

Gas meters — Diaphragm gas meters

The European Standard EN 1359:1998, with the incorporation of amendment A1:2006, has the status of a British Standard

ICS 75.180.30; 91.140.40

National foreword

This British Standard is the official English language version of EN 1359:1998, including amendment A1:2006. It supersedes BS 4161-3:1989 and BS 4161-5:1990, which are withdrawn.

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

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English version

Gas meters — Diaphragm gas meters

Compteurs de gaz — Compteurs de volume de gaz Gaszähler — Balgengaszähler
à parois déformables

This European Standard was approved by CEN on 28 November 1998.

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CEN

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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by June 1999, and conflicting national standards shall be withdrawn at the latest by June 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

In the preparation of this European Standard, the content of the Marcogaz/Facogaz/AEGPL liaison committee CL5 document, the content of OIML Publications *International Recommendation R 6* and *International Recommendation R 31* and the content of member countries' national standards for diaphragm gas meters, have been taken into account.

The meterological aspects of this European Standard can be subject to final modification to bring them into line with the proposed Measuring Instruments Directive.

Foreword to amendment A1

This document (EN 1359:1998/A1:2006) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

This Amendment to the European Standard EN 1359:1998 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

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1 Scope

[A1] This European Standard specifies the requirements and tests for the construction, performance, safety and production of class 1,5 mechanical diaphragm gas meters (hereinafter referred to as meters) having co-axial single pipe, or two pipe connections, used to measure volumes of fuel gases of the 1st, 2nd and 3rd families according to EN 437, at maximum working pressures not exceeding 0,5 bar and maximum actual flow rates not exceeding 160 m³/h over a minimum ambient temperature range of -10 °C to + 40 °C and a gas temperature range as specified by the manufacturer with a minimum span of 40 K.

This standard applies to meters with and without built-in mechanical 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.

This standard does not cover meters with electronic indexes.

Unless otherwise stated, all pressures given in this document are gauge pressure.

Clauses 1 to 9 and annexes B and F are for design and type testing only.

NOTE Mechanical meters are not susceptible to electromagnetic interference and are therefore suitable for any electromagnetic environment. **[A1]**

2 Normative references

This European Standard incorporates by dated or undated references provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[A1] EN 437:2003, *Test gases — Test pressures — Appliance categories*. **[A1]**

EN 50020:1994, *Electrical apparatus for potentially explosive atmospheres — Intrinsic safety “i”*.

EN 55022:1994, *Limits and methods of measurement of radio disturbance characteristics of information technology equipment*. (CISPR 60022:1993)

EN 60529:1991, *Degrees of protection provided by enclosures (IP code)*. (IEC 60529:1989)

EN 60730-1:1995, *Automatic electrical controls for household and similar use — Part 1: General requirements*.

(IEC 60730-1:1993, modified)

EN 60801-2: 1993, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements*.

(IEC 60801-2:1991)

EN ISO 9001:1994, *Quality systems — Model for quality assurance in design/development, production, installation and servicing*.

(ISO 9001:1994)

EN ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing*.

(ISO 9002:1994)

ISO 228-1:1994, *Pipe threads where pressure-tight joints are not made on the threads —*

Part 1: Dimensions, tolerances and designation.

ISO 834:1975, *Fire resistance tests — Elements of building construction*.

ISO 1518:1992, *Paints and varnishes — Scratch test*.

ISO 2409:1992, *Paints and varnishes — Cross-cut test*.

ISO 2812-1:1993, *Paints and varnishes —*

Determination of resistance to liquids: Part 1: General methods.

ISO 4628-2:1982, *Paints and varnishes — Evaluation of degradation of paint coatings — Designation of intensity, quantity and size of common types of defect — Part 2: Designation of degree of blistering*.

ISO 4628-3:1982, *Paints and varnishes; Evaluation of degradation of paint coatings — Designation of intensity, quantity and size of common types of defect Part 3: Designation of degree of rusting*.

[A1] EN ISO 6270-1, *Paints and varnishes — Determination of resistance to humidity — Part 1: Continuous condensation* (ISO 6270-1:1998) **[A1]**

ISO 6272:1993, *Paints and varnishes — Falling weight test*.

ISO 7005-1:1992, *Metallic flanges — Part 1: Steel flanges*.

ISO 7253:1984, *Paints and varnishes — Determination of resistance to neutral salt spray*.

[A1] ISO 7724-3 1984, *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*.

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*. **[A1]**

IEC 61000-4-3:1996, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test*.

3 Terminology

3.1 Definitions

For the purposes of this standard, the following definitions apply.

3.1.1

gas volume meter

instrument designed to measure, memorize and display the volume of a fuel gas that has passed through it

3.1.2

diaphragm gas meter

gas volume meter in which the gas volume is measured by means of measuring chambers with deformable walls

3.1.3

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

3.1.4

working pressure

difference between the pressure of the gas at the inlet of the meter and the atmospheric pressure

3.1.5

maximum working pressure

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

3.1.6

pressure absorption

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

3.1.7

external leak tightness

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

3.1.8

error of indication

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

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

where

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

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

3.1.9

normal conditions of use

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 and gas temperature range;
- with the distributed gas

3.1.10

initial permissible errors

those errors of indication which are permitted when first determining the accuracy of a meter, prior to any other tests being carried out

3.1.11

endurance permissible errors

those errors of indication which are permitted during and on completion of the endurance test

3.1.12

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)

3.1.13

cyclic volume

volume of gas corresponding to the working cycle of the gas meter, i.e. to all the movements of the moving components which, except for the indicating device and the intermediate transmissions, resume for the first time the position they occupied at the beginning of the cycle

Text deleted

3.1.14

distributed gas

gas locally available

3.1.15

metering conditions

conditions of the gas, the volume of which is to be measured, at the point of measurement (e.g. temperature and pressure of the measured gas)

3.1.16

mechanical temperature conversion device

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

The conversion formula is

$$V_b = \frac{T_b}{T} \times V$$

where

V is the volume at metering conditions in cubic metres (m³);

V_b is the volume at base gas temperature in cubic metres (m³);

T is the gas temperature at metering conditions in kelvin (K);

T_b is the base gas temperature 15 °C (288,15 K).

A1 3.1.17 **A1**

meter error curve

plot of average error of indication against actual flow rate

A1 3.1.18

class 1,5 meter

meter which has an error of indication between -3% and $+3\%$ for flow rates Q where $Q_{\min} \leq Q < Q_t$, $-1,5\%$ and $1,5\%$ for flow rates Q where $Q_t \leq Q \leq Q_{\max}$ and when the errors between Q_t and $Q_{\max}$ all have the same sign, they do all not exceed 1% **A1**

3.2 Symbols

A1 3.2.1

$Q_{\min}$

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

3.2.2

Q_t

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

3.2.3

$Q_{\max}$

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

3.2.4

Q_r

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

3.2.5

V

cyclic volume

3.2.6

$P_{\max}$

maximum working pressure

3.2.7

t_b

base gas temperature

3.2.8

$t_{b,i}$

base gas temperature for meters declared suitable for differential temperature and intermittent operation

3.2.9

t_m

ambient temperature

3.2.10

t_g

gas temperature

3.2.11

t_{sp}

specified centre temperature for meters with temperature conversion **A1**

4 Working conditions

4.1 Flow range

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

A1

Table 1 — Flow range

$Q_{\max}$ (m ³ /h)	Upper limits of $Q_{\min}$ (m ³ /h)	Q_t (m ³ /h)	Q_r (m ³ /h)
2,5	0,016	0,25	3,0
4	0,025	0,4	4,8
6	0,04	0,6	7,2
10	0,06	1,0	12,0
16	0,1	1,6	19,2
25	0,16	2,5	30
40	0,25	4,0	48
65	0,4	6,5	72
100	0,65	10,0	120
160	1	16,0	192

A1

A gas meter may have a lower value for the minimum flow rate than that shown in Table 1 but this lower value shall be equal to one of the values shown in the table or to a decimal submultiple of these values.

4.2 Maximum working pressure

The manufacturer shall declare the maximum working pressure of the meter and this figure shall be marked on the index of the meter.

4.3 Temperature range

A1 All meters shall be capable of meeting the requirements for a minimum ambient temperature range of $-10\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ and a minimum gas temperature range of 40 K (see 7.1.3) and minimum storage temperature range of $-20\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$ (see 6.4.1). 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 may declare a wider ambient temperature range using a minimum temperature of $-10\text{ }^{\circ}\text{C}$, $-25\text{ }^{\circ}\text{C}$ or $-40\text{ }^{\circ}\text{C}$ and a maximum temperature of $40\text{ }^{\circ}\text{C}$, or $70\text{ }^{\circ}\text{C}$ and/or a wider storage temperature range. The meter shall be capable of meeting the requirements over this declared wider range. **A1**

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 6.5.5 and 8.1).

A1
4.4 Climatic environment

Meters meeting the requirements of this standard except for Annex F are deemed suitable for installation in closed (indoor or outdoor with protection as specified by the manufacturer) locations with condensing humidity.

If the manufacturer declares that the meter is suitable for installation in open (outdoor without any protection) locations with condensing humidity then it shall also meet the requirements of Annex F. A1

5 Metrological performance

5.1 Errors of indication

5.1.1 Requirements

- a) The individual errors of indication of the meter shall be within the initial permissible error limits specified in Table 2, when tested by the method given in 5.1.2a) A1 When the errors between 0,1 Q_{max} (Q_t) and Q_{max} all have the same sign, they shall all not exceed 1 %. A1
- b) After the meter has been subjected to other influences, given in the individual clauses of this European Standard, the average of the errors of indication of the meter shall either not vary from the average of the initial errors of indication by more than that allowed by those clauses or, shall be within the error limits specified within those clauses, whichever is applicable, when tested by the methods given in 5.1.2b) or 5.1.2c).

5.1.2 Test

- a) Thermally stabilize the meter to be tested to the temperature of the test laboratory and carry out the error of indication test using air at laboratory temperature.
- Immediately before commencing the test, pass a quantity of test air equal to at least 50 cyclic volumes of the meter under test, through the meter under test at a flow rate of Q_{max}.
- Pass a volume of air, the actual volume of which is measured by a reference standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the notified body.
- Calculate the error of indication (see 3.1.7).

- Carry out this test six times at each of the flow rates Q_{min}, 3 Q_{min}, 0,1 Q_{max}, 0,2 Q_{max}, 0,4 Q_{max}, 0,7 Q_{max} and Q_{max}; ensure that the flow rates between each individual test are different (i.e. it is not permissible to carry out consecutive tests at the same flow rate).
- Calculate the six errors of indication at each of the flow rates. Calculate the average of the six errors of indication and note as the error curve of the meter.
- b) Thermally stabilize the meter to be tested to the temperature of the test laboratory and carry out the error of indication test using air at laboratory temperature.
- Pass a volume of air, the actual volume of which is measured by a reference standard, through the meter under test and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the notified body.
- Calculate the error of indication (see 3.1.7).
- Carry out this test three times at each of the flow rates Q_{min}, 3 Q_{min}, 0,1 Q_{max}, 0,2 Q_{max}, 0,4 Q_{max}, 0,7 Q_{max} and Q_{max}; ensure that the flow rates between each individual test are different (i.e. it is not permissible to carry out consecutive tests at the same flow rate).
- Average the three errors of indication calculated at each of the flow rates.
- c) Thermally stabilize the meter to be tested to the temperature of the test laboratory and carry out the error of indication test using air at laboratory temperature.
- Pass a volume of air, the actual volume of which is measured by a reference standard, through the meter under test, and note the volume indicated by the meter index. The minimum volume of air to be passed through the meter under test is specified by the manufacturer and agreed with the notified body.
- Calculate the error of indication (see 3.1.7).
- Carry out this test three times at each of the flow rates 0,1 Q_{max}, 0,4 Q_{max} and Q_{max}; ensuring that the flow rates between each individual test are different (i.e. it is not permissible to carry out consecutive tests at the same flow rate).
- Average the three errors of indication calculated at each of the flow rates.

Table 2 — Maximum permissible errors

Flow rate m ³ /h	Maximum permissible errors	
	Initial	Endurance
Q _{min} ≤ Q < 0,1 Q _{max}	±3 %	−6 % to +3 %
0,1 Q _{max} ≤ Q ≤ Q _{max}	±1,5 %	±3 %

5.2 Pressure absorption

5.2.1 Requirements

The pressure absorption of a meter, averaged over a measuring cycle, with a flow of air of density $1,2 \text{ kg/m}^3$, at a flow rate equal to Q_{max} , shall not exceed the values given in Table 3.

5.2.2 Test

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

Note the maximum and minimum differential pressures over at least one measuring cycle, and average them.

The distance between the pressure test points and the meter connections is not to exceed three times the nominal connection diameter.

Table 3 — Pressure absorption

Q_{max} m^3/h	Maximum permissible values for average pressure absorption	
	Initial mbar	Post endurance mbar
A_1 2,5 to 16 inclusive A_1	2	2,2
A_1 25 to 65 inclusive A_1	3	3,3
100 and 160	4	4,4

5.3 Starting flow rate

5.3.1 Requirements

When tested by the method given in 5.3.2, the starting flow rate shall not be greater than those specified in Table 4.

Table 4 — Starting flow rates

Q_{max} m^3/h	Maximum starting flow rate dm^3/h
A_1 2,5 A_1	3
4 and 6	5
10	8
16 and 25	13
40	20
65 and 100	32
160	50

5.3.2 Test

Run the meter under test at Q_{max} for 10 min, using air, at normal laboratory ambient temperature.

Leave the meter under test at rest for a period of 2 h to 4 h.

Connect the meter under test in series with, and upstream of, an accurate flow measuring instrument and a flow regulating device.

After checking the leak tightness of the complete test apparatus, supply air at ambient temperature up to a maximum pressure of 2 mbar and maintain the flow rate at the maximum allowable starting flow rate. At this maximum starting flow rate ascertain that the meter under test registers continuously for at least one cyclic volume.

Do not check the metrological characteristics of the meter under test at the starting flow rate.

Do not add lubricant for the test.

5.4 Metrological stability

5.4.1 Requirements

The error of indication found at each of the specified test flow rates, shall not differ one from another by more than 0,6 %.

5.4.2 Test

Using the calculated errors of indication, obtained when carrying out the initial error of indication test in 5.1.2a), at flowrates $0,1 Q_{\text{max}}$, $0,2 Q_{\text{max}}$, $0,4 Q_{\text{max}}$, $0,7 Q_{\text{max}}$ and Q_{max} , check the differences between each of the six errors of indication at each flow rate to ascertain that they are within 0,6 % of each other.

A_1 5.5 Overload flow rate

5.5.1 Requirements

After exposure to an overload flow rate of $1,2 Q_{\text{max}}$ the error of indication shall remain within the initial maximum permissible error limits specified in Table 2.

5.5.2 Test

One meter shall be supplied with air for one hour at a flow rate of $1,2 Q_{\text{max}}$. The error of indication shall be determined as specified in 5.1.2 (c).

5.6 Environment and humidity

5.6.1 Requirements

After testing in accordance with 5.6.2 the error of indication shall remain within the initial maximum permissible error limits specified in Table 2 and the index and markings shall remain legible.

5.6.2 Test

One meter shall be tested for error of indication in accordance with 5.1.2 (c) and shall then be tested in accordance with ISO 6270 for a duration of 120 hours. The meter shall then be re-tested for error of indication in accordance with 5.1.2 (c) and shall be visually inspected for legibility of the index and the markings.

5.7 Influence of other devices

5.7.1 Requirements

If any device (e.g. a removable pulse generator) which the manufacturer permits to be connected to the meter influences its metrological performance then this influence shall be less than 0,3 % at a flowrate equal to $0,1 Q_{\text{max}}$ A_1

A1 5.7.2 Test

One meter shall be tested ten times for error of indication at 0,1 $Q_{\max}$. The device shall then be attached to the meter and the error of indication at 0,1 $Q_{\max}$ shall be determined again ten times. The difference between the averages of the two errors of indication shall be less than 0,3 %.

5.8 Cyclic volume

5.8.1 Requirements

The cyclic volume of any meter shall be within $\pm 5\%$ of the cyclic volume indicated on the index plate.

5.8.2 Test

The possible range of cyclic volume is determined by multiplying the value of the volume corresponding to one complete revolution of the test element, or the value of a scale interval, by the transmission ratio of the measuring device to the indicating device, for the extreme possible transmission gear ratios. A1

6 Construction and materials

6.1 General

A1 The meter shall be visually examined to confirm it is constructed in such a way that any mechanical interference capable of affecting the measuring accuracy results in permanently visible damage to the meter or the verification or protection marks. A1

No additional lubricants shall be required during the life of the meter.

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

A1 Production requirements for the meter are given in Annex A. A1

6.2 Robustness

A1 Meters meeting the requirements of 6.2 are deemed to be suitable for use in locations with vibration and shocks of low significance; e.g. they may be floor mounted or fastened to light supporting structures and will be subject to negligible vibrations and shocks transmitted from local blasting or pile driving activities, slamming doors etc. A1

6.2.1 Meter case

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 this European Standard.

6.2.2 External leak tightness

6.2.2.1 Requirements

The meter shall be leak tight under normal conditions of use. When tested in accordance with 6.2.2.2, no leakage shall be observed.

6.2.2.2 Test

NOTE In some countries, the meter is operating during this test.

Pressurize the meter under test, at normal laboratory temperature, with air to 1,5 times the declared maximum working pressure.

Carry out the test by:

- a) immersing the meter, without its index, in water and observing for leakage for 30 s after any external trapped air has been dispersed; or
- b) any equivalent procedure.

6.2.3 Resistance to internal pressure

6.2.3.1 Requirements

When tested in accordance with the test method given in 6.2.3.2, any residual deformation of the unpressurized meter case shall not exceed 0,75 % of the linear dimension over which it is measured. After the test, the meter case shall remain leak tight in accordance with 6.2.2.1.

6.2.3.2 Test

Pressurize the case of the meter under test progressively, with air or water to 1,5 times the maximum working pressure. Maintain the test pressure for 30 min and then release.

Ensure that the rate of pressurization or depressurization does not exceed 350 mbar/s.

6.2.4 Meter case sealing

6.2.4.1 Requirements

Effective additional mechanical means for sealing shall be provided for the gas containing components of the meter case where the failure of any sealant/adhesive can cause external leakage (e.g. at the junction of the top and bottom case of the meter).

6.2.4.2 Test

Conduct a visual inspection of a fully assembled meter case.

6.2.5 Connections

6.2.5.1 Orientation

6.2.5.1.1 Requirements

The connections of meters having top mounted two pipe connections shall have the centrelines of these connections within 1° of 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 $\pm 0,5$ mm of the nominal distance between centrelines, or within $\pm 0,25$ % of the nominal distance between centrelines, whichever is the greater, and the centrelines shall be within 1° 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.

6.2.5.1.2 Test

Measurements are taken using appropriate instruments.

6.2.5.2 Threads and flanges for single and two pipe meters

6.2.5.2.1 Requirements

The threads of threaded meter connections shall be as specified by the meter manufacturer.

Flanges of flanged meter connections shall have dimensions which are in accordance with one of the types of flange given in Table 10 (the PN 10 Table) of ISO 7005-1:1992, as declared by the meter manufacturer.

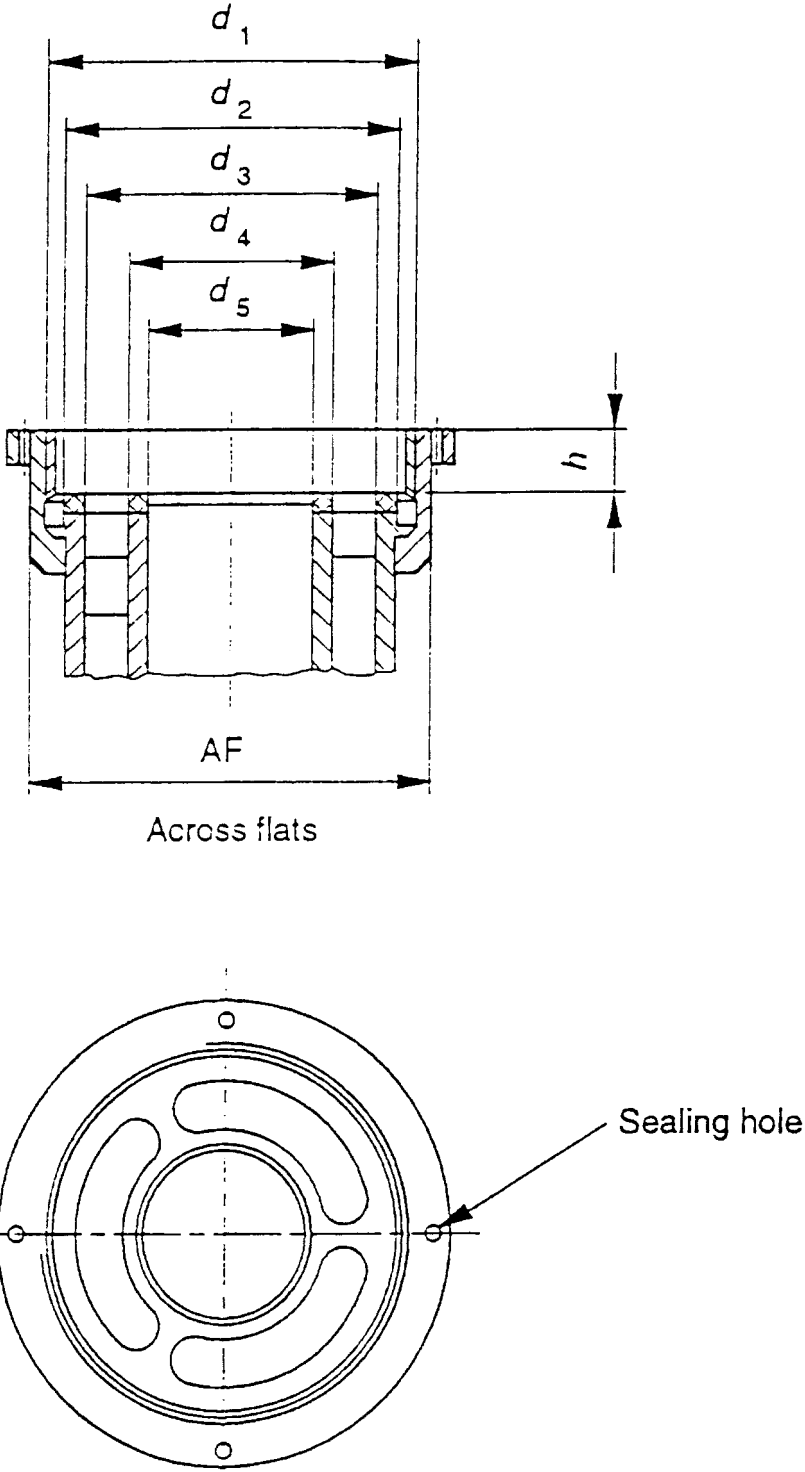
NOTE The fact that the dimensions are taken from Table 10 of ISO 7005-1:1992 (the PN 10 Table) does not denote that the meter has a pressure rating of 10 bar.

The connections of meters having a co-axial single pipe connection shall be in accordance with Figure 1a) or Figure 1b).

6.2.5.2.2 Test

Measurements are taken using suitable instruments.

$Q_{\max}(\text{m}^3/\text{h})$	$d_1^{1)}$	d_2	d_3	d_4	d_5	h	SW
≤ 10	G2	54	46	32	26	9^{+3}_0	65
16/25	G2½	76,5	63	48	41	10^{+4}_0	90

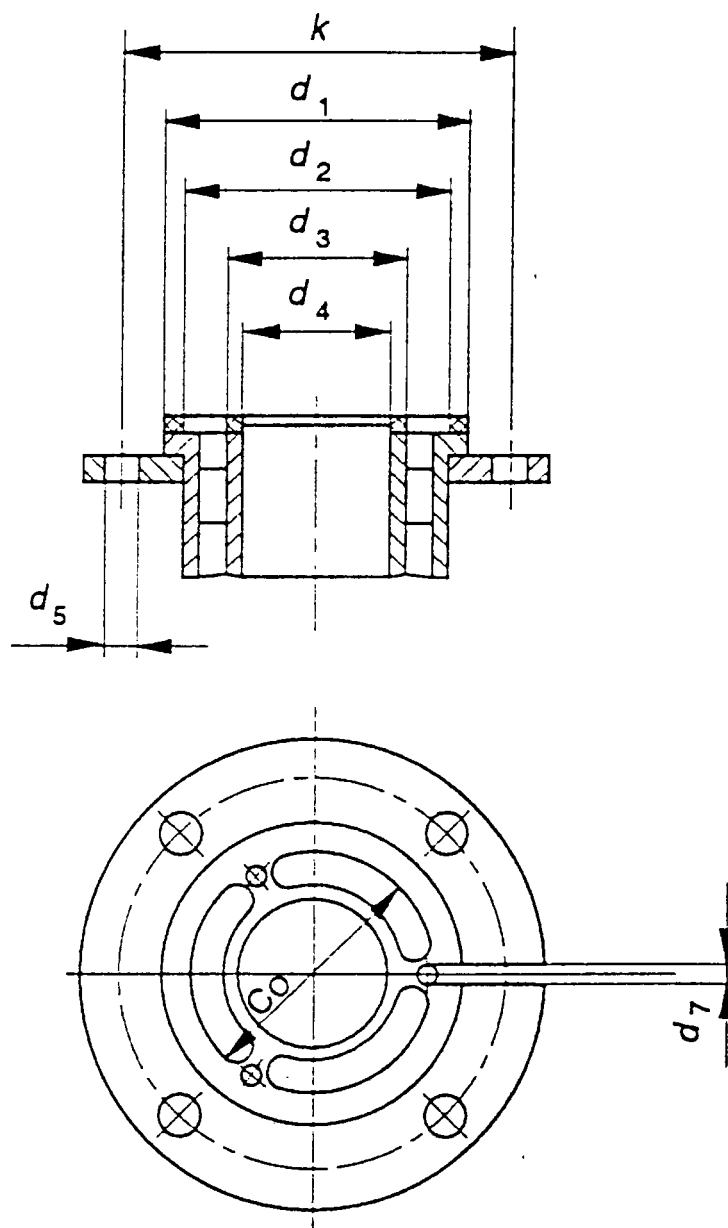


NOTE All dimensions are in millimetres unless otherwise shown.

Figure 1a) — Co-axial single pipe screw connections

¹⁾ Designation for threads to ISO 228-1:1994.

$Q_{\max}$ (m ³ /h)	d_1	d_2	d_3	d_4	d_5	d_6	d_7	No. of d_7	k	No. of holes
40	98	82	60	50	12	75	2,6	3	125	4
65	158	114	82,5	68	18	139	3	3	180	8
100	188	133	95	77	18	160	3	3	210	8
160	240	194	133	113	22	217	3	4	270	8



NOTE All dimensions are in millimetres unless otherwise shown.

Figure 1b) — Co-axial single pipe flanged connections

6.2.5.3 Strength

6.2.5.3.1 Torque

6.2.5.3.1.1 Requirements

The meter connection shall be subjected to the appropriate torque specified in Table 5, in accordance with 6.2.5.3.1.2 and shall then comply with the following:

- external leak tightness (see 6.2.2.1);
- any residual rotational deformation of the meter connection shall not exceed 2°.

6.2.5.3.1.2 Test

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

6.2.5.3.2 Bending moment

6.2.5.3.2.1 Requirements

The meter shall be subjected to the bending moment given in Table 5 in accordance with 6.2.5.3.2.2 and, during and after the test, the meter shall remain leak tight in accordance with 6.2.2.1.

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

Before the bending moment test given in 6.2.5.3.2.2, the meter under test shall comply with 5.1.1a).

After the bending moment test given in 6.2.5.3.2.2, the meter under test shall be retested in accordance with the method given in 5.1.2c), plus an error of indication check at Q_{min} . The errors of indication shall be within the allowed endurance maximum permissible error limit given in Table 2.

6.2.5.3.2.2 Test

Rigidly support the meter under test by one of its connections [see Figure 2a) and b)] and subject to the appropriate bending moment for a period of 2 min. Different meters are used for the lateral test(s) and the fore and aft test.

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

6.2.6 Resistance to vibration

6.2.6.1 Requirements

The meter shall remain leak tight and its error of indication shall be within the initial permissible limits given in Table 2, before and after being subjected to the vibration test described in 6.2.6.2.

6.2.6.2 Test

Carry out the error of indication test, specified in 5.1.2a), to ensure that the accuracy of the meter under test is within the maximum permissible initial error limits and confirm that the meter under test is leak tight, by carrying out the test described in 6.2.2.2. Secure the meter under test to the vibration test rig, a diagrammatic layout of which is shown in Figure 3, by means of a horizontal clamp across the top of the meter.

In Figure 3, the meter under test (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. Subject the meter under test to a swept frequency of between 10 Hz and 150 Hz ($\pm 5\%$) at a sweep rate of 1 octave per minute with a peak acceleration of $2 g_n$ ($\pm 5\%$), for 20 sweeps in the vertical plane, 20 sweeps in the fore-aft plane and 20 sweeps in the lateral plane.

Recheck the error of indication of the meter under test, by carrying out the test specified in 5.1.2c) and confirm the leak tightness by carrying out the test described in 6.2.2.2.

NOTE 1 The clamping force should be sufficient to restrain the meter under test 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. Therefore, the time taken to sweep from 10 Hz to 100 Hz at a sweep rate of 1 octave per minute is 3 min 15 s.

Table 5 — Torque and bending moment

Nominal connection diameter		Torque value N·m	Bending moment N·m
Inches	DN		
½	15	50	10
¾	20	80	20
1	25	110	40
1 ¼	32	110	40
1 ½	40	140	60
2	50	170	60
2 ½	65	170	60
3	80	170	60
4	100	170	60
5	125	170	60