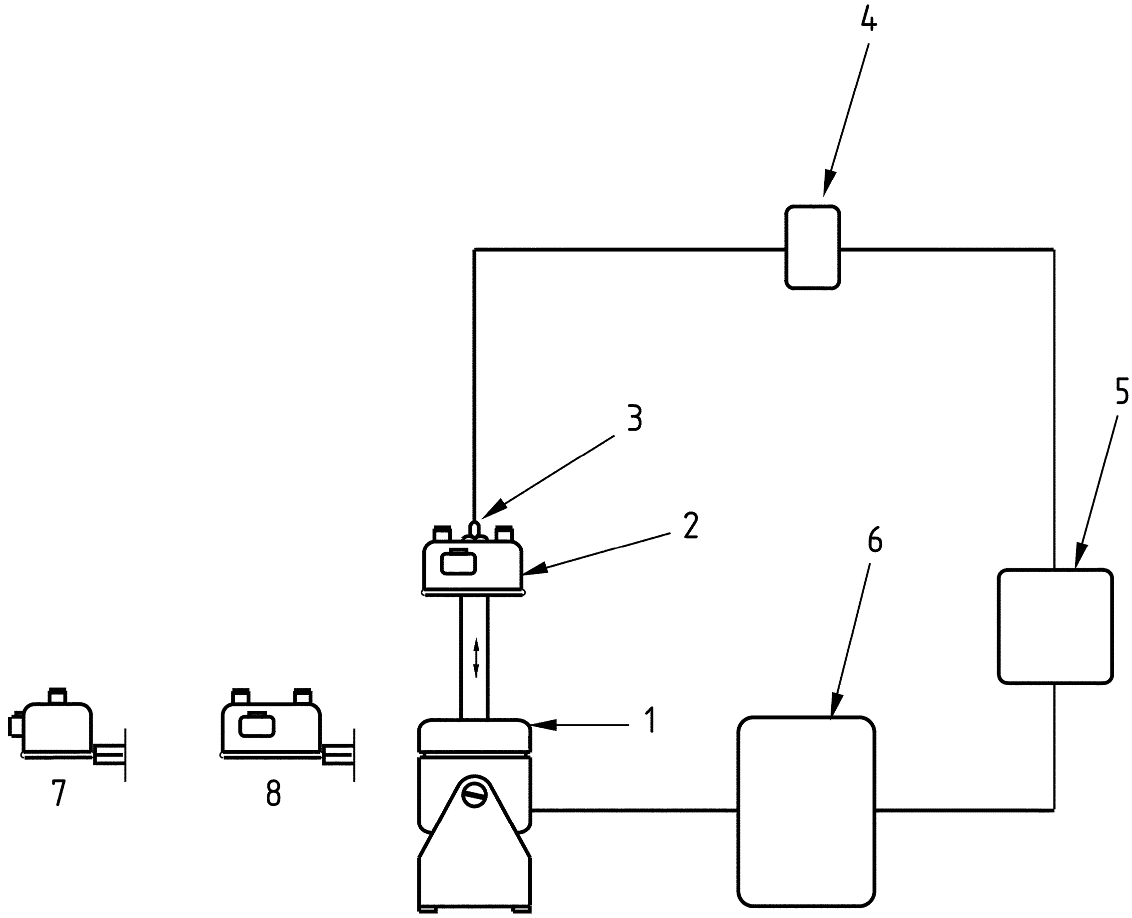
Carry out the test specified in 5.3.2 a) at 0,1 Q_{max} and Q_{max}.

Secure the meter to the vibration test rig, a diagrammatic layout of which is shown in Figure 5, by means of a horizontal clamp across the top of the meter.

In Figure 5, the meter (2) is shown mounted to the spindle of an electrodynamic shaker (1), which is driven by an amplified sine wave from a voltage generator. The head of the shaker can be rotated through 90° for the fore-aft and lateral planes.

The acceleration level is sensed using an accelerometer (3) (piezoelectric transducer) whose output is conditioned using a charge amplifier (4).

An automatic vibration exciter control (5), which is inserted between the conditioned accelerometer signal and the power amplifier (6), is used in a sweeping mode in which the frequency is cycled between a pair of selected frequencies, alternatively increasing and decreasing.



Key

1 electrodynamic shaker
2 meter under test
3 accelerometer
4 charge amplifier
5 automatic vibration exciter control
6 power amplifier
7 ror-aft plane
8 lateral plane

Figure 5 — Diagrammatic layout of the vibration test apparatus

Subject the meter to a swept frequency of between (10 ± 0,5) Hz and (150 ± 7,5) Hz at a sweep rate of 1 octave per minute with a peak acceleration of (2 ± 0,1) *g*, for 20 sweeps in the vertical plane, 20 sweeps in the fore-aft plane and 20 sweeps in the lateral plane.

Recheck the mean errors of the meter, by carrying out the test specified in 5.3.2 a) at Q_{min}, 0,1 Q_{max} and Q_{max} and confirm the leak tightness by carrying out the test described in 6.2.3.2.

NOTE 1 The clamping force should be sufficient to restrain the meter without causing damage or distortion to the meter case.

NOTE 2 An octave is a band of frequency where the upper frequency limit of the band is exactly twice the lower limit, e.g. 10 Hz to 20 Hz, 20 Hz to 40 Hz, 40 Hz to 80 Hz and 80 Hz to 160 Hz.

The time to sweep from 10 Hz to 100 Hz at a sweep rate of 1 octave per minute is 3 min 15 s.

6.2.8 Resistance to impact

6.2.8.1 Requirement

The meter shall remain leak tight, in accordance with 6.2.4.1, after being subjected to an impact load using the method described in 6.2.8.2.

6.2.8.2 Test

Test the meter in accordance with 6.2.4.2 and perform the impact load test as follows.

The test apparatus consists of a hardened steel hemispherical tipped striker and a rigid smooth-bore tube in which the striker is capable of sliding freely (see Figure 6).

The total mass of the striker is 3 kg. There are two sizes of striker tip, one having a radius of 1 mm, the other having a radius of 4 mm (see Figure 7).

Use both sizes of striker tip during the test, but do not subject any test area on any one meter sample to more than one impact for each size of striker. In the case of the same area being selected for test with each size of striker tip, use two meter samples.

For each strike, rigidly support the meter on a firm base with the intended area of impact, which can be any area of the meter case, horizontal. Place the end of the guide tube on the chosen impact area of the meter. Allow the striker to fall freely and vertically through the tube onto the test area. The striker tip falls from a height of h mm above the test area, where:

a) for the 1 mm striker, *h* is 100 mm thus producing an impact energy of 3 J and

b) for the 4 mm striker, *h* is 175 mm thus producing an impact energy of 5 J.

NOTE The impact energy, *E*, (joules) is given by the equation:

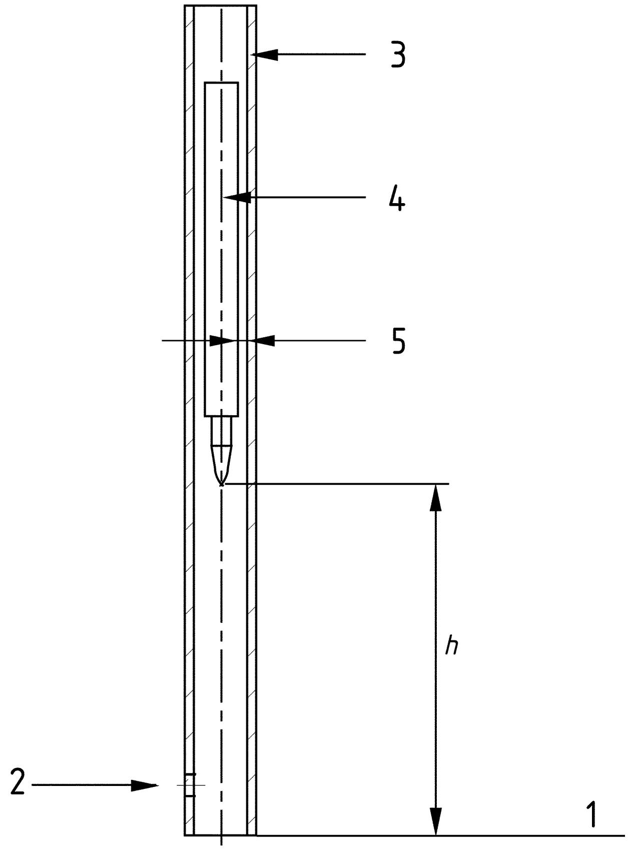
$$E = m \cdot g \cdot h$$

where

- m is the mass, in kilograms (kg);
- g is the acceleration due to gravity, in metres per square second ($m \cdot s^{-2}$);
- h is the height of fall, in metres (m).

Test the meter again in accordance with 6.2.4.2.

Dimensions in millimetres

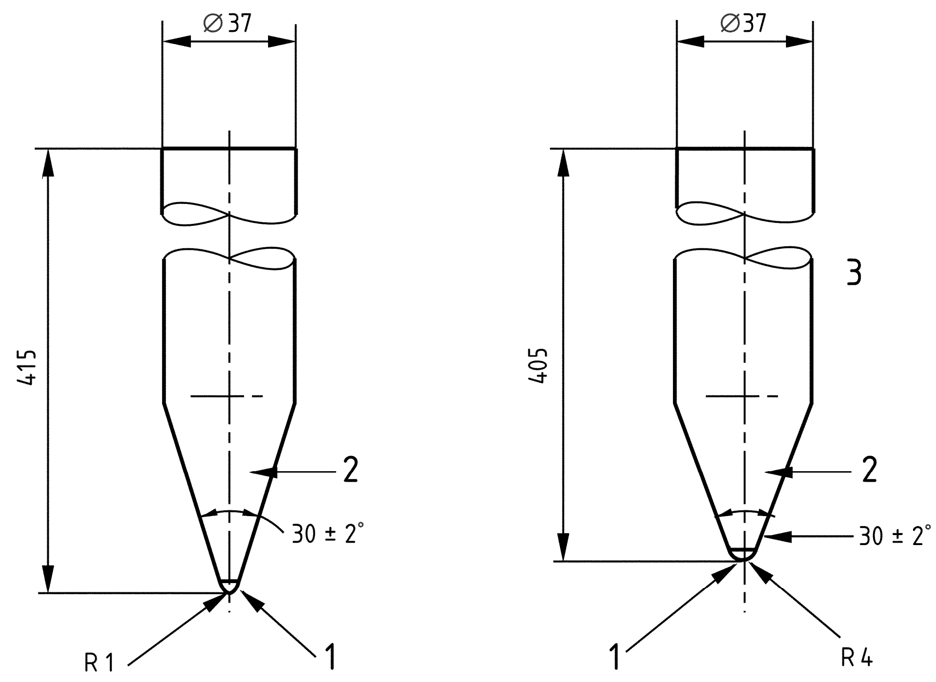


Key

1 meter level
2 vent hole
3 smooth bore rigid tube
4 hardened hemispherically tipped striker of mass 3 kg
5 radial clearance (0,5 ± 0,25)

Figure 6 — Impact test apparatus

Dimensions in millimetres



Key

1 hardened steel ball
2 steel
3 total mass of each striker 3 kg

Figure 7 — Typical hemispherically tipped strikers used in impact test

6.2.9 Resistance to mishandling

6.2.9.1 Requirements

When tested in accordance with 6.2.9.2, the meter shall remain leak tight in accordance with 6.2.4.1 and the mean errors shall remain within 2 *MPE* specified in Table 4.

6.2.9.2 Test

Hold the meter, with no packaging, in the upright position (in its horizontal plane), and drop vertically, from rest, on to a flat, hard, horizontal surface from a height of 0,5 m. This height refers to the distance from the base of the meter to the surface onto which it will fall.

Test the meter in accordance with 5.3.2 a) at 0,1 Q_{max} and $Q_{max.}$

6.3 Corrosion protection

6.3.1 General

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

Tests shall be performed on the gas containing components themselves or on sample plaques.

Sample plaques shall only be used in place of a component if no forming operations are carried out on the component after any protective or decorative finish has been applied.

Sample plaques, if used, shall be approximately 100 mm square in size, their thickness being that of the component they are replacing, unless otherwise specified by the meter manufacturer.

Any finishes on items supplied for test shall have been fully dried and cured.

Attack at the edges or up to 2 mm from the edge of sample plaques shall be ignored if the component it replaces has no exposed edges when fully installed in the finished meter.

For resistance to external corrosion, gas-containing components shall comply with 6.3.2.1 to 6.3.2.6 unless the manufacturer declares that these are manufactured from base materials that are corrosion resistant. In this case, the base materials shall comply with 6.3.3.1 to 6.3.3.3, in accordance with the appropriate subclauses dependant on whether the material is metallic or non-metallic and the tests shall be carried out with no additional protection.

For resistance to internal corrosion, gas-containing components shall comply with 6.3.4.1 to 6.3.4.4 unless the manufacturer declares that these are manufactured from base materials that are corrosion resistant. In this case, the base materials shall comply with 6.3.5.1 to 6.3.5.2, in accordance with the appropriate subclauses dependant on whether the material is metallic or non-metallic and the tests shall be carried out with no additional protection.

6.3.2 Protection against external corrosion for material which is not corrosion resistant

6.3.2.1 Scratch resistance of the protective coating

6.3.2.1.1 Requirements

After testing as described in 6.3.2.1.2, corrodible base material shall not be exposed.

6.3.2.1.2 Test

Test in accordance with ISO 1518, using a loading of 19,6 N.

Where a metallic protective coating is applied directly onto a metal surface, the indicator lamp will light without any penetration of the surface. In this case the surface is to be visually inspected for penetration.

6.3.2.2 Adhesion of the protective coating

6.3.2.2.1 Requirement

After testing as described in 6.3.2.2.2, the result shall be less than classification 2 given in EN ISO 2409.

6.3.2.2.2 Test

Test in accordance with EN ISO 2409.

6.3.2.3 Impact resistance of the protective coating

6.3.2.3.1 Requirements

There shall be no cracking or loss of adhesion of the protective coating when tested for impact resistance in accordance with 6.3.2.3.2.

6.3.2.3.2 Test

Test in accordance with the method given in EN ISO 6272-1.

The falling height shall be 0,5 m.

The depth of the indentation shall be limited to 2,5 mm.

During the test, place the surface of the test piece that would normally be the outside surface of the meter, so that it faces upwards.

6.3.2.4 Chemical resistance of the protective coating

6.3.2.4.1 Requirements

After testing in accordance with 6.3.2.4.2, any blistering of the protective coating shall be less than that given as the degree of blistering 2/(S2) in Figure 1 a) of EN ISO 4628-2:2003, and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of EN ISO 4628-3:2003.

The samples used for these tests shall be complete meters.

6.3.2.4.2 Test

Test in accordance with 7.4 of EN ISO 2812-1:1994, procedure A, using a test period of 168 h.

During the tests, immerse at least 30 % of the sample in the liquid, including the area at which the meter case joins the meter connection, a separate sample being used for each of the following test liquids:

a) mineral oil — ASTM oil Nr.2 according to ASTM D 471 [Aniline point (93 ± 3) °C/Viscosity 19,2 mm^2/s to 21,5 mm^2/s at 99 °C];

b) Ethanol (C_2H_5OH);

c) 5 % aqueous solution of sodium salts of sulphated broadcut primary alcohol, chain length C_9 to C_{13} pH values 6,5 to 8,5 (e.g. Shell Teepol HB7[2)]) ($N_2SO_4(CH_2)_xOH$).

2) This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of the product named. Equivalent products can be used if they can be shown to lead to the same results.

6.3.2.5 Resistance to salt spray

6.3.2.5.1 Requirements

After testing in accordance with 6.3.2.5.2, the degree of corrosion shall not be greater than that given as *R*i 1 in Table 1 of EN ISO 4628-3:2003.

The sample used for this test shall be a complete meter.

6.3.2.5.2 Test

Test in accordance with EN ISO 9227, using a test duration of 500 h.

6.3.2.6 Resistance to humidity

6.3.2.6.1 Requirements

After testing in accordance with 6.3.2.6.2, any blistering of the coating shall be less than that given as the degree of blistering 2/(2) in Figure 1 a) of EN ISO 4628-2:2003 and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of EN ISO 4628-3:2003.

6.3.2.6.2 Test

Test in accordance with EN ISO 6270-1, using a test duration of 340 h.

6.3.3 Protection against external corrosion for corrosion resistant material

6.3.3.1 Chemical resistance

6.3.3.1.1 Requirements (metallic material)

When tested in accordance with 6.3.3.1.2, there shall be no signs of pitting, or of corrosion deposits.

6.3.3.1.2 Test (metallic material)

Test in accordance with 6.3.2.4.2.

6.3.3.1.3 Requirements (non-metallic material)

After being tested in accordance with 6.3.3.1.4, the sample plaques or meters shall withstand the impact test given in 6.2.8.2.

6.3.3.1.4 Test (non-metallic material)

Test the sample plaques or meters, after they have been subjected to the tests given in 6.3.3.1.2, in accordance with 6.2.8.2.

6.3.3.2 Resistance to salt spray

6.3.3.2.1 Requirements (metallic material)

When tested in accordance with 6.3.3.2.2, there shall be no signs of pitting or corrosion deposits.

6.3.3.2.2 Test (metallic material)

Test in accordance with 6.3.2.5.2.

6.3.3.2.3 Requirements (non-metallic material)

After being tested in accordance with 6.3.2.5.2, the sample plaques or meters shall withstand the impact test given in 6.2.8.2.

6.3.3.2.4 Test (non-metallic material)

Test the sample plaques or meters, after being subjected to the tests given in 6.3.2.5.2, in accordance with 6.2.8.2.

6.3.3.3 Resistance to humidity

6.3.3.3.1 Requirements (metallic material)

When tested in accordance with 6.3.3.3.2, there shall be no signs of pitting or corrosion deposits.

6.3.3.3.2 Test (metallic material)

Test in accordance with EN ISO 6270-1, using a test duration of 120 h.

6.3.3.3.3 Requirements (non-metallic material)

After being tested in accordance with 6.3.3.3.4, the sample plaques or meters shall withstand the impact test given in 6.2.8.2.

6.3.3.3.4 Test (non-metallic material)

Test the sample plaques or meters in accordance with 6.3.3.3.2 and then in accordance with 6.2.8.2.

6.3.4 Protection against internal corrosion for material which is not corrosion resistant

6.3.4.1 Adhesion of the protective coating

6.3.4.1.1 Requirement

After being tested in accordance with 6.3.4.1.2, the result shall be less than classification 2 given in EN ISO 2409.

6.3.4.1.2 Test

Test in accordance with EN ISO 2409.

6.3.4.2 Impact resistance of the protective coating

6.3.4.2.1 Requirement

There shall be no cracking or loss of adhesion of the protective coating when tested for impact resistance in accordance with 6.3.4.2.2.

6.3.4.2.2 Test

Test in accordance with EN ISO 6272-1.

The falling height is 0,5 m.

The depth of the indentation is limited to 2,5 mm.

During the test, the surface of the test piece that would normally be the inside surface of the meter is placed facing downwards and it is this surface which is to be examined.

6.3.4.3 Chemical resistance of the protective coating

6.3.4.3.1 Requirements

After testing in accordance with 6.3.4.3.2, any blistering of the protective coating shall be less than that given as the degree of blistering 2/(2) in Figure 1 a) of EN ISO 4628-2:2003 and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of EN ISO 4628-3:2003.

The sample used for these tests shall be representative parts of the meter, which include at least one of the connections.

6.3.4.3.2 Test

Test in accordance with 7.4 of EN ISO 2812-1:1994, procedure A, using a test period of 168 h.

During the tests, immerse at least 30 % of the sample in the liquid, including the area at which the meter case joins the meter connection, a separate sample being used for each of the following test liquids:

a) mineral oil – ASTM oil Nr. 2 according to ASTM D471/79
[Aniline point (93 ± 3) °C/Viscosity 19,2 mm^2/s to 21,5 mm^2/s at 99 °C];

b) ASTM Reference petrol B according to ASTM D471/79 (this corresponds to a mixture of 30 % toluene/70 % iso-octane by volume);

c) Diethylene glycol ($C_4H_{10}O_3$).

6.3.4.4 Resistance to humidity

6.3.4.4.1 Requirements

After testing in accordance with 6.3.4.4.2, any blistering of the coating shall be less than that given as the degree of blistering 2/(2) in Figure 1 a) of EN ISO 4628-2:2003 and the degree of corrosion shall be not greater than that given as *R*i 1 in Table 1 of EN ISO 4628-3:2003.

6.3.4.4.2 Test

Test in accordance with EN ISO 6270-1, using a test duration of 48 h.

6.3.5 Protection against internal corrosion for corrosion resistant material

6.3.5.1 Chemical resistance

6.3.5.1.1 Requirements (metallic material)

When tested in accordance with 6.3.5.1.2, there shall be no signs of pitting or corrosion deposits.

6.3.5.1.2 Test (metallic material)

Test in accordance with 6.3.4.3.2.

6.3.5.1.3 Requirements (non-metallic material)

After testing in accordance with 6.3.5.1.4, the sample plaques or meters shall withstand the impact test given in 6.2.8.2.

6.3.5.1.4 Test (non-metallic material)

Test the sample plaques or meters in accordance with 6.3.5.1.2 and then in accordance with 6.2.8.2.

6.3.5.2 Resistance to humidity

6.3.5.2.1 Requirements (metallic material)

When tested in accordance with 6.3.5.2.2, there shall be no signs of pitting or corrosion deposits.

6.3.5.2.2 Test (metallic material)

Test in accordance with 6.3.4.2.2.

6.3.5.2.3 Requirements (non-metallic material)

After testing in accordance with 6.3.5.2.4, the sample plaques or meters shall withstand the impact test given in 6.2.8.2.

6.3.5.2.4 Test (non-metallic material)

Test the sample plaques or meters in accordance with 6.3.4.4.2 and then in accordance with 6.2.8.2.

6.4 Casework decorative finish

6.4.1 Scratch test

6.4.1.1 Requirements

After testing the decorative finish (i.e. finish without corrosion protection) or a sample plaque in accordance with 6.4.1.2, the finish shall not be fully penetrated neither shall any jagged edges extend by more than 1 mm from any scratch mark.

6.4.1.2 Test

Test in accordance with ISO 1518 using a spring force of 9,8 N.

6.4.2 Humidity

6.4.2.1 Requirements

After testing the decorative finish or a sample plaque in accordance with 6.4.2.2, there shall be no lifting of the coat.

Any blistering shall be less than that given as a degree of blistering 2/(2) in Figure 1 a) of EN ISO 4628-2:2003.

6.4.2.2 Test

a) Subject the finish to the scratch test in 6.4.1.2.

b) Test in accordance with EN ISO 6270-1, for a duration of 340 h.

6.5 Ageing of non-metallic casework

6.5.1 Requirements

When tested in accordance with 6.5.2, the meters shall satisfy the requirements of 6.2.4.1.

6.5.2 Test

a) Expose a complete meter to ultraviolet exposure for five periods, each of 8 h duration, using a suspended sun lamp that has been in use for a total of not less than 50 h and not more than 400 h.

   Ensure that the light source of the sun lamp is a combination tungsten filament mercury arc, enclosed in glass that has a low transmission below 280 nm, the glass envelope is conical and silvered internally to form a reflector and that the lamp is rated between 275 W and 300 W.

   Position the sample with its normally exposed surface facing the lamp, 400 mm below the bottom of the lamp and on the axis of the lamp. Ensure that the surrounding air is not confined and is free to circulate.

   After each exposure except the last, immerse the sample completely in de-ionized water for 16 h. Clean and carefully dry it with cotton wool after each immersion period.

   Test in accordance with 6.2.8.2.

b) Heat a separate meter in air at (100 ± 3) °C for 24 h.

   Test in accordance with 6.2.8.2.

6.6 Ageing of external surfaces of the meter, including index windows and adhesion of the index window

6.6.1 Requirements

After testing separate meters in accordance with 6.6.2, the following requirements apply:

a) the external surfaces of the meter shall not sustain damage that will affect the function of the meter;

b) the index window shall not become detached, crazed or blistered and the index shall remain clearly visible through the window from a minimum of 15° from the normal to the window;

c) the meter shall continue to register the volume of gas.

6.6.2 Test

a) Test a meter in accordance with radiation test 6.5.2 a).

b) Test a separate meter heated in air at (90 ± 3) °C for 24 h.

c) Drop a solid steel ball of 25 mm diameter three times from a height of 350 mm normal to the surface of the meter while in the operating condition and maintained at a temperature of (–5 ± 1) °C. Repeat the test for each external surface of the meter including the index window.

6.7 Protection against solar radiation

6.7.1 Requirements

After the test specified in 6.7.2, the visual appearance of the meter shall not alter and the meter index shall still be legible.

6.7.2 Test

Perform a visual inspection of the meter.

Carry out the procedure according to EN 60068-2-5 under the following conditions:

a) with the meter in the non-operating condition, i.e. not connected to gas lines;

b) test procedure A (8 h irradiation and 16 h darkness);

c) upper temperature of 55 °C;

d) a test of 3 days duration (3 cycles).

Perform a second visual inspection of the meter.

6.8 Resistance to external humidity

6.8.1 Requirements

After the completion of the test specified in 6.8.2, the meter shall satisfy the following requirements:

a) there shall be no evidence of damage or change of information;

b) the meter shall remain leak tight in accordance with 6.2.4.1;

c) there shall be no visual evidence of corrosion of the internal electronic circuits likely to affect the functional properties of the meter, nor shall there be any apparent degradation of protective coatings (e.g. lacquer);

d) the errors of these meters shall not exceed the following:

— Class 1,5 Mean error: 2 *MPE*; Error shift: 2 % between Q_t to Q_{max};

— Class 1,0 Mean error: *MPE*; Error shift: one third of the *MPE* in Table 4.

6.8.2 Test

Test the meter in each orientation, where more than one installation orientation is specified by the manufacturer.

Test the meter in accordance with 5.3.2 a) but at 0,1 Q_{max} and $Q_{max.}$

Carry out the procedure for the effects of humidity in accordance with EN 60068-2-30, under the following conditions:

a) with the meter in normal conditions of operation;

b) with all voltage circuits energized by the battery;

c) upper temperature of (40 °C if the upper rated temperature does not exceed 40 °C, or 55 °C if the upper rated temperature is greater than 40 °C);

d) no special precautions shall be taken regarding the removal of surface moisture;

e) a duration of test of at least two cycles.

24 h after these tests, test the meter again in accordance with 5.3.2 a) but only at 0,1 Q_{max} and $Q_{max.}$

6.9 Flame retardance of external surfaces

6.9.1 Requirements

All external surfaces of the meter (including the index window) and gas containing casework material shall not support combustion. The material shall have a flammability rating of V-0 in accordance with EN 60707.

6.9.2 Test

Subject the external surfaces of the meter to the flame test as specified in EN 60695-11-5. Apply the flame to the edges, corners and surfaces of the casing, each for a period of 30 s.

6.10 Resistance to storage temperature range

6.10.1 Requirement

When tested in accordance with 6.10.2, the mean errors shall stay within the *MPE* specified in Table 4.

6.10.2 Test

Test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

Maintain the meter, with no gas flowing through it, under the following conditions:

— 3 h at a temperature of –20 °C, or lower if declared by the manufacturer;

— 3 h at a temperature of +60 °C, or higher if declared by the manufacturer.

At the end of each period, return the meter to normal laboratory ambient temperature and test in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

6.11 Resistance to the effects of toluene/iso-octane vapour

6.11.1 Requirements

When tested in accordance with 6.11.2, the mean errors after any stage of the test shall remain within the *MPE* specified in Table 4.

6.11.2 Test

6.11.2.1 General

Test the meter in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max}.

Pass nitrogen, to which has been added approximately 3 % by gaseous volume of 30 % toluene/70 % iso-octane mixture (see 6.11.2.2) through the meter, for a minimum of 42 days (1 008 h) at (20 ± 2) °C, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max}.

Check the mean errors of the meter every 7 days (168 h) in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max} until a steady state of mean errors is attained (see NOTES 1, 2).

It is permissible, as an alternative method, to exercise the meter with air having a relative humidity of (85 ± 5) % for the complete period of 42 days (1 008 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max} and then test the meter in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max}.

NOTE 1 A steady state is considered to be attained if the movement in registration between two consecutive tests is less than the uncertainty of measurement as calculated using ISO/TR 5168, or if there is a reverse in the movement over a period of 14 days (336 h).

NOTE 2 It is important that, when removing the meter from the exercise rig in order to check the error of indication at the 7 day intervals, the meter ports be sealed, to prevent the ingress of air, until the error of indication is about to be checked.

Exercise the meter with air for a further period of 7 days (168 h) at (20 ± 2) °C, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max}.

Test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

6.11.2.2 Example of a typical apparatus

Referring to Figure 8, the apparatus consists of the following components:

a) a meter exercise rig (A), open to atmosphere, fitted with a suitable circulating pump or blower;

b) a nitrogen supply with a flow rate measurement capability (B) (rotameter, meter or both);

c) relative humidity control (C), comprising a water reservoir and valves capable of giving a relative humidity of (65 ± 10) %. The relative humidity is measured by a hair or paper hygrometer or by a moisture meter;

d) solvent addition (D). The toluene/iso-octane mixture is added to the top of the vaporization tower by means of a micro-metering pump. The tower has a bottom diffuser plate and is filled with alternative layers of small glass beads and cotton fabric (or other similar material) to give a large surface area. The tower is surrounded with a heating blanket that produces a high temperature at the blanket/tower interface to speed up vaporization.

6.11.2.3 Procedure

Allow the toluene/iso-octane mixture (see 6.11.2.4) to percolate down the tower and vaporize. Introduce the carrier gas, at a controlled flow rate, through the diffuser at the bottom of the tower where it picks up the vaporized solvent. Pass the gaseous mixture into the exercise rig where it is circulated through the meter. A fresh supply of solvent is continuously added to give a stable concentration.

6.11.2.4 Preparation of 3 % by volume of a 30 % toluene/70 % iso-octane mixture with nitrogen

It is estimated that under conditions of normal temperature and pressure 1 mole of an ideal gas would occupy 22,4 l. Whilst the vapours of toluene and iso-octane cannot be considered ideal, this principle has been used to calculate the (approximate) concentration of 3 % by volume of a 30 % toluene/70 % iso-octane mixture in nitrogen.

6.11.2.5 Calculation

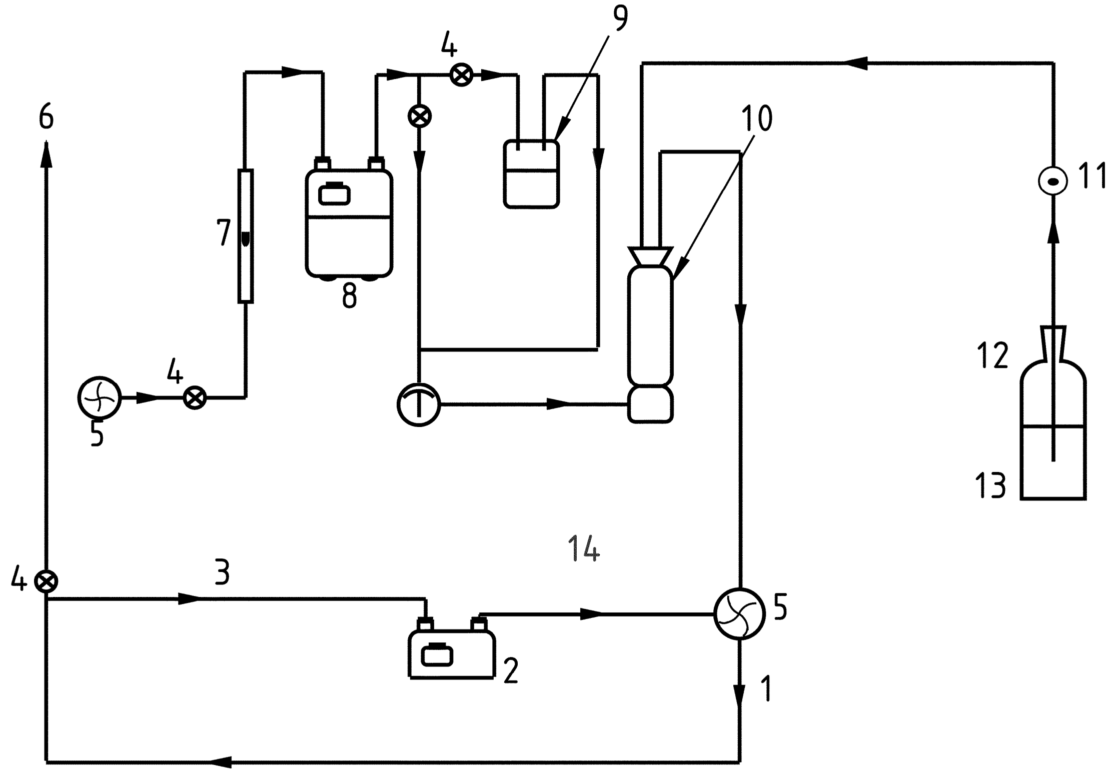
Toluene has a molecular mass of 92,13 and a density of 0,866 94 g/ml.
Iso-octane has a molecular mass of 114,23 and a density of 0,691 8 g/ml.

92,13 g = 106 ml toluene will occupy 22,4 l at normal temperature and pressure (NTP).
114,23 g = 165 ml iso-octane will occupy 22,4 l at normal temperature and pressure (NTP).

A 3 % dosage of 30/70 toluene/iso-octane mixture will therefore require:
0,9 % toluene = 95,4 ml toluene and 2,1 % iso-octane = 346,5 ml iso-octane (per 2 240 l of carrier gas).

The total volume of solvent mixture to be added to 2 240 l of carrier gas to give a 3 % concentration by volume of 30 % toluene/70 % iso-octane is 441,9 ml. This is equivalent to 0,197 ml per litre of carrier gas.

NOTE The actual amount of solvent to be added to the system will be dependent on the carrier gas flow rate and the conditions inside the tower.



Key

1	meter exercise rig (A)	8	gas meter for volume check
2	meter on exercise	9	water reservoir for moisture adjustment
3	gas provision and measurement (B)	10	vaporization tower filled with alternative layers of glass beads and cotton fabric and surrounded by a heating blanket
4	valve	11	micro-metering pump
5	blower	12	toluene/iso-octane reservoir
6	exhaust	13	solvent addition (D)
7	rotameter	14	moisture meter relative humidity control (C)

Figure 8 — Typical apparatus for toluene/iso-octane test

6.12 Resistance to water vapour

6.12.1 Requirements

When tested in accordance with 6.12.2, the mean errors shall remain within the *MPE* specified in Table 4.

6.12.2 Test

Test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

Connect the meter to the water vapour test rig (see Figure 9).

In Figure 9, the meter (3) is shown connected to a test rig which consists of a closed circuit containing a suitable circulating pump or blower (4), a chamber containing either a saturated solution of potassium acetate (CH_3COOK) to give a relative humidity of 20 % at 20 °C or a saturated solution of potassium hydrogen sulphate ($KHSO_4$) to give a relative humidity of 86 % at 20 °C (1), and a hair or paper hygrometer with a range of 0 % to 100 % relative humidity (2).

Exercise the meter with air having a relative humidity of less than 20 % for 7 days (168 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max}. At the end of this period test the meter in accordance with 5.3.2 a) but only at 0,1 Q_{max} and Q_{max}.

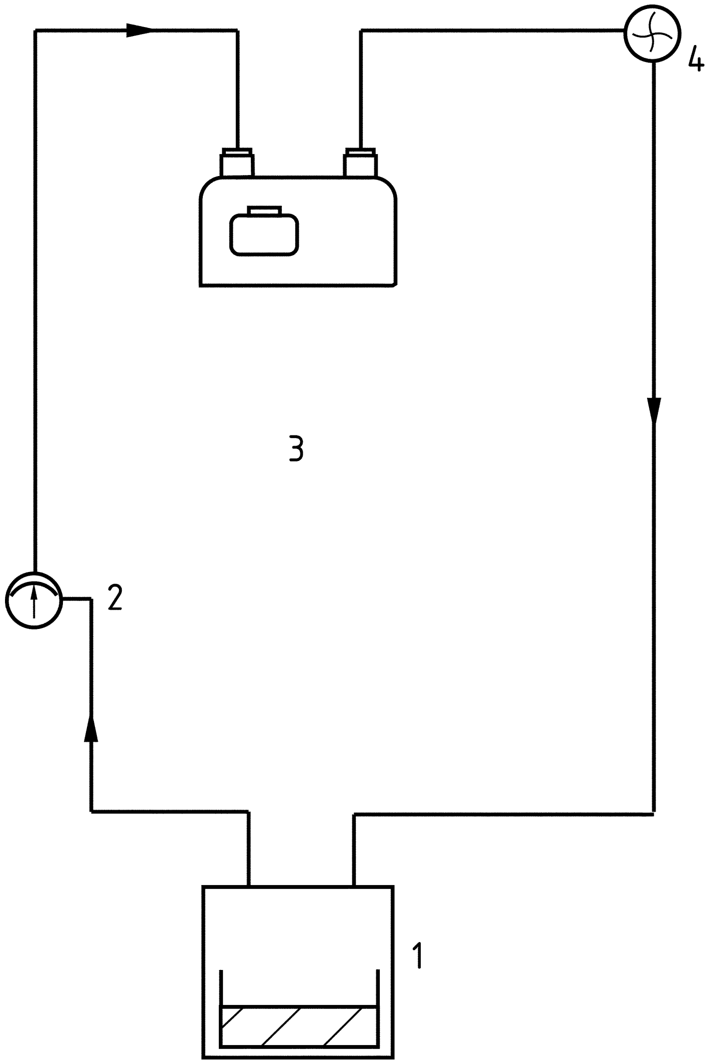
On completion of this low humidity performance test, exercise the meter with air having a relative humidity of (85 ± 5) % for a minimum of 42 days (1 008 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max}. Check the error of indication every 7 days (168 h) in accordance with 5.3.2a), until a steady state of error of indication is attained. (See NOTE below.)

It is permissible as an alternative method to exercise the meter with air having a relative humidity of (85 ± 5) % for the complete period of 42 days (1 008 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max} and then test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

Exercise the meter with air having a relative humidity of less than 20 % for at least 7 days (168 h) at (20 ± 2) °C and at a flow rate of not less than 0,25 Q_{max}.

Test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

NOTE A steady state is considered to be attained if the movement in registration between two consecutive tests is less than the uncertainty of measurement as calculated using ISO/TR 5168, or if there is a reverse in the movement over a period of 14 days (336 h).



Key

1 saturated solution for humidity control
2 moisture meter
3 meter on exercise
4 circulating blower

Figure 9 — Example of a water vapour test apparatus

6.13 Ageing

6.13.1 Requirements

Where more than one installation orientation is specified by the manufacturer, a meter shall be tested in each orientation.

When meters are tested in accordance with 6.13.2, the errors of these meters shall not exceed the following:

— Class 1,5 Mean error: 2 *MPE*; Error shift: 2 % between Q_t to Q_{max};

— Class 1,0 Mean error: MPE; Error shift: one third of the *MPE* in Table 4.

6.13.2 Test

Test the meter in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

Open the meter to atmosphere and hold it at any one of the temperatures given in Table 9, for the appropriate time period given in Table 9. The manufacturer declares the temperature at which the test is to be carried out.

Table 9 — Temperature times/ageing periods

Temperature °C	**Time period** Days
70	50
60	100
50	200

At the end of this period, the meter is slowly returned to a temperature of 20 °C ± 2 °C, at a rate of not more than 2 °C/h, and again tested in accordance with 5.3.2 a), but only at 0,1 Q_{max} and Q_{max}.

7 Optional features

7.1 Pressure measuring point

7.1.1 Requirements

If a pressure measuring point is provided on the meter:

a) the maximum diameter of the hole through the pressure measuring point shall be 1 mm;

b) the meter shall remain leak tight after carrying out tests specified in 7.1.2 b).

7.1.2 Test

a) Measure the diameter of the hole through the pressure measuring point.

b) Initially check the meter for leak tightness in accordance with 6.2.4.2.

Apply a torque of 4 N · m to the pressure measuring point in a clockwise and then anti-clockwise direction and then release. Drop a mass of 0,5 kg from a height of 250 mm, through a vertical tube, onto the outer extremity of the body of the pressure measuring point.

Recheck the meter for leak tightness in accordance with 6.2.4.2.

7.2 Resistance to high ambient temperature

7.2.1 Requirements

Where the manufacturer declares that the meter is resistant to high ambient temperatures, the meter shall conform to the following requirements:

a) the leakage rate of the meter case, when tested in accordance with 7.2.2, shall not exceed 150 dm^3 / h;

b) the meter shall be marked in accordance with 9.1.

7.2.2 Test

7.2.2.1 Apparatus

The furnace (see Figure 10) shall allow an ambient temperature rise according to the curve defined in ISO 834-1.

The dimensions of the furnace shall allow the installation of the meter and its connections to be in identical positions to those used in practice.

Make arrangements to maintain a constant pressure equal to 100 mbar during the complete test.

7.2.2.2 Test procedure

Connect the meter to the inlet and outlet connections and install the whole in the centre of the furnace using supports if necessary.

With the bleed valve closed, pressurize the meter to 100 mbar with nitrogen and verify its tightness.

With the meter under the nitrogen test pressure, increase the temperature of the furnace according to the temperature rise curve of ISO 834-1.

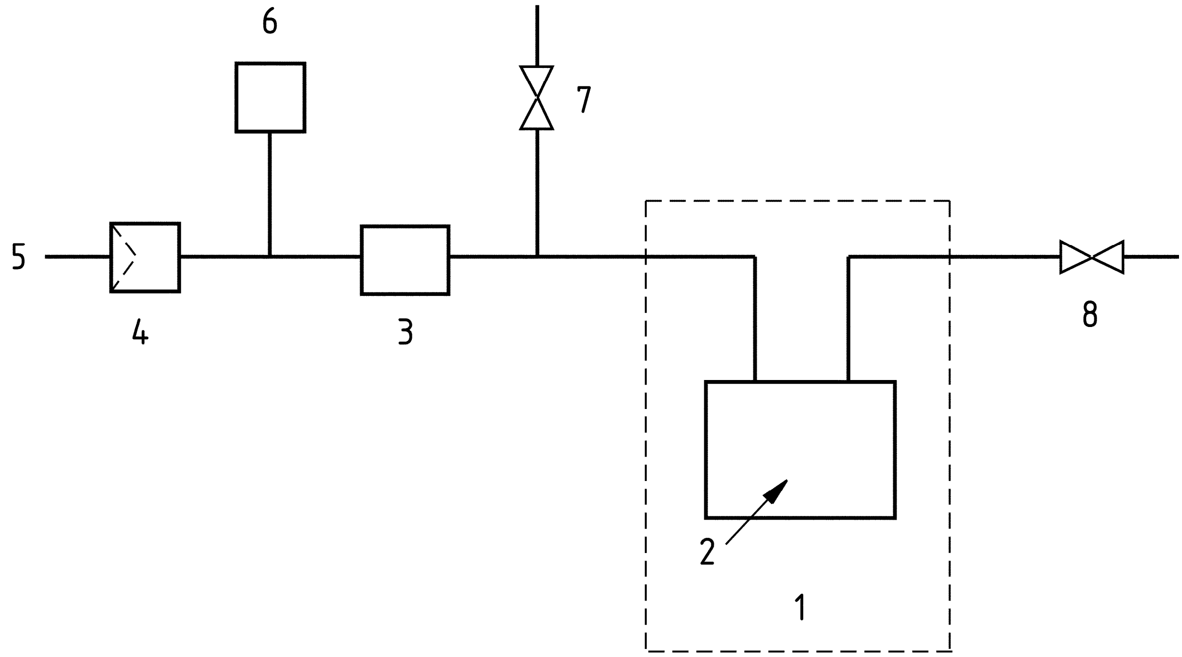
When the temperature at the coldest point of the meter reaches 650 °C, control the furnace temperature to maintain at that point a constant temperature of 650 °C for a period of 30 min.

During the complete test, maintain the pressure in the meter at the test pressure by means of the bleed valve. The leakage rate is registered by successive metering, the metering periods not exceeding 5 min.

The leakage is the quotient of the metered nitrogen volume by the measuring time.

NOTE 1 Air can be used in place of nitrogen in this test, but be aware that it can support the combustion of volatile emissions.

NOTE 2 To avoid blocking of the outlet connections by condensation of materials distilled from the internal components of the meter, it is preferable to carry out the test on an empty meter case, supplied as such by the manufacturer. If this is not possible, the outlet pipe of the apparatus should be inclined downwards and a safety tap for the removal of condensation products installed upstream of the bleed valve.



Key

1	furnace	5	inlet
2	meter at centre of furnace	6	pressure gauge
3	check meter	7	bleed valve
4	pressure regulator	8	air purge valve

Figure 10 — Example of a high ambient temperature test apparatus

7.2.3 Meter fitted with a thermal shut-off valve

7.2.3.1 Requirements

The thermal shut-off valve shall not close when tested in accordance with 7.2.3.2.

7.2.3.2 Test

Maintain the shut-off valve at (70 ± 1) °C for 7 days.

7.3 Meters with temperature conversion

For requirements and tests, see Annex C.

7.4 Ancillary devices (if fitted)

7.4.1 Requirement

If ancillary devices are fitted, for example prepayment or remote reading devices, they shall not affect the metrological characteristics of the meter, nor obscure the markings specified in 9.1.

Ancillary devices approved by the meter manufacturer shall not compromise the battery life specified in 12.4.

7.4.2 Test

With the ancillary device fitted, the meter shall be tested in accordance with 5.3.2 a).

Confirm by visual inspection that the markings are not obscured.

7.5 Use in hazardous zones

Where the manufacturer declares that the meter is suitable for use in hazardous zones as defined in EN 60079-10, the design, construction and marking of the meter shall then comply with EN 60079-0 and prEN 60079-11, or EN 60079-0 and EN 60079-15, as appropriate.

8 Index

8.1 Recording and storage

8.1.1 Requirement

The recorded cumulative volume shall be shown by the display and stored in a non-volatile storage device for a minimum of 36 months. The manufacturer shall declare the memory retention time.

8.1.2 Test

Confirm by visual inspection. The memory retention time can be based on calculations from data for the relevant components, or from the results of manufacturer’s own relevant tests.

8.2 Display

8.2.1 Requirement

In addition to an alphabetical flag character, the display shall have a minimum of 8 numerical characters and the last 3 numerical characters shall be decimal places indicating thousandths of a cubic metre, e.g. 02 903,420 b. Any alphabetical flag character chosen shall not be able to be confused as a digit by the user. There shall be a sufficient number of numerals to ensure that after the volume passed during 8 000 h of flow at Q_{max}, the index cannot pass its original value.

The index shall be easily readable without the use of tools and the characters in the display shall have a minimum height of 4,95 mm. The unit of measurement (m^3) shall be unambiguously and boldly displayed, within the index.

The numerals indicating the sub-multiples of the cubic metre shall be clearly distinguishable from the other numerals and they shall be separated from the other numerals by a clearly marked decimal sign.

8.2.2 Test

Confirm by visual inspection and measurement. Where the indicated values, used in the accuracy tests, are obtained exclusively via the communications port, ensure that the inspection confirms that the reading from the communications port(s) is the same as the value registered in the display.

8.3 Segmental display

8.3.1 Requirements

The index shall have a facility to display all its segments (i.e. display registers all '8's) and then display no segments (i.e. blank display). This shall either occur periodically, the period not to exceed one minute, for a maximum duration of 5 s, or through the use of an injected test signal.

When the above display is discontinued, the display shall automatically revert to reading its updated volume measurement and the memory register shall not have been disturbed.

If test signal injection is used, the means of initiating this test signal injection shall be capable of being sealed such that unauthorized interference is detectable, and such that the metrological seal need not be broken to operate this facility.

8.3.2 Test

Confirm by visual inspection and, by using suitable measuring equipment where appropriate, time the various states of the display. If appropriate to the test, inject the test signal in accordance with the method agreed between the manufacturer and the Test House.

8.4 Non-volatile memory

8.4.1 Requirements

The non-volatile memory shall be updated at least every 6 h and shall:

— be accessible at the extremes of the ambient temperature range and

— be maintained without any power source across the maximum and minimum storage temperatures,

as declared by the manufacturer.

When tested in accordance with 8.4.2 a) the non-volatile memory shall remain accessible and constant at the extremes of the temperature range.

When tested in accordance with 8.4.2 b) there shall be no difference between the index readings recorded in 3) and 6).

8.4.2 Test

a) Access to non-volatile memory.

1) Determine a method for accessing the volume index in the non-volatile memory. Ensure that there is no difference between the two readings. The manufacturer shall declare how this can be performed;

2) cap the meter to prevent any registration;

3) note the meter index on the display and in the non-volatile memory;

4) subject the meter to the extremes of ambient temperature, as specified by the manufacturer, for a minimum of 3 h at each temperature;

5) at each of the temperature extremes, at the end of the dwell time, read the volume index from the non-volatile memory.

b) Maintenance of non-volatile memory.

1) Note the meter index;

2) immediately apply a flow rate equal to Q_{max} to the meter for a period of 5 min;

3) confirm that the meter has registered the gas flow, then cap the meter to prevent further registration and immediately note the new meter index and time;

4) leave the meter at room temperature for a minimum of 6 h 5 min after the time noted in 3);

5) remove the battery and subject the meter to the minimum and maximum storage temperatures, as specified by the manufacturer, for a minimum of 3 h at each temperature;

6) reconnect the battery and compare the current index reading with the reading noted in 3).

8.5 Display reset

8.5.1 Requirements

The display, which indicates the total quantity of gas supplied (index), shall not be able to be reset during use.

8.5.2 Test

Confirm by visual inspection the value of the volume index. Using suitable equipment and commands, supplied by the manufacturer, attempt to reset the volume index.

9 Marking

9.1 All meters

Each meter shall be marked with at least the following information:

a) type approval mark and number (if appropriate);

b) identification mark or name of the manufacturer;

c) serial number of the meter and year of manufacture;

d) maximum flow rate, Q_{max} (m^3/h);

e) minimum flow rate Q_{min} (m^3/h);

f) maximum working pressure, p_{max} (bar);

g) ambient temperature range, if greater than -10 °C to +40 °C, e.g. t_m = -20 °C...+55 °C (see 4.3);

h) gas temperature range, if different to -5 °C to +35 °C, e.g. t_g = -10 °C...+40 °C (see 4.3);

i) group(s) of gases for which the meter is approved, for example:

Groups H, L, E, P/B;

j) accuracy of the meter, e.g. Class 1,5.

If the meter is resistant to high temperatures (see 7.2) it shall be marked additionally with a ‘T’.

If the meter is temperature converted it shall be marked additionally with “t_b=” and the base temperature (e.g. t_b = 15 °C).

If the meter has a thermal shut-off valve fitted it shall be marked additionally with an ‘F’.

If the meter is declared suitable for use in an open environment (see Clause 1) it shall be marked additionally with ‘H3’.

The markings shall be in a clearly visible position and shall be durable under the normal conditions of the meter.

If all applicable information cannot be displayed on the meter, this shall be provided on the packaging or with the meter literature.

9.2 Two-pipe meters

9.2.1 Requirements

Meters with two-pipe connections shall be clearly and permanently marked with the direction(s) of flow by means of (an) arrow(s).

9.2.2 Test

Confirm by visual inspection.

9.3 Durability and legibility of marking

9.3.1 Requirements

All required labels shall remain securely fixed, in that their edges shall not lift from the backing surfaces, and the markings on the meter, on the index and on the index plate when viewed through the index window and any separate data plate if fitted, shall remain legible after being subjected to the tests given in 9.3.2 and 9.3.3.

9.3.2 Weathering

9.3.2.1 Closed locations

Expose the assembled index, index plate, index window and samples of the meter labels to ultraviolet exposure for five periods, each of 8 h duration, using a suspended sun lamp that has been in use for not less than 50 h and not more than 400 h.

Ensure that the light source of the sun lamp is a combination tungsten filament mercury arc, enclosed in glass that has a low transmission below 280 nm, that the glass envelope is conical and silvered internally to form a reflector and that the lamp is rated between 275 W and 300 W.

Position the sample with its normally exposed surface facing the lamp, 400 mm below the bottom of the lamp and on the axis of the lamp. Ensure that the surrounding air is not confined and is free to circulate.

After each exposure except the last, immerse the sample completely in de-ionised water for 16 h. Clean and carefully dry it with cotton wool after each immersion.

9.3.2.2 Open locations

Meters suitable for use in open locations shall be marked in accordance with 9.1.

9.3.2.2.1 Requirement

All markings on the meter, the index and index plate when viewed through the index window and any separate data plate, if fitted, shall remain easily legible after being subjected to the test given in 9.3.2.2.2.

Total colour difference measured in accordance with ISO 7724-3 shall be inside the following limits:

DL* ≤ 12

Da* ≤ 6

Db* ≤ 6

Light transmission in accordance with ASTM D1003 shall have Haze in % ≤ 15.

9.3.2.2.2 Test

One meter shall be exposed for 66 days to artificial weathering and exposure to artificial radiation in accordance with EN ISO 4892-3 and the parameters in Table 10. Prior to exposure measurements will be made to enable the test criteria to be assessed.

Table 10 — Weathering test criteria

Test cycle	Wavelength / Lamp type	Irradiance	Black panel-temperature
8 h dry	UVA 340	0,76 W (m^2 · nm) at 340 nm	(60 ± 3) °C
4 h condensation		light out	(50 ± 3) °C

Following exposure the meter shall be visually inspected for legibility. Appropriate tests shall be carried out to check the requirements for colour difference and transmission of light are met.

9.3.3 Indelibility test

All markings on the external surface of the meter, which can be touched when the meter is in normal use, shall satisfy the indelibility tests as specified in Annex A of EN 60730-1:2000.

9.4 Accompanying information

Operating instructions shall be available in written form or as a database and shall identify the name and address of the manufacturer.

Each meter (or a utility responsible for groups of identical meters) shall be delivered with installation, operation and maintenance manuals, in a language acceptable by the user and easily understandable, giving appropriate instructions.

As a minimum, the following information shall be included:

- rated operating conditions;
- mechanical and electromagnetic environment classes;
- suitability of meter for open or closed location;
- family(ies) and/or group(s) of gases for which the meter is approved;
- instructions for installation, maintenance, repair and permissible adjustments;
- instructions for correct operation and any special conditions of use;
- conditions for compatibility with interfaces, sub-assemblies or measuring instruments;
- position(s) of seals;
- expected battery life.

10 Software

10.1 Requirements

Software shall be designed to an established structured design method, allowing the requirements and functional operation of the software to be defined in a precise manner. The software version reference number shall be accessible for each meter. This shall be available through the serial number string.

10.2 Test

Submit the relevant documentation to the Test House.

11 Communications

11.1 General

The meter shall provide access to information stored in the meter's memory via a serial data link. Data shall be provided through a suitable interface.

The information shall, as a minimum, provide for the transmission of the index reading (volatile and non-volatile memory), the meter serial number and the status flag and provision for error detection.

Meter reading devices shall not affect the metrology of the meter.

A facility shall be provided to clear the battery change flag once the battery has been changed. A procedure shall be defined by the manufacturer.

This clause generally refers to EN 62056-21, but with provisions for:

- an alternative sign-off incorporating acknowledgement from the meter;
- a test-mode message structure, to enable common test procedures for gas meters.

NOTE These provisions augment the EN 62056-21 protocol and do not conflict with the provisions or operation of the existing protocol.

All requirements specified within 11.2 to 11.8.2 inclusive, shall be verified by visual inspection.

11.2 Character transmission

Character transmission shall conform to Clause 5 of EN 62056-21:2002.

11.3 Communications protocol

11.3.1 General

The data transmission protocol used by any available interface shall be to Mode C of EN 62056-21.

11.3.2 Wakeup

The meter shall respond to a preliminary wakeup message in accordance with Annex B of EN 62056-21:2002.

11.3.3 Sign-off

Sign off shall be applied as defined in 6.4.3.1 of EN 62056-21:2002, or alternatively as sign-off message 'SOH B 1 ETX BCC' (where SOH = start of header, B 1 is the text to be sent, ETX = end of text character, BCC = block check character) which requires the meter to transmit an ACK character before it terminates the communication session.

NOTE This provides feedback to the communicating equipment that the meter has accepted and will execute the sign-off command. The B0 command does not give an ACK response, forcing communicating equipment to wait up to 1,5 s to infer successful sign-off.

11.3.4 Security

System security shall be provided as defined in EN 62056-21, details of these systems shall be provided by the manufacturer.

11.3.5 Time-outs

11.3.5.1 General

The inter-character and inter-message time-outs shall be as defined in 6.4.3 of EN 62056-21:2002.

11.3.5.2 Inactivity time-out

Inactivity time-out shall be 10 s, 60 s or 120 s.

NOTE This alternative to EN 62056-21:2002 allows a shorter time-out at the discretion of meter manufacturers, to minimize power drain.

11.4 Data

11.4.1 General

The minimum information to be provided via the optical port shall be:

— meter recorded volume (volatile and non-volatile);

- meter serial number;
- meter flag(s).

11.4.2 Data read-out mode

The data read-out mode shall be as specified in 6.4.3.2 of EN 62056-21:2002.

11.5 Test-mode

11.5.1 General

If the meter has a test-mode, it shall meet the requirements of this clause.

The command structure shall be capable of setting the meter into and out of test-mode, demanding a test measurement, and entering any manufacturer specific test-mode option. To minimize flow metrology errors, the meter shall transmit the STX (defined in 11.5.2) of its data Section reply at a fixed time delay from the measurement event of the data.

11.5.2 Test-mode commands

The following test-mode commands, with identifiers T 0 and T 1, shall be used:

SOH T 0 ETX BCC	Request test-mode measurement;
SOH T 1 STX 1 ETX BCC	Enable test-mode – standard measurement period;
SOH T 1 STX 2 ETX BCC	Enable test-mode – fast measurement period;
SOH T 1 STX 3 ETX BCC	Disable test-mode;
SOH T 1 STX F (yyyy) ETX BCC	Manufacturer specific test-mode commands

Test-mode command identifiers T 2 to T 9 are reserved for future use.

11.5.3 Response of meter to test commands

11.5.3.1 Response of meter to T0 command

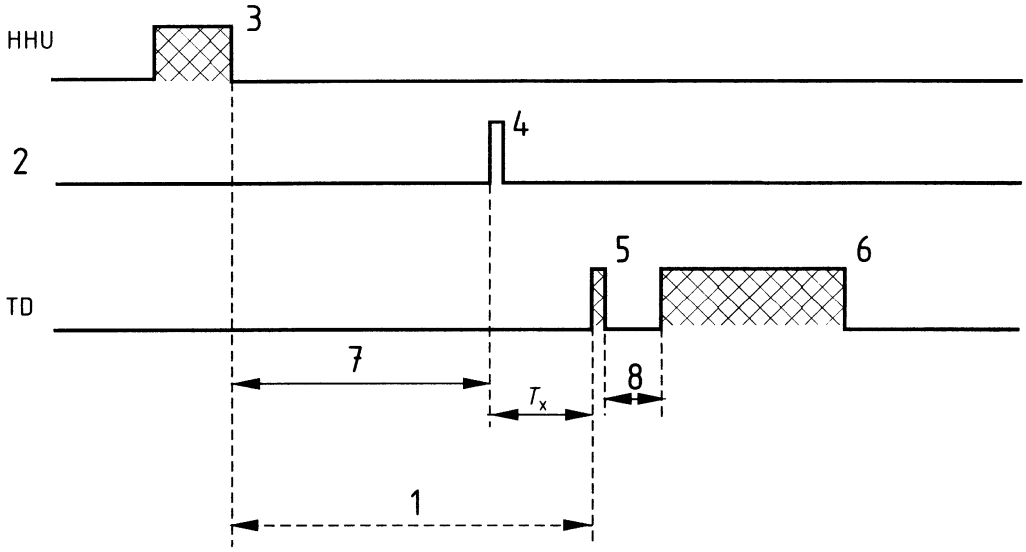
On receiving a T0 command (SOH T 0 ETX BCC) from the COMMUNICATING EQUIPMENT, the meter shall transmit the following response:

STX (data) ETX BCC

The data section of the response to a T0 request from a standard test-mode shall be:

(dddddddd) 8 digits BCD encoded data representing the meter volume index. Lsd (right hand digit) value is litres.

NOTE The data section content of the response can be modified by the manufacturer specific test-mode command, to provide additional data, different formats etc. The timing of the T0 request and data reply message are shown in Figure 11.



Key

1 $T_{r\ test\text{-}mode}$

2 meter

3 T0 command

4 meter measurement event

5 first char (STX) of data message

6 remainder of data message

7 T_x

8 $T_{STX\text{-}data}$

Figure 11 — Timing of T0 request and data reply message

During periods when test-mode is active the normal EN 62056-21 inter-message time-out specification is relaxed to allow a meter to perform its next scheduled measure event and give the data reply string:

$T_{r\ test\text{-}mode} = T_{request\text{-}event} + T_x$. T_x is manufacturer specific; an example is given in Table 11.

$T_{stx\text{-}data}$ can be 0 ms up to 1 500 ms, within the EN 62056-21 for inter-character delay.

A test-mode set using the T1,1 command shall remain active for a minimum of 4 h. After this period, the meter can disable the test-mode. While a test-mode set by the T1 command is active, normal message inactivity time-outs apply. It shall also be possible to sign-off and sign-on without altering the test-mode state.

Table 11 — Parameters

Parameter	Unit	Min.	Max.
$T_{request\text{-}event}$	ms	200	8 000
Tx	ms	10 [a]	12 [a]
$T_{stx\text{-}data}$	ms	0	1 500
T1,1 enabled	h	4	-
[a] Given as example only. Value is manufacturer specific.			

11.5.3.2 Manufacturer specific test-mode command

This command allows a manufacturer to perform specific test measurements, by using the T1 F command, to set up the meter to perform specific measurements and specify different formats in response to a T0 command. The data length yyyy between parenthesis is manufacturer specific.

11.6 Data optical port

The optical port and its associated reading head shall comply with 4.3 of EN 62056-21:2002 and shall be accessible with the meter mounted in its normal orientation.

11.7 Galvanic port (optional)

The galvanic port shall conform to the requirements in 4.1 and 4.2 of EN 62056-21:2002. As a minimum, the connector shall conform to the degree of protection IP 54 in accordance with EN 60529.

11.8 Diagnostics

11.8.1 General

The meter shall be capable of indicating key features by the use of an unambiguous alphabetic flag on the display/index. The meter shall record details of any events relating to any displayed flags.

11.8.2 Displayed flags

The meter shall indicate the most significant operational problems by showing one alphabetical character on the index. The number of flag types, the incident hierarchy and the required actions are shown in Table 12.

Table 12 — Flag types

Flag	Action
Nothing	Meter operating normally, no action
A	Meter not working, replace immediately
b	Investigate potential fraud
C	Meter working but can have a problem Read diagnostics – requires further investigation
F	Replace battery

The manufacturer shall publish the types of incidents that can lead to the flags below.

Some examples of incident descriptions are shown in Table 13.

Table 13 — Examples of incident descriptions

Flag	Examples
Nothing	Meter operating normally, no action
A	Unable to perform prime metrological function. E.g. EEPROM or microprocessor failure.
b	Power reset occurs without having received a battery change command. Meter has experienced a number of unsuccessful communications. Negative flow is detected.
C	Flow readings are out of acceptable range. Missed readings are experienced.
F	Replace battery

12 Battery

12.1 General

The battery shall be integral with the meter.

Battery connections shall be such that connection can only be made with the correct polarity.

If it is intended that the battery shall be replaceable then the battery compartment shall be accessible from the front of the meter and be so designed that the battery can be replaced by authorized personnel without removing the meter from the installation. In this case it shall be possible to change the battery within 2 min.

The battery compartment shall be capable of being separately sealed such that there will be visual evidence of tamper or other unauthorized interference. Access to the compartment shall not require the breaking of any metrological seal when replacing the battery. The manufacturer shall seal the battery compartment of each meter after fitting the battery.

Batteries shall comply with EN 60086-1. Lithium batteries shall comply with EN 60086-4.

The design of the meter shall be such that in the event that the battery leaks, there will be no detrimental effect upon the integrity of the meter case.

12.2 Voltage interruptions

12.2.1 Requirements

When tested in accordance with 12.2.2 the difference of the mean errors shall not exceed one fifth of the *MPE* specified in Table 4.

12.2.2 Test

Test the meter in accordance with 5.3.2 a), at 0,1 Q_{max} and Q_{max}. Remove and replace the battery three times in succession, waiting 5 min before each replacement. Retest the meter in accordance with 5.3.2 a), at 0,1 Q_{max} and Q_{max}.

12.3 Minimum operating voltage

12.3.1 Requirements

When tested in accordance with 12.3.2, the errors of indication shall be within the *MPE* specified in Table 4.

12.3.2 Test

Test the meter in accordance with 5.3.2 a), but with the meter's battery replaced by a voltage controlled power supply set to the manufacturer's specified minimum operating voltage.

12.4 Battery life

12.4.1 Requirements

The expected battery life, declared by the meter manufacturer, shall be at least 5 years.

After 90 % of the useful life of the battery has expired, a warning flag shall be shown (see 11.8.2).

12.4.2 Test

Simulate 90 % of the usage of the battery, as declared by the manufacturer.

13 Immunity to electromagnetic disturbances

13.1 General

The meter shall be designed and manufactured in such a way to minimize the effects of magnetic fields, electrostatic discharge and other electromagnetic disturbances. Meters meeting 13.2.1, 13.3.1 and 13.4.1 are deemed to have met this requirement.

13.2 Electrostatic discharge

13.2.1 Requirements

When tested in accordance with 13.2.2, the difference in mean errors shall not exceed one third of the *MPE* specified in Table 4.

13.2.2 Test

Test the meter in accordance with 5.3.2 a), and calculate the mean error at each flow rate.

With no flow through the meter, test the meter in accordance with EN 61000-4-2 using 10 contact discharges to each of:

a) the conductive surfaces;

b) a horizontal;

c) a vertical coupling plane with a charge voltage of 4 kV according to EN 61000-6-1 and EN 61000-6-2) at intervals of a minimum of 1 s, with the battery fitted.

With no flow through the meter, test the meter in accordance with EN 61000-4-2 using 10 air discharges (to insulating surfaces) with a charge voltage of 8 kV according to EN 61000-6-1 and EN 61000-6-2 at intervals of a minimum of 1 s, with the battery fitted.

During the test, connect the inlet boss of the meter under test to the 'ground plane'.

Repeat the test in accordance with 5.3.2 a), and calculate the difference in mean errors.

13.3 Radio frequency electromagnetic field

13.3.1 Requirements

The meter shall satisfy the following requirements:

a) during the test specified in 13.3.2 a), the meter index shall neither increment nor decrement;

b) during the test specified in 13.3.2 b), the flow rate calculated from the meter readings shall not vary by more than three times the *MPE* and after testing in accordance with 13.3.2 b), the mean errors shall be within the *MPE* specified in Table 4.

13.3.2 Test

Arrange the test equipment so that it is possible to pass air through the test meter while it is being subjected to the electromagnetic field. The flow rate shall be held constant.

NOTE One way of achieving this is to use a sonic nozzle between the meter outlet and a vacuum line.

Set the flow rate to Q_{max}. Test the meter under the conditions given below. During the test, read the index and elapsed time at suitable intervals. From these readings calculate the corresponding flow rates.

a) Set the flow rate to zero and subject the meter to the tests below;

b) test the meter in accordance with 5.3.2 a) at Q_{max} only and subject the meter again to the tests below.

Test the meter in accordance with EN 61000-4-3, under the classification E1:

frequency band:	80 MHz to 2 GHz
test field strength:	10 V/m
amplitude modulation:	80 %, 1 kHz sine wave

Read the volume register and non-volatile memory and compare with the value before the high frequency test.

Test the meter in accordance with 5.3.2 a).

NOTE E1 is applicable for meters used in residential, commercial and light industrial environments.

13.4 Electromagnetic induction (power frequency)

13.4.1 Requirements

When tested in accordance with 13.4.2 a), the meter index shall neither increment nor decrement.

During the test described in 13.4.2 b), the flow rate calculated from the meter readings shall not vary by more than six times the *MPE* specified in Table 4, during any of the eight periods of the test without showing an error flag.

After the test in 13.4.2 b), the mean errors shall be within the *MPE* specified in Table 4.

13.4.2 Test

a) Set the flow rate to zero and subject the meter to test level 3 of EN 61000-4-8 for 15 min.

b) With air passing through the meter at a flow rate of 0,05 Q_{max} test the meter to level 3 of EN 61000-4-8 for 15 min.

13.5 Electromagnetic induction (pulsed field)

13.5.1 Requirements

The meter shall satisfy the following requirements.

During test 1 of 13.5.2 a), the meter index shall neither decrement nor increment.

During the test specified in 13.5.2 b), the flow rate calculated from the meter readings shall not vary by more than half of the *MPE* specified in Table 4, during any of the eight periods of the test without displaying an error flag.

After testing in accordance with 13.5.2 b), the errors of indication shall be within the *MPE* specified in Table 4.

13.5.2 Test

a) Set the flow rate of the meter to zero and subject the meter to test level 3 of EN 61000-4-9 for 15 min.

b) With air passing through the meter at a flow rate of 0,05 Q_{max}, subject it to test level 3 of EN 61000-4-9 for 15 min.

13.6 Radio interference suppression

13.6.1 Requirements

The meter shall not generate radiated noise that can interfere with other equipment.

13.6.2 Test

Check that the meter satisfies class B radio interference limits in EN 55022 at zero flow.

14 Ultrasonic (acoustic) noise interference

14.1 Requirements

During the period in which the meter is tested in accordance with 14.2.1 a) and 14.2.1 c), the meter index shall neither increment nor decrement.

During the period in which the meter is tested in accordance with 14.2.1 b) and 14.2.1 d), the meter shall not read high or low by more than three times the *MPE* specified in Table 4, without displaying an error flag.

When tested in accordance with 14.2.1 b) and 14.2.1 d), the difference in mean errors shall not exceed one third of the *MPE* specified in Table 4.

14.2 Test

14.2.1 Test sequence

The meter shall be tested as follows:

a) carry out the test described in 14.2.2 with zero air flow through the meter;

b) carry out the test described in 14.2.2 with a flow rate of Q_{max} through the meter;

c) carry out the test described in 14.2.3 with zero air flow through the meter;

d) carry out the test described in 14.2.3 with a flow rate of Q_{max} through the meter.

14.2.2 White noise test

Ensure that the source of ultrasonic interference is an ultrasonic transducer of the same design(s) as used in the meter.

Use an electronic white noise source to drive the acoustic noise transducer at its maximum acoustic output without damaging it. Filter the white noise source so that its band-pass centre frequency is the same as that of the transducers in the meter. Set the high pass filter at or below the frequency where the output of the transducer used to test the meter falls to 50 %. Set the low pass filter at, or above the frequency where the output of the transducer used to test the meter falls by 50 %.

Connect two 450 mm lengths of 22 mm diameter pipework to the inlet and outlet ports respectively, of the meter. Position the transducer driven by the white noise source as close as possible to each of the meter’s transducers in turn, without touching the meter, for 15 min at each position. Repeat the tests but with the transducer driven by the white noise source in direct physical contact with the pipework, halfway along both lengths of pipework.

14.2.3 Scanning frequency test

Replace the electronic white noise source of 14.2.2 with a programmable signal generator to scan continuously between the maximum and minimum frequencies of the white noise source specified above. Set the signal generator to give the maximum ultrasonic output that does not damage the transducer. Use ultrasonic transducers of the same design as those used in the meter. Scan repeatedly the frequency range over a period of at least 15 min, covering the complete frequency spectrum under test at least 5 times for any specific scan rate. Carry out the scanning at rates of one, two, three, four and five scans per minute.

Connect two 450 mm lengths of 22 mm diameter pipework to the inlet and outlet ports respectively of the meter. Position the transducer driven by the white noise source as close as possible to each of the meter’s transducers in turn, without touching the meter, for 15 min at each position. Repeat the tests but with the transducer driven by the white noise source in direct physical contact with the pipework, halfway along both lengths of pipework.

15 Meters supplied for testing

The minimum number of meters to be supplied by the manufacturer for test purposes shall be no less than 15. The tests to be carried out on the supplied meters are given in Table 14.

By agreement with the manufacturer, more meters can be supplied, to enable speeding up of the test procedure.

Table 14 indicates the number of meters required for each of the tests in this European Standard. As a guide to planning the order in which tests are performed to evaluate a prototype, the table indicates where it is possible to re-use a meter for a subsequent test. The testing strategy shall be agreed between the manufacturer and the Test House.

Table 14 — Meters required for testing

	Clause	**Minimum number of meters**	**Testing meter to destruction**
Metrology			
Errors of indication — air	5.3.2 a)	3	N
Errors of indication — gas	5.3.2 b)	3	N
Gas-air relationship	5.4	3	N
Pressure absorption	5.5	3	N
Metrological stability	5.6	3	N
Immunity to contaminants in gas stream	5.7	6	Y
Installation effects	5.8	1	N
Zero flow	5.9	1	N
Reverse flow	5.10	1	N
Low flow	5.11	1	N
High flow	5.12	1	Y
Pulsed flow	5.13	1	Y
Temperature sensitivity	5.14	3	N
Construction and Materials			
Penetration of dust and water	6.2.2	1 (see [d])	Y
Resistance to internal pressure	6.2.3	1 (see [d])	Y
External leak tightness	6.2.4	1	N
Heat resistance	6.2.5	1 (see [d])	Y
Connections — orientation	6.2.6.1	1	N
Connections — single and two pipe	6.2.6.2	1	N
Connections — torque	6.2.6.3	1 (see [d])	Y
Connections — bending moment	6.2.6.4	1	Y
Resistance to vibration	6.2.7	1	Y
Resistance to impact	6.2.8	1 (see [d])	Y
Resistance to mishandling	6.2.9	1	Y
Resistance to corrosion	6.3	see [c]	Y
Resistance to salt spray	6.3.2.5	1 (see [d])	Y
Casework decorative finish	6.4	see [c]	Y

Table 14 — Meters required for testing (*concluded*)

	Clause	Minimum number of meters	Testing meter to destruction
Ageing of non-metallic casework	6.5	1 (see [d])	Y
Ageing of external surfaces	6.6	2 (see [d])	Y
Protection against solar radiation	6.7	1	N
Resistance to external relative humidity	6.8	1	N
Resistance to flame	6.9	see [c]	Y
Resistance to storage temperature	6.10	1	N
Resistance to toluene and iso-octane vapour	6.11	1 (see [d])	Y
Resistance to water vapour	6.12	1	Y
Ageing	6.13	1	Y
Optional features			
Pressure measuring point	7.1	1	N
Resistance to high ambient temperature	7.2	1 (see [a])	Y
Meter fitted with shut off valve	7.2.3	1 (see [d])	Y
Meters with temperature conversion	7.3	3	N
Hazardous zones	7.5	1	N
Indication and operation			
Index	8	1	N
Marking	9	see [c]	Y
Communications	11	1	N
Voltage interruptions	12.2	1	N
Minimum operating voltage	12.3	1	N
Electromagnetic compatibility			
Electrostatic discharge	13.2	1 (see [b])	Y
Radio frequency electromagnetic field	13.3	1 (see [b])	Y
Electromagnetic induction (power frequency)	13.4	1 (see [b])	Y
Electromagnetic induction (pulsed field)	13.5	1 (see [b])	Y
Radio interference suppression	13.6	1 (see [b])	Y
Acoustic noise interference	14	1 (see [b])	Y

[a] The highly destructive nature of this test is such that, by agreement between the manufacturer and the Test House, meters which have undertaken other destructive tests can be used for this test.

[b] The nature of these tests is such that, by agreement between the manufacturer and the Test House, meters which have undertaken other tests in this group can be used for different tests in the same group.

[c] For the majority of tests in this group, representative component samples, rather than complete meters, are acceptable, unless specifically stated otherwise in the test.

[d] Can use meters from other, specific tests in the approval program, e.g. 5.7.

Annex A
(informative)

Test gases

A.1 General

Ultrasonic domestic meter technology has been designed almost exclusively for use on second family gases, although it is feasible to use it to measure gases of the other families as well. The meters are typically designed to operate on gases with speeds of sound in the range 300 m/s to 475 m/s.

Natural gases fall into the second family of gases. The majority of distributed natural gases exist within the high methane groups H and E as defined by EN 437.

One gas that exceeds the limits of ultrasonic meters is the test gas G 222 that has a speed of sound of 497 m/s due to the 23 % hydrogen content. However, this is not felt to be a problem as this gas is designed to test the performance limits of domestic appliances and is not intended to represent distributed natural gases.

A.2 Test gas properties

The physical properties of a gas which can change due to variations in gas composition and which are most likely to influence the performance of ultrasonic domestic gas meters are:

a) speed of sound range;

b) attenuation range;

c) viscosity range;

d) density / specific gravity range.

A set of test gases has been developed for second family gases in order to provide a suitably wide range of physical properties to exercise several meter technologies, without requiring tests across a very wide range of different gas mixtures. These are:

Speed of sound range:	min.:	Air
	max.:	100 % CH_4 (with the exception of G 222 as defined in EN 437)
Attenuation:	min.:	Air
	max.:	94 % CH_4, 6 % CO_2 (100 % CH_4 has 3 dB lower attenuation and this level of CO_2 would not be tolerated in a distributed gas)
Viscosity:	min.:	70 % CH_4, 30 % C_2H_6 (100 % CH_4 is within 3 % of the same viscosity and will exercise this parameter sufficiently)
	max.:	Air
Density:	min.:	89 % CH_4, 11 % H_2 (100 % CH_4 is sufficiently close i.e. within 10 % to exercise this parameter)
	max.:	Air

Testing on air and 99,5 % distributed gas will provide a thorough assessment of the meter under extreme conditions.

Annex B
(normative)

Production requirements for gas meters

B.1 Specification

B.1.1 All gas meter manufacturers shall be approved to EN ISO 9001.

B.1.2 In addition to the above requirements, the meter shall be manufactured to any agreed options between the manufacturer and customer, e.g. consumer requires Class 1,0 meters, LPG meters etc.

NOTE Meters should be constructed in accordance with the legal requirements pertaining to the country in which the meter will be used.

B.2 Technical requirements

B.2.1 The documented production test procedures shall include external leak tightness, error of indication, pressure absorption, markings, test medium (if other than air) and acceptance and rejection criteria. Every meter shall be tested for external leak tightness.

The tests for the error of indication shall give assurance that the metrological requirements are met.

B.2.2 The period of manufacture shall be traceable from the serial number and all relevant quality records shall relate either to the period of manufacture or a serial number. The manufacturer shall retain such records for a minimum period of 5 years.

B.2.3 The manufacturer shall provide a facility to supply spare parts for a minimum of 5 years after the manufacture of the product ceases.

B.3 Certificates of conformity

When required to do so by the customer, the manufacturer shall supply Certificates of Conformity, which provide the following minimum information as appropriate to the meters:

a) manufacturer’s name and address;

b) serial/batch numbers of the meters;

c) customer’s name and address;

d) customer’s purchase order number;

e) description of the meters, the quantity, and where appropriate, the manufacturer's batch, lot, or item identification;

f) type approval number(s) for the meter(s);

g) identification of the specification/drawing to which the meters are supplied;

h) any agreed deviations from the contract;

i) following statement, signed by the person nominated by the manufacturer as responsible for quality control, or his deputy:

"CERTIFIED THAT THE SUPPLIES/SERVICES DETAILED HEREON HAVE BEEN INSPECTED AND TESTED IN ACCORDANCE WITH THE CONDITIONS AND REQUIREMENTS OF THE CONTRACT OR PURCHASE ORDER, AND UNLESS OTHERWISE SPECIFIED AS AN AGREED DEVIATION FROM THE CONTRACT, CONFORM IN ALL RESPECTS TO THE SPECIFICATION(S) AND DRAWING(S) RELEVANT THERETO".

j) date of the certificate.

Annex C
(normative)

Meters with gas temperature conversion devices

C.1 Scope

This annex specifies requirements and tests for meters with built-in gas temperature conversion devices.

C.2 Metrological performance

C.2.1 Errors of indication

This clause replaces 5.3.

C.2.1.1 Requirements

For meters with temperature conversion the initial maximum permissible errors shall be increased from the values given in Table 4 by 0,5 % in a range of 30 °C extending symmetrically around the temperature t_b specified by the manufacturer that lies between 15 °C and 25 °C. Outside this range, an additional increase of 0,5 % is permitted in each interval of 10 °C.

When the initial maximum permissible errors between 0,1 Q_{max} (Q_t) and Q_{max} all have the same sign, they shall all not exceed error limits which are reduced by 0,5% from the above initial maximum permissible errors.

C.2.1.2 Test

Place the meter in a test rig (an example of which is shown in Figure C.1) and pass a volume of the test gas (dried air), the actual volume of which is measured by a reference standard, through the meter. The minimum volume of the test air to be passed through the meter shall be specified by the manufacturer and agreed with the Test House.

Determine the error of indication of the meter six times at a temperature of 20 °C at the flow rates of Q_{min}, 3 Q_{min}, 5 Q_{min}, 10 Q_{min}, 0,1 Q_{max}, 0,4 Q_{max}, 0,7 Q_{max} and Q_{max}.

Then determine the error of indication of the meter six times at temperatures of t_{min} and t_{max} and at temperatures equidistant between t_{min} and t_b and between t_b and t_{max}, at flow rates of 5 Q_{min}, 0,1 Q_{max}, 0,4 Q_{max} and Q_{max}.

At each temperature, ensure that the temperatures of the test gas, the meter and the temperature inside the temperature-controlled cabinet are within 1 K.

Stabilize the temperatures after each change of temperature, and keep within ± 0,5 K during the measurements.

Calculate the error of indication for each temperature and flow as follows:

$$E = \left[\frac{V_M}{V_R} \cdot \frac{T_R}{T_B} \cdot \frac{P_M}{P_R} - 1 \right] \cdot 100$$

where

E is the error of indication, expressed as a percentage;

V_M is the volume registered by the test meter in cubic metres (m^3);

V_R is the volume registered by the reference standard in cubic metres (m^3);

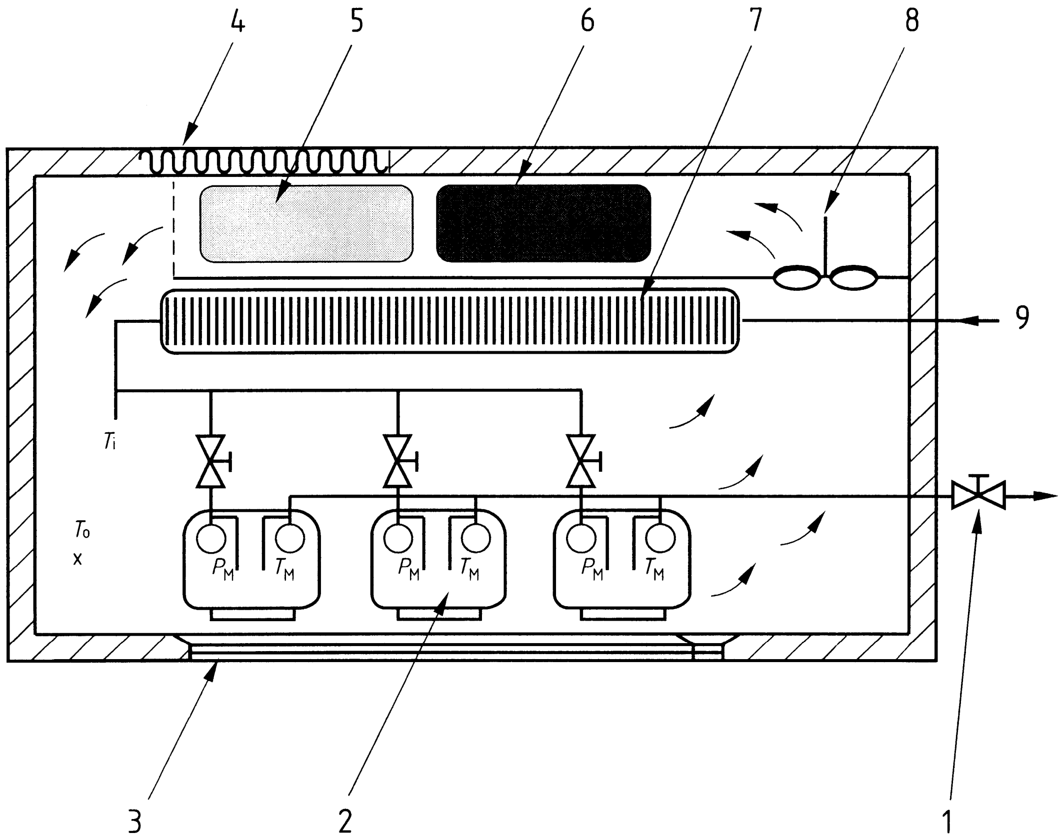
T_R is the temperature of the reference standard in Kelvin (K);

T_B is the base temperature in Kelvin (K);

P_M is the pressure of the test meter inlet in Pascals (Pa);

P_R is the pressure of the reference standard in Pascals (Pa).

NOTE All temperature and pressure values used in the above equation are absolute.



Key

1	flow control	6	cooling element
2	gas meter	7	heat exchanger
3	3 lay thermo window	8	fan
4	insulation	9	air from reference standard
5	heating element		

Figure C.1 — Example of test rig for temperature related tests

C.2.2 Error of indication where the temperature of the gas at the meter inlet is significantly different from the ambient temperature of the air surrounding the meter

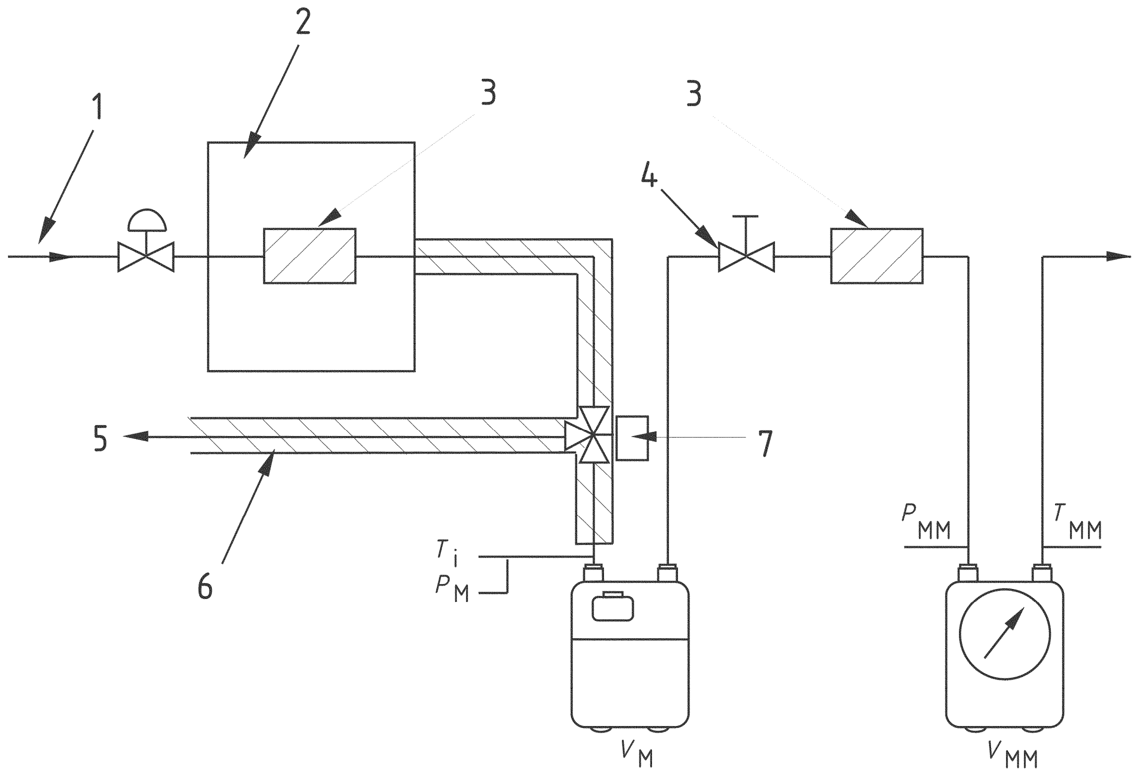
C.2.2.1 Requirements

If a meter is declared suitable for this application, it shall be tested in accordance with 5.3.2 a), and its error of indication shall be within the initial maximum permissible errors given in Table 4.

C.2.2.2 Test

Place the meter under test in the test rig (see Figure C.2). Carry out the test using dry air at a flowing temperature of t_{sp} + 20 °C and a meter in an ambient temperature of t_{sp} °C. The intermittent operation shall consist of repeated cycles of a 2 min run followed by 4 min to 8 min pause. During each cycle, the air temperature at the meter inlet (T_i) shall be (t_{sp} + 20 ± 1) °C at the commencement and throughout each flow period. Laboratory temperature and inlet air temperature to the reference standard shall be (t_{sp} ± 1) °C. The difference in laboratory temperature at the test meter and at the reference standard shall not exceed 1 K.

Stabilize the operating conditions before the volume measurements are taken. Determine the volume indicated and passed over 7 temperature cycles for each of the flowrates Q_{max}, 0,7 Q_{max} and 0,2 Q_{max}. Calculate the error in the volume using the equation given in C.2.1.2.



Key

1 pressure regulator

2 temperature controlled cabinet

3 heat exchanger

4 flow regulator

5 exhaust

6 insulated pipework

7 3-way valve actuating control

Figure C.2 — Example of test rig used for differential temperatures under intermittent operation tests

C.2.2.3 Marking

Each meter shall be marked with the following information in addition to that listed in Clause 8, either on the index or on a separate data plate:

a) meters declared suitable for differential temperature and intermittent operation, the base gas temperature expressed as, e.g. $t_{b,i}$ = 15 °C;

b) the manufacturer specified temperature expressed as, e.g. t_{sp} = 20 °C.

C.2.3 Temperature sensitivity

This requirement replaces 5.14.1.

C.2.3.1 Requirement

When tested in accordance with 5.14.2, the meter shall meet the requirement that no single test result shall differ from the regression line of distributed gas by more than the *MPE*, specified in Table 4, and all results shall remain within the errors shown in C.2.1.1.

C.2.3.2 Test

Test in accordance with 5.14.2.

C.2.4 Temperature converted volume

C.2.4.1 Requirement

The only gas volume that can be shown on a temperature converted meter is the temperature converted volume.

C.2.4.2 Test

Confirm by visual inspection and communication with the meter that it is the temperature converted volume is being shown on the index.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2004/22 Measuring Instruments Directive

This European Standard has been prepared under a mandate given to CEN/CENELEC by the European Commission [and the European Free Trade Association] to provide a means of conforming to Essential Requirements of the New Approach Directive 2004/22, Measuring Instruments Directive.

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 — Identification form on the compliance of EN 14236 with the essential requirements of EU Directive 2004/22/EC (MID) on the approximation of the laws of member states on Measuring Instruments

Essential Requirement		Subject	Conformity (Clause)
ANNEX I			
1		Allowable errors under rated operating conditions	
	1.1	Within MPE – no disturbance	5.3, 5.4, 5,6, 5.14, 6.2.7, 7.3 (C.2.1)
	1.2	Within MPE – disturbance	1, 5.8, 5.13, 6.2.7, 13
	1.3	Specify climatic, mechanical and EM environment	1, 6.2.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.13, 9.1, 9.4, 13.2, 13.3, 13.4, 13.5
	1.3.1	Climatic environments	1, 4.3, 6.4.2, 6.5, 6.6, 6.7, 6.8, 6.10
	1.3.2	Mechanical environments	1, 6.2.7, 6.2.8, 6.2.9
	1.3.3	Electromagnetic environments	1, 12.2, 13
	1.3.4	Other influence quantities	5.3.2 b), 5.7, 5.8, 5.13, 5.14, 6.2.6.4, 6.11, 6.12, 6.13, 12.3, 14
	1.4	The following apply when conducting tests:	
	1.4.1	Basic rules	Covered by standard.
	1.4.2	Ambient humidity	6.8
2		Reproducibility	N/A
3		Repeatability	5.6

4		Discrimination and sensitivity appropriate for measurement task	5.11
5		Sufficient durability for intended task (see….)	5.5, 5.7, 6.8, 6.13
6		Reliability	Whole standard
7		Suitability	
	7.1	Design discourages fraudulent use and minimises unintentional misuse	5.10, 5.12, 5.13, 6.1, 8.5, 9.1, 9.2, 9.4
	7.2	Designed to be suitable for its intended use and working conditions. User friendly	4, 5.3, 5.5, 5.7, 5.8, 5.13, 6.2.4, 6.8, 6.11, 6.12, 8.2
	7.3	The errors of a utility measuring instrument at flows or currents outside the controlled range shall not be unduly biased	5.11, 5.12
	7.4	Where a measuring instrument is designed for the measurement of values of the measurand that are constant over time, the measuring instrument shall be insensitive to small fluctuations of the value of the measurand, or shall take appropriate action	N/A
	7.5	Robust and materials suitable for intended use	6.
	7.6	A measuring instrument shall be designed so as to allow the control of the measuring tasks after the instrument has been placed on the market and put into use	8.2, 11.1, 11.4, 11.5, 11.6
8		Protection against corruption	
	8.1	Measurement cannot be affected by feature of instrument, connection of external or communicating device	7.4, 8.5
	8.2	Critical hardware components secure or tampering is evident	6.1
	8.3	Critical software shall be identified and secure. Identification readily available. Tampering evidenced for 'reasonable' time	6.1, 8.4, 8.5, 10.1, 11.8
	8.4	Data and critical parameters protected against corruption	6.1, 8.1, 8.4, 8.5
	8.5	Display cannot be reset during use	8.5
9		Information on/accompanying	
	9.1	Shall bear manufacturers mark or name and information in respect of its accuracy. Where applicable data on conditions of use, identity marking, number of type examination certificate	7.4, 9.1
	9.2	If too small, information placed on packaging	9.1
	9.3	Accompanied by information on rated operating conditions, climatic, mechanical and EM environment classes. instruction	9.4

		operation and maintenance etc.	
	9.4	Utility meters do not require individual instruction manuals	9.4
	9.5	Decimal scale interval	8.2
	9.6	Material measure	N/A
	9.7	Units of measure	8.2
	9.8	Durability of marking	9.3
10		Indication of result	
	10.1	Display	8.2
	10.2	Clear indication	8.2, 9.3
	10.3	Hard copy	N/A
	10.4	Direct trading	N/A
	10.5	Indicator required	8.2
11		Further processing of data to conclude the trading transaction	
	11.1	Durable record	N/A
	11.2	Durable proof	N/A
12		Conformity evaluation	Covered by standard
Annex MI002			
Part 1		Specific requirements gas meters	
1		Rated operating conditions	1, 4
	1.1	Class and Q_{max}/Q_{min} ratio	1, 4.1
	1.2	T ≥ 40 gas	4.3
	1.3	Gas family/MOP	1, 4.2, 4.4, 6.2.4, 9.1
	1.4	T ≥ 50 climatic	4.3
	1.5	Limits of dc supply	12.3, 12.4
2		Maximum permissible errors	
	2.1	*MPE*	5.2, 5.3, 5.4, 6.2.7, 6.2.9
	2.2	*MPE* TC	7.3 (Annex C)
3		Permissible effects of disturbances	
	3.1	EMC	1, 13
	3.2	Flow disturbances	5.8, 5.13
4		Durability	
	4.1	Durability – Class 1,5 meters	4.5, 5.3, 5.5, 5.7, 6.8, 6.13
	4.2	Durability – Class 1,0 meters	4.5, 5.3, 5.5, 5.7, 6.8, 6.13
5		Suitability	
	5.1	Mains power	N/A

	5.2	Battery power	11.5.2, 12.4
	5.3	8 000 h	8.2
	5.4	Any position	4.5, 9.4
	5.5	Test element	5.2
	5.6	Flow direction marked	9.2
6		Units	8.2
Part II		Specific requirements – Volume conversion devices	N/A
7		Base conditions for converted quantities	N/A
8		Maximum permissible error	N/A
9		Suitability	N/A
Part III		Putting into use and conformity assessment	
10		Putting into use	
	(a)		N/A
	(b)		N/A
	(c)		N/A
		Conformity assessment	N/A

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

Bibliography

[1] EN 437, *Test gases — Test pressures — Appliance categories*

[2] EN ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

[3] ISO 5168, *Measurement of fluid flow — Procedures for the evaluation of uncertainties*

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