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DE MÉTROLOGIE LÉGALE

INTERNATIONAL RECOMMENDATION

Diaphragm gas meters

Compteurs de gaz à parois déformables

OIML R 31

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CONTENTS

FOREWORD

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DIAPHRAGM GAS METERS

1 Scope

This Recommendation applies to diaphragm gas meters, that are gas volume meters in which the gas flow is measured by means of measuring chambers with deformable walls, including gas meters with a built-in temperature conversion device.

With regard to the gas volume meters defined above, this Recommendation complements International Recommendation OIML R 6, *General provisions for gas volume meters,* the provisions of which apply jointly with the following requirements.

Note: In this Recommendation diaphragm gas meters are designated "gas meters" or "meters".

2 Range of flowrates

2.1 The authorized values of maximum flowrates and the corresponding values of the upper limits of the minimum flowrates are given in Table 1.

Table 1

Q_{max} m^3/h	Upper limit of Q_{min} m^3/h
1	0.016
1.6	0.016
2.5	0.016
4	0.025
6	0.040
10	0.060
16	0.100
25	0.160
40	0.250
65	0.400
100	0.650
160	1.000
250	1.600
400	2.500
650	4.000
1 000	6.500

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

3 Details of construction

3.1 For each gas meter the difference between the calculated value of the cyclic volume and the nominal value (V) of this volume, indicated on the gas meter, shall not exceed 5 % of the latter at reference conditions.

3.2 Gas meters may be provided with a device to prevent the measuring device from functioning whenever the gas is flowing in an unauthorized direction.

4 Indicating device and test element

4.1 General

For a gas meter equipped with an indicating device (index) with an integral test element (test dial or drum) the following conditions apply.

The standard deviation of the results of a series of at least thirty consecutive measurements of a volume of air equal to ten times the nominal cyclic volume (or, twenty times when ten times the nominal cyclic volume is less than the volume corresponding to one revolution of the test element), carried out under identical conditions at a flow-rate of the order of 0.1 Q_{max}, shall not exceed the values given in Table 2. The test will be carried out on one of the meters supplied for pattern examination.

Table 2

Q_{max} m^3/h	Maximum standard deviation dm^3
1 to 10 inclusive	0.2
16 to 100 inclusive	2
160 to 1 000 inclusive	20

Note: This test, to be carried out only in the course of pattern examination, is intended to assess the repeatability of the gas meter and to ascertain that the resolution of the test element matches the need for testing.

4.2 Test element of a mechanical indicating device

4.2.1 A mechanical indicating device may have either an integral test element according to the provisions of R 6, subclause 5.2.2, or a device which allows the fitting of a removable test element.

4.2.2 An integral test element of a mechanical indicating device shall have a maximum scale interval and a scale numbering as specified in Table 3.

Table 3

Q_{max} m^3/h	Maximum scale interval dm^3	Numbering every dm^3
1 to 10 inclusive	0.2	1
16 to 100 inclusive	2	10
160 to 1 000 inclusive	20	100

4.3 Gas meters with built-in temperature conversion device

A gas meter with a built-in temperature conversion device may have only one indicating device displaying the volume at base conditions. The symbol "m^3" shall appear on the face plate, accompanied by the specification of the base temperature, expressed as:

$$t_b = \ldots \text{ °C}$$

Note: The values chosen for base temperature shall preferably be 0 °C, 15 °C, or 20 °C.

Additionally, the face plate shall bear a marking of the temperature specified by the manufacturer according to 5.5.1, expressed as:

$$t_{sp} = \ldots \text{ °C}$$

5 Maximum permissible errors

5.1 Under the conditions laid down in R 6, clause 6, and with air of a density of 1.2 kg/m^3 as a test medium, the maximum permissible errors on pattern examination and initial verification, and the recommended values for the maximum permissible errors in service, are given in Table 4.

Table 4

Flowrate	Maximum permissible errors	
	On pattern examination and initial verification	In service
$Q_{min} \le Q < 0.1\ Q_{max}$	± 3 %	– 6 %, + 3 %
$0.1\ Q_{max} \le Q \le Q_{max}$	± 1.5 %	± 3 %

Provisionally, OIML Member States may prescribe values for the maximum permissible errors as specified in Annex A.

5.2 On pattern examination and initial verification of a meter the absolute value of each meter error shall not exceed 1 % at flowrates between 0.1 Q_{max} and Q_{max} where these errors are all of the same sign.

5.3 The maximum permissible errors on initial verification apply to new gas meters and to gas meters submitted for verification after reconditioning or after the protective seals have been damaged.

5.4 When the maximum torques indicated on the gas meters as specified in R 6, subclauses 3.2.1 or 3.2.2, are applied to the drive shafts, the indication of the gas meter at Q_{min} shall not vary by more than 1.5 %.

5.5 For a gas meter with a temperature conversion device and equipped with one indicating device as specified in 4.3, the conventional true value of the volume at the metering temperature shall be converted to the volume at base temperature. The following provisions shall apply.

5.5.1 The maximum permissible errors specified in Table 4 shall be increased by ± 0,5 % in an interval of 10 °C, extending symmetrically around a temperature specified by the

manufacturer. The specified temperature shall be between 15 °C and 25 °C. The resulting interval shall be within the range of temperature of the metering conditions indicated on the data plate of the gas meter.

5.5.2 Within the range of temperature of metering conditions indicated on the data plate of the gas meter but outside the interval defined in 5.5.1, the maximum permissible errors specified in Table 4 shall be increased by ± 1,0 %.

5.5.3 Compliance with the requirements of 5.5.1 and 5.5.2 shall be verified at temperatures not more than 2 °C from the upper and lower limits of the specified intervals.

6 Pressure absorption

The total pressure absorption of a gas meter, averaged over a measuring cycle, with a flow of air of density 1.2 kg/m^3, at a flowrate equal to Q_{max}, shall not exceed the values given in Table 5.

Table 5

Q_{max} m^3/h	Maximum permissible values for average total pressure absorption	
	On pattern examination and initial verification Pa	In service Pa
1 to 10 inclusive	200	220
16 to 65 inclusive	300	330
100 to 1 000 inclusive	400	440

Note: "In service" values are recommended values.

7 Pattern approval

7.1 Application for pattern approval

At the same time as the pattern sample is submitted, the applicant shall place at the disposal of the authority responsible for the examination from two to six sample gas meters manufactured in conformity with the pattern.

7.2 Examination

7.2.1 The pattern and the sample gas meters shall comply with the provisions of R 6 and of clauses 2, 3, 4, 5 and 6 of this Recommendation. The gas meters shall be submitted to the testing procedures for pattern approval as specified in Annex B.

7.2.1.1 The errors of the sample gas meters shall be determined at seven flowrates evenly distributed over the working range.

7.2.1.2 At flowrates equal to or greater than 0.1 Q_{max} the errors shall be determined independently at least six times, by varying the flowrate between each consecutive measurement. The difference between any two errors found at each test flow rate shall not exceed 0.6 %.

7.2.2 In addition, the difference between the minimum and maximum of the mean error curve as a function of the flowrate shall not exceed 2 % for the range 0.1 Q_{max} to Q_{max}.

7.2.3 Endurance test

7.2.3.1 The authority responsible for the examination shall choose the number of meters to be submitted to the endurance test from the options given in Table 6 after discussion with the applicant.

Table 6

Q_{max} m^3/h	Number of meters to be submitted	
	Option 1	Option 2
1 to 25 inclusive	3	6
≥ 40	2	4

If different sizes of meter are included, the total number of meters to be submitted shall be as stated in option 2.

7.2.3.2 The endurance test shall be carried out:

- for gas meters with Q_{max} from 1 to 16 m^3/h inclusive: at the maximum flowrate, using gas for which the gas meter is intended to be used;
- for gas meters with Q_{max} ≥ 25 m^3/h: as far as possible at the maximum flowrate, using gas for which the gas meter is intended to be used; the flowrate during the test shall be at least equal to 0.5 Q_{max}.

If the manufacturer demonstrates that the material of the gas meter is sufficiently insensitive to the gas composition, the approving authority may decide to perform the endurance test with air.

7.2.3.3 The duration of the endurance test shall be as follows:

- for gas meters with Q_{max} from 1 to 16 m^3/h inclusive: 2000 hours; the endurance test may be discontinuous but shall be completed within 100 days;
- for gas meters with Q_{max} from 25 to 1000 m^3/h inclusive: such that each gas meter measures a volume corresponding to 2000 hours of operation of the gas meter at maximum flowrate: the test shall be completed within 180 days.

7.2.4 After the endurance test the gas meters (with the exception of one of them if the endurance test has been carried out on a number of gas meters according to option 2) shall comply with the following requirements.

7.2.4.1 The error curve shall be within the maximum permissible in-service errors as specified in Table 4.

7.2.4.2 The difference between the minimum and maximum of the mean error curve as a function of the flowrate shall not exceed 3 % for the range 0.1 Q_{max} to Q_{max}.

7.2.4.3 The error values over the range 0.1 Q_{max} to Q_{max} shall not vary by more than 1 % from the initial corresponding values.

7.2.5 For patterns of gas meters with one or more drive shafts, at least three gas meters of each size shall be tested with air at a density of 1.2 kg/m^3 for compliance with the requirements of R 6, subclause 3.2.4, and subclause 5.4 of this Recommendation.

For patterns of gas meters with more than one shaft, the test shall be carried out on the shaft which gives the least favorable result.

For gas meters of the same size, the lowest torque value obtained in the tests shall be used as the maximum permissible torque value.

Where a type of gas meter includes various sizes, the torque test need only be carried out on the smallest size, provided that the same torque is specified for the larger gas meters and that the drive shaft of the latter has the same or a greater output constant.

7.3 Modification of a previously approved pattern

If the request for pattern approval concerns a modification to a previously approved pattern, the authority which approved the original pattern shall decide, according to the nature of the modification, whether and to what extent the requirements of 7.1 and 7.2 are applicable.

8 Initial verification

8.1 Examinations

8.1.1 Gas meters shall be examined and tested to ascertain whether they conform generally with their approved pattern.

8.1.2 Gas meters shall be examined and tested to ascertain whether they satisfy the requirements of R 6 and of this Recommendation. The gas meters shall be submitted to the testing procedures for initial verification as specified in Annex B.

8.2 Accuracy tests

A gas meter is considered to comply with the requirements concerning the maximum permissible errors if these are met at the following flowrates: Q_{min}, 0.2 Q_{max} and Q_{max}.

If the examination is conducted at different flowrates the assurance shall be at least equal to that obtained by the tests mentioned above.

9 Subsequent verification

9.1 If gas meters are subject to subsequent verification the time interval between verifications should preferably be 10 years.

9.2 Subsequent verification may be carried out using statistical sampling methods.

9.2.1 It is recommended that the in-service error limits be applied for gas meters with undamaged seals.

9.2.2 In the case of detachment of a gas meter from the network for the purpose of subsequent verification at the end of the validity period, the meter shall satisfy the error limits for initial verification if it is to be remounted in the network for a new period. This requirement does not apply to meters that have been detached for the purpose of verification by request of the customer.

ANNEX A

(Optional)

TRANSITORY VALUES FOR MAXIMUM PERMISSIBLE ERRORS OF DIAPHRAGM GAS METERS

Instead of the requirements of 5.1, OIML Member States may for the time being apply the maximum permissible errors given in Table 7.

Table 7

Flowrate	Maximum permissible errors	
	On initial verification	In service
$Q_{min} \leq Q < 2\ Q_{min}$	± 3 %	To be specified by national regulations
$2\ Q_{min} \leq Q \leq Q_{max}$	± 2 %	

These values correspond to the provisions of the first edition (1973) of this Recommendation.

Application of the above-mentioned errors shall be transitory.

ANNEX B

(Mandatory)

TEST PROCEDURES FOR PATTERN EXAMINATION AND INITIAL VERIFICATION OF DIAPHRAGM GAS METERS

B.1 Test room and test installation

B.1.1 General

B.1.1.1 The test room shall be set up so that gas meters can be tested in a correct and efficient way.

B.1.1.2 The test room shall be clean and in good order. Engines and other noise-producing machines should be placed outside the test room.

B.1.2 Ambient conditions

B.1.2.1 The average ambient temperature is defined as the arithmetic mean of the following temperatures:

- the ambient temperature near the reference standard(s),
- the ambient temperature near the meters to be tested,
- the air temperature at the air inlet of the test installation,
- the ambient temperature near the place in the test room where the meters to be tested are stored prior to examination.

Note: The meters to be tested may also be stored in a neighboring room with the same temperature conditions.

B.1.2.2 The conditions of the test room air shall be sufficiently stable. This demands at least that:

- the average ambient temperature does not vary by more than 4 °C per 12 hours and by not more than 2 °C per hour,
- the difference between any two temperatures mentioned in B.1.2.1 does not exceed 2 °C.

B.1.2.3 If the following requirements are met the meters may be tested without applying a correction for temperature differences between the reference meter and the meter to be tested:

- the air used to test the meters is at ambient conditions,
- the average ambient temperature does not vary by more than 2 °C per 12 hours and by not more than 0.5 °C per hour,
- the difference between any two temperatures mentioned in B.1.2.1 does not exceed 0.5 °C.

In all other cases corrections for temperature differences shall be made (see B.1.3.3).

B.1.2.4 It shall be established that stable conditions are reached before the start of the first test and that they are maintained until immediately after the last test.

B.1.2.5 During measurements the temperature in the test room shall be checked at least once a day.

B.1.2.6 The barometric pressure in the laboratory should be measured at least once a day.

B.1.3 Test installation

B.1.3.1 Test air

B.1.3.1.1 The test air shall be clean and free from dust and oil.

B.1.3.1.2 The temperature of the test air shall be within 0.5 °C of the average ambient temperature.

B.1.3.1.3 The relative humidity shall be such that condensation is avoided at all times.

B.1.3.2 Pressure measurement

B.1.3.2.1 Pressure tappings for meters under test shall be located one pipe diameter upstream of the meter inlet and one pipe diameter downstream of the meter outlet, or the pressures actually measured shall be verified to be correct indications of the pressures at the above-mentioned locations.

B.1.3.2.2 There shall be a straight length of at least one pipe diameter upstream of the inlet pressure tapping and one downstream of the outlet pressure tapping. Each straight length shall be of the same nominal size as the inlet or outlet, respectively.

B.1.3.2.3 The holes for pressure tappings shall be perpendicular to the pipe axis. They shall have a diameter of at least 3 mm. The tappings shall not protrude into the gas flow. The inside wall of the pipe near the pressure tapping shall be smooth and free from burrs.

Note: In the case of a single pipe connection, B.1.3.2.1 through B.1.3.2.3 apply to the single pipes upstream and downstream of the connection piece.

B.1.3.2.4 The pressure measuring device used to monitor the average pressure absorption of the meter under test shall allow the normal variations in pressure over the meter to be averaged.

B.1.3.3 Temperature measurement

The temperature representative of the measured gas volume should be measured at the outlet of the meter under test.

B.1.3.4 Leakage

Periodically the test installation should be extensively tested for leakage, both externally, i.e. into or out of the installation, and internally, i.e. through valves, etc. These leakage tests should be performed with the minimum or maximum operating pressure of the installation, whichever is applicable. The rate of leakage shall be smaller than the greater of the following values:

- 0.1 % of the minimum flowrate for which the installation is intended to be used;
- 100 cm^3/h.

B.1.3.5 Series testing

If meters are to be tested in series, there should be no interaction between the meters. This condition may be verified by testing every meter of the series once at each position in the line.

B.1.4 Reference standards

B.1.4.1 The test installation shall be equipped with reference standards that are suitable for the testing of diaphragm gas meters. The working range of the reference standards shall match that of the meters to be tested.

B.1.4.2 Manometers, thermometers, and reference volume flow standards used to measure parameters that enter into the calculation of any quantity in connection with pattern approval or with initial verification shall have calibration certificates traceable to national or international standards.

B.1.4.3 The certificates mentioned in B.1.4.2 shall cover the range for which the instruments are used and shall report the calibration uncertainty.

B.1.4.4 The laboratory shall at all times be able to specify type A and type B uncertainties in the determination of meter error. The uncertainties shall be calculated according to the *Guide to the expression of uncertainty in measurement* (1993 edition) and the overall (expanded) uncertainty shall be calculated with a coverage factor k = 2.

B.1.4.5 The overall uncertainty in the determination of the meter error shall be at least a factor of 3 smaller than the value of the maximum permissible errors for the meters tested, taken from the applicable values of Table 4.

For test installations used for the purpose of pattern approval the same factor shall be at least 5.

B.2 Pattern approval

B.2.1 Documents and meters to be submitted

B.2.1.1 The applicant shall submit the documents specified in R 6, clause 11.3.

B.2.1.2 The applicant shall submit a number of meters for examination as specified in 7.1.

B.2.1.3 The documents shall be examined to verify that they are in agreement with the meters submitted.

B.2.2 General inspection

B.2.2.1 The markings and inscriptions on the meters shall be examined (see R 6, subclauses 3.1, 3.2.1 or 3.2.2, 4.1 and 5.1.1.3, and subclause 4.3 of this Recommendation). The working range indicated shall comply with 2.1.

B.2.2.2 The places provided for verification marks and protection marks shall be checked (see R 6, clause 8).

B.2.2.3 The indicating device(s) shall be checked as specified in R 6, clause 5.1. The test element(s) shall be checked as specified in R 6, clause 5.2 and as in clause 4 of this Recommendation.

B.2.2.4 The meters to be tested shall be ready for operation as specified in the manufacturer's operating instructions.

B.2.2.5 Meters having additional devices shall be checked to ensure that these devices are correctly connected and that they conform to the documents supplied by the manufacturer (see also B.2.4 and B.2.5).

B.2.3 Initial performance test at ambient conditions

B.2.3.1 Error curve

B.2.3.1.1 Meters shall be stabilized at the temperature of the test room.

B.2.3.1.2 Meters shall be installed on the test installation as specified in the manufacturer's operating instructions. Pipes connected to the inlet and outlet of the meter shall be of at least the same nominal sizes as those of the meter connections.

B.2.3.1.3 After a meter is installed on the test installation it shall be brought to the minimum or maximum gauge pressure of the test installation, whichever is applicable.

After temperature stabilization the leak rate shall be as specified in B.1.3.4.

B.2.3.1.4 Before starting the first series of tests, the meter shall be run at maximum flowrate. The volume passed through the meter shall be at least fifty times the cyclic volume of the meter. The actual duration of running in may depend on the time that has elapsed since the meter was last in operation.

B.2.3.1.5 The error curve of all meters submitted shall be determined at a minimum of seven flowrates. These flowrates shall include:

$$Q_{max} \quad 0.7\,Q_{max} \quad 0.4\,Q_{max} \quad 0.2\,Q_{max} \quad 0.1\,Q_{max} \quad 3\,Q_{min} \quad Q_{min}$$

B.2.3.1.6 The meter should be tested with a volume of air that equals an integer multiple of the cyclic volume of the meter. If this is not possible the volume of air passing through the meter should be chosen so that the influence of the periodic variation of the working cycle is less than 0.2 % for the tests at flowrates equal to or greater than $0.1\,Q_{max}$ and 0.4 % for the tests at flowrates less than $0.1\,Q_{max}$.

B.2.3.1.7 If a number of meters are tested in series the average inlet pressure at each meter shall be measured in order to account for the effect on the measured volume of the decreasing pressure in the test line.

B.2.3.1.8 The error at each flowrate shall be determined as the mean value of the errors measured. For flowrates Q_{min} and $3\,Q_{min}$ the error shall be determined twice, once with decreasing flowrate and once with increasing flowrate. For flowrates equal to or greater than $0.1\,Q_{max}$, the error shall be determined at least six times, thrice with decreasing flowrate and thrice with increasing flowrate.

B.2.3.1.9 The error at each flowrate shall be within the maximum permissible errors specified in 5.1 and 5.2.

B.2.3.2 During the test at Q_{max} the pressure differential between the inlet and the outlet of the meter shall be read to check that the average total pressure absorption of the meter complies with clause 6.

B.2.3.3 In order to detect mechanical wear occurring during the endurance test the pressure absorption at Q_{min} should be determined.

B.2.3.4 The indication of each of the meters submitted shall be determined as specified in 7.2.1.2.

B.2.4 Performance test at temperatures other than reference temperature conditions

B.2.4.1 When a meter without a built-in temperature conversion device is designed to be used at temperatures other than reference conditions, the meter performance shall be

checked over the range of metering temperatures indicated on the meter, as specified in R 6, subclause 4.1(i). The meters shall be tested at least at the following temperatures:

- a temperature within 5 °C of the minimum metering temperature;
- a temperature within 5 °C of the maximum metering temperature.

B.2.4.2 The temperatures of the ambient conditions of the meter and of the test air at the meter inlet shall be the same within 1 °C, and the metering temperature at the meter to be tested shall be kept constant within 0.5 °C at a given temperature setting.

The temperature shall be fully stabilized before testing at a given temperature. The temperature shall be measured.

Note: The reference standard shall always run at a temperature for which its calibration is valid. The humidity of the test air shall be such that no condensation occurs.

B.2.4.3 The test shall be performed at the following flowrates:

$$0.2\ Q_{max},\ 0.7\ Q_{max} \text{ and } Q_{max}$$

B.2.4.4 The errors shall be determined twice, once with decreasing flowrate and once with increasing flowrate.

B.2.4.5 The errors at each test temperature shall be within the maximum permissible errors on initial verification as specified in 5.1 and 5.2.

B.2.5 Additional devices

B.2.5.1 If the meter is equipped with a prepayment device it shall be verified that this device has no significant influence on the meter performance (see R 6, clause 3.1).

B.2.5.2 If the meter is equipped with a pulse generator, its correct operation and the number of pulses per unit volume shall be checked (see R 6, clause 3.1).

B.2.5.3 A meter equipped with output drive shafts shall be checked as specified in 7.2.5 to verify that the connection between the measuring device and the gearing remains intact when a torque of three times the maximum torque M_{max} is applied (see R 6, subclause 3.2.4). Similarly, the error at Q_{min} shall be determined to verify that it does not vary by more than the value specified in 5.4 when the maximum torque M_{max} is applied.

B.2.6 Built-in temperature conversion device

B.2.6.1 General

B.2.6.1.1 All tests specific to the temperature conversion device shall be carried out on the same sample size as used for the pattern approval of non-converting meters (see B.2.1.2).

B.2.6.1.2 The meters shall be tested at various constant temperatures as specified in B.2.6.2.

B.2.6.2 Temperature tests

B.2.6.2.1 The meters shall be tested as specified in B.2.4.2 and B.2.4.3. The test temperatures shall be the temperatures that follow from 5.5.3.

Tests shall be carried out with increasing and decreasing temperatures.

B.2.6.2.2 The errors at each test temperature shall be within the maximum permissible errors on initial verification as specified in clause 5.

B.2.7 Endurance test (see 7.2.3 and 7.2.4)

B.2.7.1 If the endurance tests are carried out outside the laboratory of the approving authority, the meters shall be completely sealed.

B.2.7.2 The main components of the gas measured during the endurance test should be known.

B.2.7.3 The ambient conditions should not be more severe than the normal operating conditions of the meter.

B.2.7.4 For each meter, the meter reading at the beginning and at the end of the endurance test shall be noted. The indication of the measured volume shall be verified as being compatible with the measured flowrate and the duration of the test.

B.2.7.5 Final error curve

B.2.7.5.1 The final error curve shall be determined as soon as possible but no later than 48 hours after termination of the endurance test. During the time interval between termination and the determination of the error curve the meters shall remain shut off and filled with gas.

B.2.7.5.2 The conditions and procedure for the determination of the final error curve shall be those of the initial performance test, as specified in B.2.3. The errors shall be determined twice, once with decreasing flowrate and once with increasing flowrate. The tests shall be carried out on the same test installation used to determine the initial error curve.

B.2.7.5.3 The shift of the mean error curve shall be within the tolerances specified in 7.2.4.

B.2.7.6 If the pressure absorption at Q_{min} has changed significantly the meter should be examined for the possible cause.

B.2.8 Conclusion

If the meters submitted for pattern approval are shown to comply with all the relevant requirements a pattern approval certificate shall be issued as specified in R 6, clause 11.4.

B.3 Initial verification

B.3.1 Preparation

B.3.1.1 The meters shall be stabilized at the temperature of the test room.

B.3.1.2 If meters are brought into the test room from a room at a different temperature care shall be taken to avoid water condensation in the meters.

B.3.1.3 If meters are provided with mechanical indicating devices the roll-over of all index drums shall be checked prior to or during the test.

B.3.1.4 Prior to the test all markings and inscriptions on the meters shall be examined.

B.3.1.5 Prior to the test the meters shall be checked to verify that they conform to the approved pattern.

B.3.1.6 The meters to be tested shall be ready for operation as specified in the manufacturer's operating instructions.

B.3.1.7 Meters shall be installed on the test installation as specified in the manufacturer's operating instructions. Pipes connected to the inlet and outlet of the meter shall be of at least the same nominal size as the meter connections.

B.3.1.8 Meters having additional devices shall be checked to ensure that these devices are connected correctly and that they conform to the documents supplied by the manufacturer.

B.3.2 Test procedure

B.3.2.1 After a meter is installed on the test installation, it shall be brought to the minimum or maximum gauge pressure of the test installation, whichever is applicable. After temperature stabilization the leak rate shall be as specified in B.1.3.4.

B.3.2.2 Before starting the tests, the meter shall be run in at maximum flowrate. The volume passed through the meter shall be at least fifty times the cyclic volume of the meter.

B.3.2.3 The meter shall be tested at least at the flowrates specified in 8.2. The actual flowrate shall not differ by more than 5 % from the nominal value.

B.3.2.4 The meter should be tested with a volume of air that equals an integer multiple of the cyclic volume of the meter. If this is not possible the volume of air passing through the meter should be chosen so that the influence of the periodic variation of the working cycle is less than 0.2 % for the tests at flowrates equal to or greater than 0.1 Q_{max} and 0.4 % for the tests at flowrates less than 0.1 Q_{max}.

B.3.2.5 At each flowrate the error shall be within the maximum permissible errors specified in 5.1 and 5.2 and as amended by 5.5 if applicable.

B.3.2.6 During the test at Q_{max} the pressure differential between the inlet and the outlet of the meter should be read to check that the average total pressure absorption of the meter complies with clause 6.

B.3.2.7 If a number of meters are tested in series the average inlet pressure at each meter should be measured in order to account for the effect on the measured volume of the decreasing pressure in the test line.

B.3.2.8 If a meter is tested without the indicating device or with a device replacing the indicating device at least one test shall be repeated with the indicating device fitted to the meter. This test should be carried out at a flowrate of 0.2 Q_{max}. The quality of the indicating device and of its positioning on the meter may be judged by comparing the errors and the pressure absorptions of the two tests.

If the error difference is greater than a value that complies with 4.1 all the accuracy tests shall be performed with the indicating device placed on the meter.

B.3.2.9 If the meter is equipped with a pulse generator the number of pulses per unit volume shall be checked.

B.3.2.10 If the meter is equipped with output drive shafts to which no additional device is attached, these shafts shall be checked to verify that they are suitably protected against external interference (R 6, subclause 3.2.3).

B.3.2.11 If a meter is adjusted it shall be retested at a minimum of one flowrate in order to check whether the adjustment has been carried out correctly. The retest should be done at a flowrate of 0.2 Q_{max}. A judgement may be made by comparing the errors and the pressure absorptions of the two tests.

B.3.2.12 If a meter is sealed after the examination the sealing shall be carried out carefully, without damaging the meter and preferably without hammering.

B.3.3 Test procedure for built-in temperature conversion device

B.3.3.1 If the meters are of a pattern equipped with a built-in temperature conversion device a sample of meters from the lot that has been tested as specified in B.3.2 shall be tested at three constant temperatures as specified in B.3.3.2. The sampling scheme shall be based on the results from the pattern approval tests, and on additional information, e.g. quality control information from the manufacturer or from experience in the verification of a specific type of meter.

B.3.3.2 The sample meters shall be tested at a temperature within 5 °C of the minimum and the maximum metering temperatures indicated on the meter as specified in R 6, subclause 4.1(i) and at the mean value of the two. If this mean value is within 5 °C of the test air temperature during the testing carried out as specified in B.3.2 the results from these tests may be used for statistical sampling. If the same mean value is outside the range of 5 °C a test shall be performed with the ambient conditions as specified in B.1.2 for statistical sampling.

B.3.3.3 The temperatures of the ambient conditions of the meter and the test air at the meter inlet shall be the same within 1 °C, and shall be kept constant within ± 0.5 °C at a given temperature setting.

Note: The humidity of the test air shall be such that no condensation occurs.

B.3.3.4 The flowrates shall be 0.2 Q_{max} and Q_{max}.

ANNEX C

TEST REPORT FORMAT
FOR THE EVALUATION OF DIAPHRAGM GAS METERS

Note: This Annex is informative with regard to implementation of this Recommendation in national regulations; however, use of this test report format is mandatory for the application of the Recommendation within the OIML Certificate System.

C.0 General

C.0.1 Application no. : (new/modification)

Manufacturer :

Applicant :

Representative :

C.0.2 General information on the gas meter(s)

Q_{max} (m^3/h)	Q_{min} (m^3/h)	p_{max} (bar)	V (dm^3)

Type of display : mechanical/electromechanical/LCD/LED/...

Number of drums/figures :

Additional devices :
- prepayment device : yes/no
- pulse generator : yes/no ... pulses/m^3 or m^3/pulses
- number of output drive shafts :

Built-in temperature conversion device : yes/no
- one indicating device : [ ]
- two indicating devices : [ ]

C.0.3 Overall result of the pattern evaluation

Overall result of pattern evaluation	+/– (*)
1 Documents and meters submitted	
2 General inspection	
3 Initial performance test	
4 Additional devices	
5 Built-in temperature conversion device	
6 Endurance test	

(*) mark + when the result meets the requirements of R 6 and R 31
mark - when the result does not meet the requirements of R 6 and R 31

Final result

C.1 Documents and meters submitted

C.1.1 List of documents submitted (B.2.1.1)*

Declaration of conformity with safety regulations (R 6, 11.3): yes/no

C.1.2 List of meters submitted (B.2.1.2)

Q_{max}	Manufacturer's serial number

C.1.3 Meters and documents compatible (B.2.1.3): yes/no

C.2 General inspection

C.2.1 Inscriptions on the meters (B.2.2.1)

C.2.1.1 Display panel/data plate

- approval sign of the gas meter :
- maker's trade mark/trade name :
- serial number and year :
- Q_{max} : m^3/h
- Q_{min} : m^3/h
- p_{max} : MPa, kPa, Pa, bar, mbar
- V : dm^3
- t_m : / °C
- p_m : MPa, kPa, Pa, bar, mbar

C.2.1.2 Additional devices

- pulse generator : pulses/m^3 or m^3/pulses
- output drive shaft : N.mm

C.2.1.3 Conversion devices

- t_b : °C
- t_{sp} : °C
- p_b : MPa, kPa, Pa, bar, mbar

C.2.1.4 Other indications

- symbol "m^3" : yes/no
- flow direction indication : yes/no

(*) References are to clauses of this Recommendation unless otherwise stated.

C.2.2 Check on location of sites for verification and protection marks (B.2.2.2)

C.2.3 Indicating device(s), test element(s) (B.2.2.3)

Indicating device(s), test element(s)	+/–
General construction	
Test element	
Diameter drums/dials	
Reading of indicating device	
Advance of figure	
Removal of indicating device	

C.2.4 Reading of indicating device

Flowrate (appr. 0.1 Q_{max}) : m^3/h
Air volume per measurement : dm^3
Tolerance : dm^3
Indicated volume (V_i) : see report page 7
Mean indicated volume
$V_m = (\Sigma V_i)/30$: dm^3

$$\text{Standard deviation} = \sqrt{\frac{\Sigma\ (V_m - V_i)^2}{29}}$$

Result

C.3 Initial performance test

Ambient conditions t = °C ± °C

RH = %

p_{amb} = kPa

C.3.1 Error curve (B.2.3.1)

Running in: m^3 at m^3/h

Flowrate m^3/h	Test volume m^3, dm^3	Errors % 1	2	3	4	5	6	Maximum difference %
Q_{max}								
0.7 Q_{max}								
0.4 Q_{max}								
0.2 Q_{max}								
0.1 Q_{max}								
3 Q_{min}								
Q_{min}								

Flowrate m^3/h	Mean error %	mpe %	Result +/–
Q_{max}			
0.7 Q_{max}			
0.4 Q_{max}			
0.2 Q_{max}			
0.1 Q_{max}			
3 Q_{min}			
Q_{min}			

General result for error curve

C.3.2 Average total pressure absorption at Q_{max} (B.2.3.2) : Pa

Tolerance : Pa

C.3.3 Pressure absorption at Q_{min} (B.2.3.3) : Pa

Result pressure absorption

C.3.4 Constant temperature test (B.2.4)

Metering temperature: °C

Flowrate m^3/h	Test volume dm^3	Error %	Test volume dm^3	Error %
0.2 Q_{max}				
0.7 Q_{max}				
Q_{max}				

Metering temperature: °C

Flowrate m^3/h	Test volume dm^3	Error %	Test volume dm^3	Error %
0.2 Q_{max}				
0.7 Q_{max}				
Q_{max}				

Result constant temperature test

Test No.	Indicated volume V_i (dm^3)	$V_m - V_i$ (dm^3)	$(V_m - V_i)^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

C.4 Additional devices

C.4.1 Prepayment device (R 6, 3.1)

Influence of prepayment device on meter performance

C.4.2 Pulse generator (R 6, 3.1)

Correct operation

Number of pulses per unit volume correct

C.4.3 Output drive shafts (R 6, 3.2.4, R 31, 5.4, 7.2.5)

Maximum torque to be applied M_{max} = N.mm

Application of 3 M_{max}: connection remains intact

Application of M_{max} at Q_{min} :
Initial error at Q_{min} : %
Error at Q_{min} with M_{max} : %
Difference : %

Result

C.5 Built-in temperature conversion device

C.5.1 List of meters submitted

Q_{max}	Manufacturer's serial number

Indicated temperature range : t_m = / °C
Base temperature : t_b = °C
Specified temperature : t_{sp} = °C

C.5.2 Constant temperature tests (B.2.6.2)

Test temperatures: °C
°C
°C

C.5.2.1 Increasing temperature

Flowrate m^3/h	t = °C error % up	down	t = °C error % up	down	t = °C error % up	down
0.2 Q_{max}						
0.7 Q_{max}						
Q_{max}						
mpe %						

C.5.2.2 Decreasing temperature

Flowrate m^3/h	t = °C error % up	down	t = °C error % up	down	t = °C error % up	down
0.2 Q_{max}						
0.7 Q_{max}						
Q_{max}						
mpe %						

Result constant temperature test

C.6 Endurance test (7.2.3, 7.2.4)

C.6.1 Meter completely sealed :

C.6.2 Test medium: gas, composition : mol % CO_2
mol % N_2
mol % CH_4
mol % C_2H_6

Relative humidity : %

C.6.3 Ambient conditions at test site

Ambient temperature : / °C

Environmental classification : B/C/F

C.6.4 Data endurance test

Flow rate : m^3/h
Duration : hours

Meter number (m^3/h)	Meter reading m^3		Measured volume m^3
	at beginning	at end	

Date and time of termination endurance test:

C.6.5 Final error curve

Date and time of determination of error curve:

Flowrate (m^3/h)	Test volume (m^3)	Error (%)	Mean error (%)	Shift (%)	mpe (%)	Result ±
Q_{max}						
0.7 Q_{max}						
0.4 Q_{max}						
0.2 Q_{max}						
0.1 Q_{max}						
3 Q_{min}						
Q_{min}						

General result for error curve shift

C.6.6 Pressure absorption at Q_{min} : Pa
Change : Pa

C.6.7 Average total pressure absorption at Q_{max} : Pa
Change : Pa

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