

|   |                          | <b>Technical Specification for Type Approval<br/>of Diaphragm Gas Meters</b>           |                     | S/N  | CNPA 137 |
|--|--------------------------|--|---------------------|--|----------|
|  |                          |  |                     | Rev.   | 2        |
| <p>1. This Technical Specification is enacted pursuant to Paragraph 3, Articles 25 of the Weights and Measures Act.</p> <p>2. The date of promulgation, document number, date of enforcement and content of the amendment are listed as follows:</p> |                          |  |                     |  |          |
| Rev.   | Date of Promulgation     | Document No.   | Date of Enforcement | Content of Amendment   |          |
| 1  | 2003-11-19<br>(CNPA 31)  | No. 09240008950  | 2004-01-01          |  |          |
| 2  | 2016-09-05<br>(CNPA 31)  | No. 10540016080  | 2016-09-05          | <p>Referring to OIML R 137-1&amp;2: 2012, adding the provisions on the maximum working pressure and other features to meet the metrological requirements.</p> <p>Adding the testing on pressure features for gas meters with working pressure over 10 kPa.</p> <p>Corresponding to the testing capacity of the constant temperature, revising the applicable maximum measurable range for temperature.</p> |          |
| 3  | 2017-10-27<br>(CNPA 31)  | No. 10640006480  | 2018-01-01          | Adding the manufacturing year on the name plate.   |          |
| 1  | 2023-02-06<br>(CNPA 137) | No. 11240000520  | 2023-07-01          | <p>Referring to OIML R 137-1 &amp; 2: 2012, amending the existing CNPA 31.</p> <p>Changing the document number and the revision of this specification from CNPA 31, rev.3 to CNPA 137, rev.1 .</p>   |          |
| 2  | 2024-08-15<br>(CNPA 137) | No. 11350004330  | 2024-08-15          | <p>Adding the requirements of indicated values of gas consumption being identical for gas meters with a combination of mechanical and electronic indicating devices.</p> <p>Deleting the related marking requirements for gas meters with electronic indicating devices.</p>   |          |
| <p>3. This specification is formulated with reference to the following standards:</p>  |                          |  |                     |  |          |
| OIML R137-1&2  |                          | Gas meters   | (2012)              |  |          |
| OIML R31   |                          | Diaphragm gas meters   | (1995)              |  |          |
| CNS 14741  |                          | Diaphragm gas meter with micro computer for nature gas                                 | (2007)              |  |          |
| Date of Promulgation<br>2024-08-15   |                          | <b>Bureau of Standards, Metrology and Inspection,<br/>Ministry of Economic Affairs</b> |                     | Date of Enforcement<br>2024-08-15  |          |

**NO GUARANTEE ON THE TRANSLATION**

In case of discrepancies between the English translation and Chinese text, the Chinese text shall govern.

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## 1. Scope

This technical specification applies to diaphragm gas meters for metering natural gas and liquidified petroleum gas. These gas meters are gas volume meters in which the gas flow is measured by means of measuring chambers with deformable films, including any other (electronic) devices that may be attached to the gas meters and have potential impact to their metrological performance.

## 2. Definition

### 2.1 Gas meter and constituents

#### 2.1.1 Gas meters

Instrument intended to measure, memorize and display the quantity of gas passing the flow sensor.

#### 2.1.2 Measurand

Quantity intended to be measured.

#### 2.1.3 Sensor

Element of a measuring system that is directly affected by a phenomenon, body, or substance carrying a quantity to be measured.

#### 2.1.4 Measuring transducer

Device, used in measurement, that provides an output quantity having a specified relation to the input quantity.

#### 2.1.5 Calculator

Part of the gas meter which receives the output signals from the measuring transducer(s) and, possibly, associated measuring instruments, transforms them and, if appropriate, stores the results in memory until they are used. In addition, the calculator may be capable of communicating both ways with ancillary devices.

#### 2.1.6 Indicating or displaying device

Part of the gas meter which displays the measurement results, either continuously or on demand.

#### 2.1.7 Ancillary device

Device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results. The main ancillary devices include repeating indicating device, printing device, memory device, and communication device. An ancillary device is not necessarily subject to metrological control and may be integrated in the gas meter.

#### 2.1.8 Equipment under test (EUT)

(part of the) Gas meter and/or associated devices which is exposed to one of the tests.

#### 2.1.9 Family of gas meters

Group of gas meters of different sizes and/or different flow rates, in which all the meters shall have the following characteristics:

- the same manufacturer,
- geometric similarity of the measuring part,
- the same metering principle,
- roughly the same ratios  $Q_{\max}/Q_{\min}$  and  $Q_{\max}/Q_t$ ,
- the same accuracy class,
- the same temperature range,
- the same electronic device for each meter size,
- a similar standard of design and component assembly,
- using the same metrological software routines (if applicable) and the same materials for those components that are critical to the performance of the meter.

#### 2.1.10 Diaphragm gas meter with micro computer

A diaphragm gas meter consists of metrological unit and safety reference detection control unit, the former being composed of metrology related components and the latter being composed of flow sensor, shut-off valve, pressure sensor, earthquake sensor, mother board for identification of abnormal conditions and lithium battery.

### 2.2 Metrological characteristics

#### 2.2.1 Quantity of gas

Total quantity of gas obtained by integrating the flow passed through the gas meter over time, which is expressed as volume  $V$ , disregarding the time taken. The quantity of gas is the measurand concerned.

#### 2.2.2 Indicated value (of a quantity)

Value of a quantity, as indicated by the meter.

#### 2.2.3 Cyclic volume

Volume of gas corresponding to one full revolution of the moving part(s) inside the meter.

#### 2.2.4 Error

Measurand quantity value minus a reference quantity value (relative error).

#### 2.2.5 Weighted Mean Error ( $WME$ )

The weighted mean error ( $WME$ ) within the scope of The Specification is defined as:

$$WME = \frac{\sum_{i=1}^n k_i E_i}{\sum_{i=1}^n k_i}$$

with  $k_i = \frac{Q_i}{Q_{\max}}$  for  $Q_i \leq 0.7Q_{\max}$

$$k_i = 1.4 - \frac{Q_i}{Q_{\max}} \quad \text{for } 0.7Q_{\max} < Q_i \leq Q_{\max}$$

where:

$k_i$  = weighting factor at the flow rate  $Q_i$ ;

$E_i$  = the error at the flow rate  $Q_i$ .

#### 2.2.6 Intrinsic error

Error determined under reference conditions.

#### 2.2.7 Fault

Difference between the error of indication and the intrinsic error of a measuring instrument. In practice fault is the difference between the error of the meter observed during or after a test, and the error of the meter prior to this test, performed under reference conditions.

#### 2.2.8 Maximum Permissible Error (MPE)

Extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a measuring instrument.

#### 2.2.9 Accuracy class

Class of gas meters that meet stated metrological requirements to keep measurement errors within specified limits under specified operating conditions.

#### 2.2.10 Durability

Ability of a gas meter to maintain its performance characteristics over a period of use.

#### 2.2.11 Measurement precision

Closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions.

#### 2.2.12 Repeatability

Measurement precision under a set of repeatability conditions of measurement.

#### 2.2.13 Repeatability of error

Repeatability under reference conditions and not changing the flow rate between the measurements.

#### 2.2.14 Reproducibility

Measurement precision under reproducibility condition of measurement.

#### 2.2.15 Reproducibility of error

Reproducibility under reference conditions and changing the flow rate between the measurements.

#### 2.2.16 Operating conditions

Conditions of the gas (temperature, pressure, flow rate and composition) at which the quantity of gas is measured.

### 2.2.17 Rated operating conditions

Operating conditions of use giving the range of values of the measurand and the influence quantities, for which the errors of the gas meter are required to be within the limits of the maximum permissible error.

### 2.2.18 Reference conditions

Set of reference values, or reference ranges of influence quantities, prescribed for testing the performance of a gas meter, or for the intercomparison of the results of measurements.

### 2.2.19 Test element

Device to enable precise reading of the measured gas quantity.

### 2.2.20 Resolution

Smallest difference between displayed indications that can be meaningfully distinguished. For a digital device, this is the change in the indication when the least significant digit changes by one step. For an analogue device, this is half the difference between subsequent scale marks.

### 2.2.21 Drift

Continuous or incremental change over time in indication, due to changes in the metrological properties of a measuring instrument.

## 2.3 Operating conditions

### 2.3.1 Flow rate, $Q$

Quotient of the actual quantity of gas passing through the gas meter and the time taken for this quantity to pass through the gas meter.

### 2.3.2 Maximum flow rate, $Q_{\max}$

Highest flow rate at which a gas meter is required to operate within the limits of its maximum permissible error, whilst operated within its rated operating conditions.

### 2.3.3 Minimum flow rate, $Q_{\min}$

Lowest flow rate at which a gas meter is required to operate within the limits of its maximum permissible error, whilst operated within its rated operating conditions.

### 2.3.4 Transitional flow rate, $Q_t$

Flow rate which occurs between the maximum flow rate  $Q_{\max}$  and the minimum flow rate  $Q_{\min}$  that divides the flow rate range into two zones, the "upper zone" and the "lower zone", each characterized by its own maximum permissible error.

### 2.3.5 Working temperature

Temperature of the gas to be measured at the gas meter.

### 2.3.6 Minimum and maximum working temperature, $t_{\min}$ and $t_{\max}$

Minimum and maximum gas temperature that a gas meter can withstand, within

its rated operating conditions, without unacceptable deterioration of its metrological performance.

#### 2.3.7 Working pressure

Pressure of the gas to be measured at the gas meter.

#### 2.3.8 Minimum and maximum working pressure, $P_{\min}$ and $P_{\max}$

Minimum and maximum internal pressure that a gas meter can withstand, within its rated operating conditions, without deterioration of its metrological performance.

#### 2.3.9 Static pressure loss or pressure differential, $\Delta P$

Mean difference between the pressures at the inlet and outlet of the gas meter while the gas is flowing.

#### 2.3.10 Working density, $\rho_w$

Density of the gas flowing through the gas meter, corresponding to working pressure and working temperature.

#### 2.3.11 Pressure absorption

With a flow of air of density  $1.2 \text{ kg/m}^3$  as a medium, at a flow rate equal to  $Q_{\max}$ , the pressure loss averaged over a measuring cycle of a gas meter as the total pressure absorption.

### 2.4 Test conditions

#### 2.4.1 Influence quantity

Quantity that, in a direct measurement, does not affect the quantity that is actually measured, but that affects the relation between the indication and the measurement result.

#### 2.4.2 Disturbance

Influence quantity having a value within the limits specified in This Specification, but outside the specified rated operating conditions of the gas meter.

#### 2.4.3 Overload conditions

Conditions outside the rated operating conditions (including flow rate, temperature, pressure, humidity and electromagnetic interference) that a gas meter is required to withstand without deterioration.

#### 2.4.4 Test

Series of operations intended to verify the compliance of the equipment under test (EUT) with certain requirements.

#### 2.4.5 Test procedure

Detailed description of the test operations.

#### 2.4.6 Test program

Description of a series of tests for a certain type of equipment.

### 2.4.7 Performance test

Test intended to verify whether the equipment under test (EUT) is capable of accomplishing its intended functions.

## 2.5 Electronic equipment

### 2.5.1 Electronic gas meter

Gas meter equipped with electronic devices. Ancillary equipment, as far as it is subject to metrological control, is considered part of the gas meter, unless the ancillary equipment is approved and verified separately.

### 2.5.2 Electronic device

Device performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being tested independently.

### 2.5.3 Electronic component

Smallest physical entity in an electronic device used to affect electrons and/or their associated fields in their movement through a medium or vacuum.

## 3. Metrological requirements

### 3.1 Rated operating conditions

| Rated operating conditions for a gas meter |                                   |   |
|--|-----------------------------------|---|
| (1)  | Ambient temperature               | -5 °C to +55 °C   |
| (2)  | Ambient relative humidity         | at least up to 93 %   |
| (3)  | Vibration less than               | 10 Hz - 150 Hz, 1.6 ms <sup>-2</sup> , 0.05 m <sup>2</sup> s <sup>-3</sup> , -3 dB/octave |
| (4)  | DC mains voltage, if applicable   | as specified by the manufacturer  |
| (5)  | AC mains voltage, if applicable   | $U_{nom} - 15 \%$ to $U_{nom} + 10 \%$  |
| (6)  | AC mains frequency, if applicable | $f_{nom} - 2 \%$ to $f_{nom} + 2 \%$  |
| (7)  | Flow rate range                   | $Q_{min}$ to $Q_{max}$ inclusive  |
| (8)  | Working pressure range            | $P_{min}$ to $P_{max}$ inclusive  |

### 3.2 Values of $Q_{max}$ , $Q_t$ and $Q_{min}$

The flow rate characteristics of a gas meter shall be defined by the values of  $Q_{max}$ ,  $Q_t$  and  $Q_{min}$ . Their ratios and relations shall be within the ranges as stated in table 1.

Table 1

| $Q_{max}$<br>m <sup>3</sup> /h | Upper limit of $Q_t$<br>m <sup>3</sup> /h | Upper limit of $Q_{min}$<br>m <sup>3</sup> /h |
|--------------------------------|---|---|
| 1                              | 0.10                                      | 0.016   |
| 1.6                            | 0.16                                      | 0.016   |
| 2.5                            | 0.25                                      | 0.016   |
| 4                              | 0.40                                      | 0.025   |
| 6                              | 0.60                                      | 0.040   |
| 10                             | 1.0                                       | 0.060   |
| 16                             | 1.6                                       | 0.100   |
| 25                             | 2.5                                       | 0.160   |
| 40                             | 4.0                                       | 0.250   |

|      |     |       |
|------|-----|-------|
| 65   | 6.5 | 0.400 |
| 100  | 10  | 0.650 |
| 160  | 16  | 1.000 |
| 250  | 25  | 1.600 |
| 400  | 40  | 2.500 |
| 650  | 65  | 4.000 |
| 1000 | 100 | 6.500 |

### 3.3 Accuracy classes and maximum permissible errors

#### 3.3.1 General

A gas meter shall be designed and manufactured such that its errors do not exceed the applicable MPE under rated operating conditions.

#### 3.3.2 Accuracy classes

Gas meters may be divided in two accuracy classes, 1.0 and 1.5. The value of the MPE is dependent on the applicable accuracy class as listed in Table 2 below.

#### 3.3.3 Maximum permissible errors (MPE)

Use air of ambient temperature and ambient pressure as the test medium. The maximum permissible errors are given in Table 2.

Table 2

| Flow rate                  | During type evaluation and verification<br>(During in-service) |                                |
|----------------------------|--|--------------------------------|
|                            | Accuracy class   |                                |
|                            | 1.0  | 1.5                            |
| $Q_{\min} \leq Q < Q_t$    | $\pm 2 \%$<br>( $\pm 4 \%$ )                                   | $\pm 3 \%$<br>( $\pm 6 \%$ )   |
| $Q_t \leq Q \leq Q_{\max}$ | $\pm 1 \%$<br>( $\pm 2 \%$ )                                   | $\pm 1.5 \%$<br>( $\pm 3 \%$ ) |

#### 3.3.4 Calculation of error

The instrument error of measuring shall be expressed by percentage to the relative value; i.e., the ratio of deviation between the indicated value of gas meter and standard value made from standard element, then divided by the standard value made from standard element:

$$\text{Error (\%)} = \frac{(\text{Indicated value} - \text{standard value})}{(\text{standard value})} \times 100\%$$

### 3.4 Weighted mean error (WME)

The weighted mean error shall only be applicable during type evaluation and shall be within the ranges given in table 3.

Table 3

| Accuracy class | 1.0          | 1.5          |
|----------------|--------------|--------------|
| WME            | $\pm 0.4 \%$ | $\pm 0.6 \%$ |

### 3.5 Reproducibility

For flow rates equal to or greater than  $Q_t$  the reproducibility of error at the specific flow rate shall be less than or equal to one third of the maximum permissible error.

### 3.6 Repeatability

The repeatability of error of three consecutive measurements at the specific flow rate shall be less than or equal to one third of the maximum permissible error.

### 3.7 Working pressure

The requirements of accuracy class and weighted mean error for the gas meter shall be fulfilled within the rated working pressure range.

### 3.8 Working temperature

The requirements of accuracy class and weighted mean error for the gas meter shall be fulfilled within the rated working temperature range, where the ambient temperature equals the gas temperature within 5 °C.

### 3.9 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<sup>3</sup>, at a flow rate equal to  $Q_{max}$ , shall not exceed the values given in Table 4.

Table 4

| Flow rate             | Maximum permissible values for average total pressure absorption (equipped with safety reference detection control unit)<br>Pa |
|-----------------------|--|
| 1 to 10 inclusive     | 200 (242)  |
| 16 to 65 inclusive    | 300 (330)  |
| 100 to 1000 inclusive | 400 (440)  |

### 3.10 Durability test

A gas meter shall meet the following requirements after being subjected to a flow with rate between 0.8  $Q_{max}$  and  $Q_{max}$  comprising a quantity that is equivalent to a flow at  $Q_{max}$  during a period of 2000 hours (The test may be discontinuous but shall be completed within 100 days):

- the maximum permissible errors as specified in Table 2 for in-service, and
- for flow rates from  $Q_t$  up to  $Q_{max}$  a fault of less than or equal to:
  - 1.0 times the maximum permissible error applicable for class 1.5, or 0.5 times the maximum permissible error applicable for class 1.0.

### 3.11 Overload flow

A gas meter shall meet the following requirements, after being exposed to an overload of 1.2  $Q_{max}$  for a period of 1 hour:

- the maximum permissible errors as mentioned in Table 2 for verification,

- and a fault of less than or equal to one third of the maximum permissible error.

### 3.12 Vibrations and shocks

The fault after the gas meter being exposed to the following vibrations and shocks shall be less than or equal to 0.5 times the maximum permissible error for verification.

#### 3.12.1 Vibrations

total frequency range: 10 Hz – 150 Hz

total RMS level:  $7 \text{ ms}^{-2}$

ASD level 10 Hz – 20 Hz:  $1 \text{ m}^2\text{s}^{-3}$

ASD level 20 Hz – 150 Hz:  $-3 \text{ dB/octave}$

#### 3.12.2 Shocks

Height of fall: 50 mm

### 3.13 Metrological requirements specific to certain types of gas meters

#### 3.13.1 Electronics

If a gas meter includes electronic components, the requirements as presented in Table 5 and Table 6 apply. The test methods are given in Annex A: Environmental tests for electronic instruments or devices (mandatory).

#### 3.13.2 Influences from ancillary devices

Gas meters provided with ancillary devices shall be designed such that all functions of the ancillary devices (e.g. provisions for communication purposes) do not affect the metrological behavior.

Table 5 Requirements for gas meters containing electronic components

| No | Influence factor                               | Range   | Error limit |
|----|--|---|-------------|
| 1  | Dry heat                                       | upper temperature specified                         | MPE         |
| 2  | Cold   | lower temperature specified                         | MPE         |
| 3  | Damp heat, steady state (non-condensing)       | upper temperature specified, 93 % relative humidity | MPE         |
| 4  | DC mains voltage variation, if applicable      | as specified by the manufacturer                    | MPE         |
| 5  | AC mains voltage variation, if applicable      | 85 % & 110 % of the rated voltage                   | MPE         |
| 6  | Low voltage of internal battery, if applicable | as specified by the manufacturer                    | MPE         |

Table 6 Immunity requirements for gas meters containing electronic components

| No. | Disturbance                    | Required immunity   | Fault limit / test condition <sup>(1)</sup> |
|-----|--------------------------------|---|---|
| 1   | Damp heat, cyclic (condensing) | upper temperature specified<br>93 % relative humidity                         | 1/2 MPE / NSFa                              |
| 2   | Vibrations (random)            | Total frequency range: 10 Hz ~ 150 Hz<br>Total RMS level: $7 \text{ ms}^{-2}$ | 1/2 MPE / NSFa                              |

|   |  |   |                  |
|---|--|---|------------------|
|   |  | ASD level 10 Hz~20 Hz: $1 \text{ m}^2\text{s}^{-3}$<br>ASD level 20 Hz~150 Hz: -3 dB/octave   |                  |
| 3   | Mechanical shock   | 50 mm   | 1/2 MPE / NSFa   |
| 4   | Radiated, RF, electromagnetic fields                         | 10 V/m, up to 3 GHz   | MPE / NSFd       |
| 5   | Conducted (common mode) currents generated by RF EM fields   | 10 V (e.m.f), up to 80 MHz  | MPE / NSFd       |
| 6   | Electrostatic discharges                                     | 6 kV contact discharge<br>8 kV air discharge  | 1/2 MPE / NSFa+d |
| 7   | Bursts (transients) on signal, data and control lines        | Amplitude 1 kV<br>Repetition rate 5 kHz   | 1/2 MPE / NSFd   |
| 8   | Surges on signal, data and control lines                     | unsymmetrical lines:<br>line to line 0.5 kV<br>line to ground 1.0 kV<br>symmetrical lines:<br>line to line NA<br>line to ground 1.0 kV<br>shielded I/O and communication lines:<br>line to line NA<br>line to ground 0.5 kV | 1/2 MPE / NSFd   |
| 9   | AC mains voltage dips and short interruptions, if applicable | 1/2 cycle 0 %<br>1 cycle 0 %<br>12 cycles 40 %<br>30 cycles 70 %<br>300 cycles 80 %   | 1/2 MPE / NSFd   |
| 10  | DC mains voltage dips and short interruptions, if applicable | 40 % and 70 % of the rated voltage during 0.1 s and 0 % of rated voltage during 0.01 s  | 1/2 MPE / NSFd   |
| 11  | Bursts (transients) on AC and DC mains                       | Amplitude 2 kV<br>Repetition rate 5 kHz   | 1/2 MPE / NSFd   |
| 12  | Surges on AC and DC mains                                    | line to line 1.0 kV<br>line to ground 2.0 kV  | 1/2 MPE / NSFa+d |
| 13  | Ripple on DC mains power, if applicable                      | 2 % of nominal DC voltage   | 1/2 MPE / NSFd   |
| (1) NSFa: No significant fault shall occur after the disturbance.<br>NSFd: No significant fault shall occur during the disturbance. |  |   |                  |

## 4. Technical requirements

### 4.1 Construction

#### 4.1.1 Material

The materials of outer shell and internal components of the gas meter in direct contact with the gas shall be corrosion-resistant or subjected to surface anti-corrosive treatment, and comply with the requirements given in 4.1.3.

#### 4.1.2 Impact resistance

Material connecting to the fuel-gas-supplying portion should be able to withstand the external impact under normal operation, and shall comply with the requirements given in Section 4.1.4.

#### 4.1.3 Material test

##### 4.1.3.1 Metallic material test (corrosion resistance test)

The test apparatus is set up according to the requirements in CNS 8886 “Methods of salt spray testing”. After the metallic components being continuously sprayed with neutral salt solution for 24 hours under the required condition for salt spray chamber prescribed in CNS 8886, their corrosion area ratio shall be within the range between rating number 9.8 to 9 listed in the same standard.

##### 4.1.3.2 Non-Metallic material test

Three samples of same parts are taken and weighted individually, then immersed into n-pentane for 72 hours within the temperature range between 5 °C and 25 °C. After that, the samples are taken out and placed under atmosphere for 24 hours, then weighted individually. The mass change rate for individual part shall be less than 20% calculated according to the following formula, and no occurrence of degradation or deformation shall be conformed.

$$\text{Mass change rate} = \frac{\text{mass after test (g)} - \text{mass before test (g)}}{\text{mass before test (g)}} \times 100\%$$

#### 4.1.4 Impact resistance test

The gas meter is connected to the gas pipe joint, and screwed in with half of the corresponding torque according to the nominal diameter shown in Table 7. An impact torque corresponding to the nominal diameter shown in Table 8 is applied to the center of the joint connecting the gas meter and the gas pipe, as shown in Figure 1. There shall be no cracks, damage or significant deformation via visual inspection. For diaphragm gas meter with micro computer, the shut-off test in Section B.6.18.4 is performed subsequently, then the restoration action and restoration confirmation test in Section B.6.19 is performed afterwards to confirm that the shut-off and alarm functions are correct. When the impact force is applied from the front direction, the steel plate with a thickness of 5 mm should be fixed at the position of the gas meter's measuring window, and then the surface of the steel plate should be impacted.

Table 7

| Nominal diameter | Joint screw-in torque |
|------------------|-----------------------|
| 1/2 inch (15A)   | 70 N · m              |
| 3/4 inch (20A)   | 100 N · m             |
| 1 inch (25A)     | 120 N · m             |

|                  |           |
|------------------|-----------|
| 1 1/4 inch (32A) | 160 N · m |
| 1 1/2 inch (40A) | 180 N · m |

Table 8

| Nominal diameter | Impact torque |
|------------------|---------------|
| 1/2 inch (15A)   | 8 N · m       |
| 3/4 inch (20A)   | 10 N · m      |
| 1 inch (25A)     | 13 N · m      |
| 1 1/4 inch (32A) | 16 N · m      |
| 1 1/2 inch (40A) | 18 N · m      |

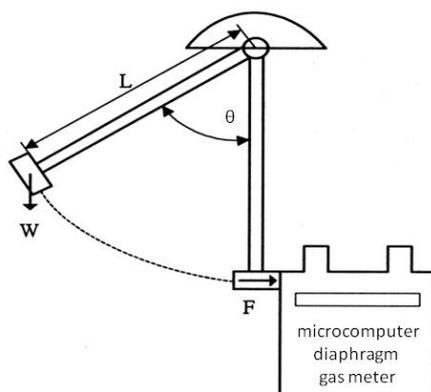


Figure 1 Impact test

Note: impact torque is calculated as follows

$$F=W \cdot L \cdot G(1 - \cos\theta)$$

Where F: impact torque (N·m)

W: mass of hammer (kg)

L: distance from the center line of the return axis of the hammer to the center of gravity

#### 4.1.5 Indicating device

The indicating device can be connected to the meter body physically or remotely. In the latter case the data to be displayed shall be stored in the gas meter.

#### 4.1.6 Safety device

The gas meter may be equipped with safety device that shuts off the gas flow in the event of calamities, such as an earthquake or a fire. For gas meters equipped with safety reference detection control unit, the requirements of Annex B “Type-evaluation tests of safety performance and electromagnetic compatibility performance for gas meters with micro computer” shall be fulfilled in addition to metrological requirements. The safety device may be connected to the gas meter, provided that it does not influence the metrological integrity of the meter. A mechanical gas meter equipped with an earthquake sensor plus an electrical

powered valve is not considered to be an electronic gas meter.

#### 4.1.7 Connections between electronic parts

Connections between electronic parts shall be reliable and durable.

### 4.2 Flow direction

#### 4.2.1 Direction of the gas flow

The flow direction of gas meter shall be indicated by a method which is clearly understood.

#### 4.2.2 Indicating device

A gas meter shall be provided with a device to prevent the indicating device from functioning whenever gas is flowing in an unauthorized direction.

### 4.3 Indicating device

#### 4.3.1 General provisions

The indicating device associated with the gas meter shall indicate the quantity of gas measured in volume and its reading shall be clear and unambiguous.

The indicating device may include:

- (1) a mechanical indicating device.
- (2) an electromechanical or electronic indicating device.
- (3) a combination of (1) and (2).

Indicating devices shall be non-resettable (i.e. they shall be able to show the last stored indication after the device has recovered from an intervening power failure). Where the indicating device shows decimal submultiples of the quantity measured, this fraction shall be separated from the integer value by a clear decimal sign.

It may be possible to use one display for other indications as well, as long as it is clear which quantity is being displayed.

In case the gas meter has a combination of mechanical indicating device and electronic indicating device and both indicating devices can synchronically display the gas consumption, their indicated values shall be identical.

#### 4.3.2 Indicating range

The indicating device shall be able to record and display the indicated quantity of gas corresponding to at least 1000 hours of operation at the maximum flow rate  $Q_{\max}$ , without returning to the original reading.

#### 4.3.3 Resolution

The quantity corresponding to the least significant digit shall not exceed the quantity of gas passed during one hour at  $Q_{\min}$ .

If the least significant digit shows a decimal multiple of the quantity measured, the faceplate or electronic display shall bear:

- (1) either one (or two, or three, etc.) fixed zero(s) after the last drum or digit; or

(2) the marking: " $\times 10$ " (or " $\times 100$ ", or " $\times 1\ 000$ ", etc.),

so that the reading is indicated in SI units or other units permitted by the competent metrology authority.

#### 4.3.4 Mechanical indicating device

The minimum height of the numerals shall be 4.0 mm and their minimum width shall be 2.4 mm.

The last element (i.e. the decade with the least significant scale interval) of a mechanical indicating device may deviate in manner of display from the other decades.

In the case of drum indicating devices the advance by one unit of a figure of any order shall take place completely while the figure of an order which is immediately below passes through the last tenth of its course.

#### 4.3.5 Electromechanical or electronic indicating device

The continuous display of the quantity of gas during the period of measurement is not mandatory. The electronic indicating device shall have the functions to display test mode or verification mode.

#### 4.3.6 Remote indicating device

If an indicating device is used remotely, the associated gas meter shall be clearly identified by their serial numbers. The integrity of the communication between the instrument and the indicating device shall be checked.

### 4.4 Test element of indicating device

#### 4.4.1 General

A gas meter shall be designed and constructed incorporating:

- (1) an integral test element, or
- (2) a pulse generator, or
- (3) arrangements permitting the connection of a portable test unit.

#### 4.4.2 Integral test element

The integral test element may consist of the last element of the mechanical indicating device in one of the following forms:

- (1) a continuously moving drum bearing a scale, where each subdivision on the drum is regarded as an increment of the test element;
- (2) a pointer moving over a fixed dial with a scale, or a disk with a scale moving past a fixed reference mark, where each subdivision on the dial or disk is regarded as an increment of the test element.

4.4.2.1 On the numbered scale of a test element the value of one complete revolution of the pointer shall be indicated in the form: " $1\ \text{rev} = \dots\text{m}^3$  (or  $\text{dm}^3$ )". The beginning of the scale shall be indicated by the figure zero.

4.4.2.2 The scale spacing shall not be less than 1 mm and shall be constant

throughout the whole scale.

4.4.2.3 The scale interval shall be in the form  $1 \times 10^n$ ,  $2 \times 10^n$ , or  $5 \times 10^n$  m<sup>3</sup> ( $n$  being a positive or negative whole number or zero).

4.4.2.4 The scale marks shall be fine and uniformly drawn.

4.4.2.5 The test element may be provided with a scale mark which stands out in contrast to the scale and is of sufficient size to allow automatic photoelectric scanning. The scale mark shall not obscure the graduation. If proper, the index mark can replace “zero” value. And its presence shall not be detrimental to the accuracy of reading.

4.4.2.6 For electronic indicating device the last digit is used as the integral test element. Through either physical or electronic means a specific test mode may be entered in which the number of digits can be increased or some alternative method can be applied for gaining resolution.

#### 4.4.3 Pulse generator

A pulse generator may be used as a test element if the value of one pulse, expressed in units of volume, is marked on the gas meter.

The gas meter shall be constructed in such a way that the pulse value can be checked experimentally. The difference between the measured value of the pulse value and its value indicated on the gas meter, shall not exceed 0.05 % of the latter.

#### 4.4.4 Attachable test device

An indicating device may include provisions for testing by inclusion of complementary elements (e.g. star wheels or discs), which provide signals for an attachable test device. The attachable test device may be used as a test element if the value of one pulse, expressed in units of volume, is marked on the gas meter.

#### 4.4.5 Increment of test element or pulse

The increment of the test element or pulse shall occur at least every 60 seconds at  $Q_{\min}$ .

#### 4.5 Ancillary device

The gas meter may include ancillary devices, which may be permanently incorporated or added temporarily. Ancillary devices shall not affect the correct operation of the instrument. If an ancillary device is not subject to legal metrology control it shall be clearly indicated.

#### 4.6 Power sources

##### 4.6.1 Types of power sources

Gas meters may be powered by mains power sources, non-replaceable power sources, or replaceable power sources. These three types of power source may be used alone or in combination.

The rechargeable power sources are considered replaceable.

##### 4.6.2 Mains power source

An electronic gas meter shall be designed such that in the event of a mains power failure (AC or DC), the meter indication of the quantity of gas just before failure is not lost, and remains accessible for reading after failure without any difficulty. Any other properties or parameters of the meter shall not be affected by an interruption of the electrical supply.

The connection to the mains power source shall be capable of being secured from tampering.

#### 4.6.3 Non-replaceable power source

The manufacturer shall ensure that the lifetime of the power source guarantees that the meter functions correctly for at least as long as the validity period of verification of the meter.

#### 4.6.4 Replaceable power source

If the gas meter is powered by a replaceable power source, the manufacturer shall give detailed specifications for the replacement thereof. The date by which the power source is to be replaced shall be indicated on the meter. Alternatively, the estimated remaining life of the power source shall be displayed or a warning shall be given when the estimated remaining life of the power source is at or below 10 %.

The properties and parameters of the meter shall not be affected during replacement of the power source. It shall be possible to replace the power source without breaking the metrological seal. The compartment of the power source shall be capable of being secured from tampering.

### 5. Inscriptions

#### 5.1 Markings and inscriptions

All markings shall be easily legible and indelible under normal conditions of use.

Any marking other than those prescribed in the type approval document shall not lead to confusion.

The information given in Section 5.1.1 shall be marked on the casing or on an identification plate.

##### 5.1.1 General applicable markings for gas meters include:

- (1) type approval number;
- (2) name of the manufacturer;
- (3) type number and serial number;
- (4) metrological gas name;
- (5) accuracy class (other than class 1.5) ;
- (6) maximum flow rate: expressed as  $Q_{\max} = \dots \text{m}^3 / \text{h}$ ;
- (7) minimum flow rate: expressed as  $Q_{\min} = \dots \text{m}^3 / \text{h}$ ;

- (8) transitional flow rate: expressed as  $Q_t = \dots \text{m}^3 / \text{h}$ , other than being equal to  $0.1 Q_{\text{max}}$ ;
- (9) working temperature range: expressed as  $t_{\text{min}} - t_{\text{max}} = \dots - \dots ^\circ\text{C}$  or  $t_m = \dots - \dots ^\circ\text{C}$ ;
- (10) working pressure range: expressed as  $P_{\text{min}} - P_{\text{max}} = \dots - \dots \text{kPa}$  or  $P_m = \dots - \dots \text{kPa}$ ;
- (11) pulse values of HF and LF outputs: expressed as  $\text{L} / \text{pulse}$  ( $\text{dm}^3 / \text{pulse}$  or  $\text{m}^3 / \text{pulse}$ ) or  $\text{pulse} / \text{L}$  ( $\text{pulse} / \text{dm}^3$ , or  $\text{pulse} / \text{m}^3$ ). The pulse value is given to at least 4 significant figures, unless it is equal to an integer multiple or decimal fraction of the used unit.
- (12) indication of the flow direction: expressed by an arrow symbol.
- (13) year of manufacture: expressed by 4 digits of the year of C.E., or year of the Republic Era;
- (14) the normal value of the cyclic volume: expressed as  $V = \dots \text{dm}^3$  (or  $\text{m}^3$ );
- (15) the maximum permissible pressure deviation between meter inlet and outlet: expresses as  $\Delta P_{\text{max}} = \dots \text{Pa}$  (or  $\text{kPa}$ );
- (16) the nominal diameter (inside diameter of inlet and outlet): expressed by mm.

#### 5.1.2 Additional markings for gas meters with electronic indicating devices

- (1) for an external power supply: the nominal voltage and nominal frequency;
- (2) for a replaceable battery: the latest date by which the battery is to be replaced or, alternatively, the remaining battery capacity can be presented on the electronic indicating device (In case an automatic alarm indicates when the battery life is below 10 %, the above markings are not required).

### 6. Operating instructions

#### 6.1 Instruction manual

Each individual gas meter shall be accompanied by an instruction manual in traditional Chinese for the user.

The instruction manual shall include:

- (1) operating instructions;
- (2) maximum and minimum storage temperatures;
- (3) rated operating conditions;
- (4) all relevant mechanical and electromagnetic environmental conditions;
- (5) any specific installation conditions, for instance a limitation of the length of signal, data, and control lines;
- (6) the specifications of the battery, if applicable;
- (7) instructions for installation, maintenance, repair, storage, transport and permissible adjustments, if applicable;
- (8) conditions for compatibility with interfaces, sub-assemblies (modules) or other

measuring instruments.

## 6.2 Installation conditions

The manufacturer shall specify the installation conditions (as applicable) with respect to:

- (1) the position to measure the working temperature of the gas;
- (2) leveling and orientation;
- (3) pulsed interference;
- (4) rapid pressure changes;
- (5) mounting instructions;
- (6) other relevant installation conditions.

## 7. Sealing

### 7.1 Verification marks and protection devices

#### 7.1.1 General provision

Protection of the metrological properties of the meter is accomplished via hardware (mechanical) sealing or via electronic sealing. Memorized quantities of gas volume measured shall be sealed to prevent unauthorized access.

#### 7.1.2 Verification marks

Verification marks indicate that the gas meter has passed the verification.

#### 7.1.3 Hardware sealing (if applicable)

In case of hardware sealing, the location of the marks shall be chosen in such a way that the dismantling of the part sealed by one of these marks results in permanently visible damage to this seal.

Seals shall be able to withstand outdoor conditions without any embrittlement. The embossing text should be easily identifiable.

#### 7.1.4 Electronic sealing (if applicable)

7.1.4.1 When the access to parameters that contribute in the determination of results of measurements needs to be protected, and electronic sealing is permitted by competent metrology authority, the protection shall fulfill the following provisions:

- (1) Only authorized people are allowed to enter the configuration mode to modify these parameters using securing means such as a code (password) or special device (hard key).
  - For access prior to changing the parameters, after which the instrument may be put into use “in sealed condition” again without any restriction, or
  - for confirmation after the parameters have been changed, in order to bring the instrument back into service being the “in sealed condition” (similar to classical sealing).
- (2) The code (password) shall be alterable.

- (3) The device shall either clearly indicate when it is in the configuration mode (not under legal metrological control), or it shall not operate while in this mode. This status shall remain until the instrument has been put into use “in sealed condition” in accordance with clause (1).
- (4) Identification data concerning the most recent intervention shall be recorded in an event logger. The record shall include at least:
  - an identification of the authorized person that implemented the intervention, and
  - an event counter or date and time of the intervention as generated by the internal clock.

In addition to the above-mentioned data the following data is to be stored:

- the old value of the changed parameter, and
- the totals of the registers.

The traceability of the most recent intervention shall be assured. If it is possible to store the records of more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

7.1.4.2 For gas meters of which parts may be disconnected, the following provisions shall be fulfilled:

- (1) Access to the parameters that contribute to the determination of results of measurements shall not be possible via a disconnected port unless the provisions in Section 7.1.4 are fulfilled.
- (2) Interposing any device which may influence the accuracy shall be prevented by means of electronic and data processing securities or, if not possible, by mechanical means.
- (3) Moreover, these gas meters shall be equipped with provisions which do not allow the meter to operate if the various parts are not configured according to the manufacturer’s specifications.

## 8. Metrological controls

### 8.1 General procedures

#### 8.1.1 Test method

All tests shall be carried out under the installation conditions stipulated by the supplier of the type of meter to be tested.

All equipment used and incorporated as part of the execution of the test procedure shall be suitable for the testing of the meter(s) under test. The working range of all equipment and reference standards shall equal or exceed that of the meter(s) under test. All reference standards used shall be traceable to national or international standards of measurement.

If meters are to be tested in series, there should be no significant interaction

between the meters. This condition may be verified by testing every meter of the series once at each position in the line.

During the tests corrections shall be made for temperature and pressure differences between the meter(s) under test and the reference standard; otherwise these differences have to be taken into account in the uncertainty calculations.

The temperature and pressure measurements have to be performed at a representative position on the meter(s) under test and on the reference standard.

### 8.1.2 Uncertainty

When a test is conducted for type evaluation, the expanded uncertainty ( $U$ ) of the determination of errors of the measured gas quantity shall be less than one-fifth of the applicable MPE. However, if the above-mentioned criteria cannot be met, the test results can be approved alternatively by reducing the applied maximum permissible errors with the excess of the uncertainties. For type evaluation the acceptance criteria  $\pm (6/5 \cdot MPE - U)$  shall be used.

The estimation of the expanded uncertainty  $U$  is made according to OIML G 1-100: 2008 *Guide to the expression of uncertainty in measurement* (GUM) with a level of confidence of 95 %.

## 9. Type evaluation

### 9.1 General provision

A submitted type of gas meter is subject to the type evaluation procedure.

A type approval certificate is issued only for the complete gas meter.

### 9.2 Documentation

Applications for type evaluation of a gas meter shall be accompanied by the following documentation:

(1) Identification of the type, including:

- name of the manufacturer and type designation;
- version(s) of hardware and software, if applicable;
- drawing of name plate with description or sample image.

(2) Metrological characteristics of the meter, including:

- description of the principle(s) of measurement;
- metrological specifications such as accuracy class and rated operating conditions (ambient temperature, ambient relative humidity, vibration, DC mains voltage, flow rate and working pressure, etc);
- any steps which should be performed prior to testing the meter.

(3) The technical specification for the meter, including:

- a structural dimension drawing, including dimension drawing of gas meters and their critical components;
- a list of parts with description of constituent materials and quantities of such parts;

- a perspective drawing of the meter, including identification of the listed parts;
- a drawing of indicating device, including its adjustment mechanism;
- a drawing of the attachable devices, if applicable;
- a table setting out the characteristics of the drive shafts, if applicable;
- a list of electronic components with their essential characteristics, if applicable;
- a description of electronic devices, including appearance, operating diagrams, software structure and brief explanation of their practice, if applicable;
- a description of the type and location for verification marks and seals or other protective methods;
- a documentation related to durability characteristics (optional);
- any document or other evidence that supports the assumption that the design and construction of the meter complies with the requirements of This Specification.

(4) User manual.

(5) Installation manual.

### 9.3 Design inspection

Each type of gas meter submitted shall be inspected externally to ensure that it complies with the provisions of the relevant preceding clauses of these requirements (Section 3, 4, 5, 6 and 7).

### 9.4 Number of specimens

The applicant shall deliver the requested number of specimens of gas meters at the disposal of the authority responsible for type evaluation.

If so requested by the authority responsible for the type evaluation, these meters shall include more than one size if simultaneous approval of a family of gas meters is requested.

Depending on the demand for tests, the authority responsible for the type evaluation may request further specimens.

In order to accelerate the test procedure, the testing laboratory may carry out different tests simultaneously on different units. In this case, the testing laboratory shall ensure that all submitted instruments are of the same type.

In general all accuracy and influence tests shall be performed on the same unit, but disturbance tests may be carried out on additional instruments. In this case, the testing laboratory decides which test(s) to be carried out on which unit.

If a specimen does not pass a specific test and as a result needs to be modified or repaired, the applicant shall apply this modification to all the specimens submitted for the test. These modified specimen(s) shall again be subjected to this particular test.

If the testing laboratory has well-founded reasons to believe that the modification could have a negative impact on the result of another test or tests already performed, these tests shall be repeated as well.

## 9.5 Type evaluation procedure

### 9.5.1 Hardware evaluation

#### 9.5.1.1 Reference conditions

All influence quantities, except for the influence quantity being tested, shall be kept to the following values during type evaluation tests on a gas meter (but high pressure tests may be performed at conditions other than reference conditions):

|                               |   |
|-------------------------------|---|
| Working (gas/air) temperature | 20.0 °C ± 5.0 °C  |
| Ambient temperature           | 20.0 °C ± 5.0 °C  |
| Ambient atmospheric pressure  | 86 kPa – 106 kPa  |
| Ambient relative humidity     | 60 % ± 25 %   |
| Power voltage (AC/DC mains)   | If one nominal voltage is specified, it is the specified nominal voltage ( $U_{nom}$ ).   |
|                               | If a voltage range is specified, it is a typical voltage within this range, to be negotiated between the manufacturer and the test laboratory |
| Power voltage (battery)       | The nominal voltage of a new or fully charged battery (not under charge)  |
| Power frequency (AC mains)    | The nominal frequency ( $f_{nom}$ )   |

#### 9.5.1.2 Flow rates

The flow rates at which the errors of the gas meters need to be determined shall be distributed over the measuring range at regular intervals and include  $Q_{min}$  and  $Q_{max}$  and preferably  $Q_t$ .

The minimum number ( $N$ ) of test points can be calculated according to:

$$N = 1 + 3 \cdot \log\left(\frac{Q_{max}}{Q_{min}}\right)$$

Where  $N \geq 6$ , and rounded to the nearest integer.

Each individual test point can be calculated according to:

$$Q_i = \left(\sqrt[3]{10}\right)^{i-1} Q_{max}$$

Where  $i = 1$  to  $i = N-1$ , and  $Q_N = Q_{min}$

#### 9.5.1.3 Test gases

All the tests listed in Section 9.6 are performed with air under the rated operating conditions stated in Section 3.1. For the temperature tests in Section 9.6.5 the gas must be dry.

## 9.6 Type evaluation tests

During the type evaluation gas meters are tested while applying the requirements as stated in Section 3.

### 9.6.1 Error

The error of the gas meter shall be determined, while using the flow rates according to the prescriptions stated in Section 9.5.1.2. The error curve as well as the WME shall be within the requirements as specified in Section 3.3 and Section 3.4 respectively.

During the accuracy test applied on the gas meter, the following quantities shall be determined:

- The pulse value of the gas meter (if applicable): the gas meter shall be constructed in such a way that the pulse value can be checked experimentally. The difference between the measured value of the pulse value and its value indicated on the gas meter, shall not exceed 0.05 % of the latter.

### 9.6.2 Reproducibility

The tests are conducted at flow rates prescribed in Section 9.5.1.2. The reproducibility of error at flow rates equal to or greater than  $Q_t$  shall be less than or equal to one third of the maximum permissible error.

For each of these flow rates, the errors shall normally be determined six times independently, while varying the flow rate between each consecutive measurement. The reproducibility of error is calculated as the difference between the maximum and the minimum measured error for each flow rate.

In case the reproducibility of error of the first three measurements is less than or equal to one sixth of the MPE the requirement is deemed to be met.

### 9.6.3 Repeatability

The repeatability of error is determined at the flow rates  $Q_{\min}$ ,  $Q_t$ , and  $Q_{\max}$ . At each of these flow rates, the errors are determined three times without changing the flow rate and the difference between the minimum and maximum measured error is calculated as the repeatability of error which shall be less than or equal to one third of the maximum permissible error.

### 9.6.4 Working pressure

The accuracy measurements under different working pressure are evaluated with the requirements as laid down in Section 3.7 and Annex C “The requirements of additional tests for diaphragm gas meters with maximum working pressure more than 10 kPa”. The requirements shall be fulfilled for the operating pressure range without intermediate adjustments.

### 9.6.5 Temperature

The temperature dependency of the gas meter shall be evaluated within the temperature range specified by the manufacturer. Flow tests at different temperatures are performed with a gas temperature equal to the ambient temperature as specified in Section 9.6.5.1.

#### 9.6.5.1 Flow tests with equal gas and ambient temperatures

The flow tests as determined in Section 9.5.1.2 are performed, in the range  $Q_t$  up to  $Q_{\max}$ , with the gas temperature equal to the ambient temperature

(within 5 °C), sequentially at:

- reference temperature;
- maximum ambient temperature;
- minimum ambient temperature;
- reference temperature.

The test results shall comply with the corresponding requirements of error for the accuracy class of the gas meter.

#### 9.6.6 Durability

All gas meters with internal moving parts are submitted to the durability test which comprises exposure to a continuous flow during the required period of time, while using gases for which the meters are intended to be used.

In case the manufacturer has demonstrated that the material composition of the gas meter is sufficiently insensitive to the gas composition, the authority responsible for the type evaluation may decide to perform the durability test with air or another suitable type of gas. The applied flow rate is at least  $0.8 Q_{\max}$ . This test shall be performed at the working pressure prescribed in relevant sections of This Specification, besides the same reference equipment shall be used before and after the test.

The authority responsible for the type evaluation shall choose the number of meters of the same type to be submitted for the durability test from the options given in Table 9 in consultation with the applicant (option 1). If different sizes are included, the total number of meters to be submitted shall be as stated in option 2.

In case the application for evaluation concerns a family of meters according to the criteria stated in Annex D (D.2) the selection of meters is to be performed according to D.3.

Table 9 Number of meters to be tested

| Maximum volume flow rate [m <sup>3</sup> /h] | Number of meters to be tested |          |
|--|-------------------------------|----------|
|  | Option 1                      | Option 2 |
| $Q_{\max} \leq 25$                           | 3                             | 6        |
| $25 < Q_{\max} \leq 100$                     | 2                             | 4        |
| $Q_{\max} > 100$                             | 1                             | 3        |

After the durability test the gas meters are tested for errors at flow rates as determined in Section 9.5.1.2. The measured errors shall comply with the requirements laid down in Section 3.10 (with the exception of one of them if the durability test has been carried out on a number of gas meters according to option 2).

#### 9.6.7 Overload flow

Gas meters with internal moving parts are submitted to the overload flow. Before and after the overload the error of the gas meter is determined for its whole flow rate range according to Section 9.5.1.2. The requirements as laid down in Section

3.11 are applicable.

#### 9.6.8 Vibration and shocks

Gas meters having a maximum mass of 10 kg are submitted to vibrations and shocks. For gas meters exceeding this weight only the electronic part of the meter is to be tested. Before and after these tests the intrinsic error of the gas meter is determined according to Section 9.5.1.2 over the whole flow rate range. The requirements as laid down in Section 3.12 are applicable.

#### 9.6.9 Gas meters containing electronic components

For gas meters containing electronic components, additionally the requirements as described in Section 3.13.1 are applicable. Performance tests shall be executed using the test methods described in Section 8 “Metrological controls” and Section 9 “Type evaluation”. An overview of the requirements is shown in Table 5 and Table 6. After each test it shall be verified that no loss of data has occurred.

If the electronic devices of a gas meter are located in a separate housing, their electronic functions may be tested independently of the measuring transducer of the gas meter by simulated signals representing the rated operating conditions of the meter. In this case the electronic devices shall be tested in their final housing.

In all cases, ancillary equipment may be tested separately.

The tests as indicated in Table 5 and Table 6 are to be performed with the meter under test being powered up and the dependency of the gas meter’s performance shall be evaluated during actual flow.

#### 9.6.10 Influences from ancillary devices

The effect of all functions of ancillary devices is determined by performing an accuracy test at  $Q_{\min}$ , with and without applying the specific function. The effect shall be negligible if the test result is less than or equal to 0.1 MPE.

### 9.7 Type approval certificate

The following information and data shall appear on the type approval certificate:

- name and address of the applicant;
- name and address of the manufacturer;
- type of the gas meter and/or trade mark;
- principal metrological and technical characteristics, including accuracy class, values of  $Q_{\max}$ ,  $Q_{\min}$  and  $Q_t$ , the rated operating conditions (Section 3.1), nominal internal diameter of the connecting pieces and the nominal value of the cyclic volume, etc;
- type approval mark;
- period of validity of the type approval;
- information on the location of the marks and inscriptions required in Section 5.1, initial verification marks and seals (where applicable, in the form of photographs or drawings);
- list of the documents accompanying the type approval certificate;

- any special comments.

#### 10. Implementation date

This Specification will be implemented from the date of promulgation, and for diaphragm gas meters containing electronic components from January 1, 2026; the correction period ends on December 31, 2027.

## Annex A

## Environmental tests for electronic instruments or devices (mandatory)

## A.1 General

This annex defines the program of performance tests intended to verify that gas meters containing electronics and their ancillary devices may perform and function as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the error.

These tests supplement any other prescribed tests. When the effect of one influence quantity is being evaluated, all other influence quantities are to be kept within the limits of the reference conditions.

## A.2 Test conditions

For each performance test, typical test conditions are indicated. These correspond to the climatic and mechanical environment conditions to which instruments are usually exposed. The competent metrology authority carries out performance tests at the test levels corresponding to these environmental conditions.

## A.3 Reference conditions

Conditions described in Section 9.5.1.1.

## A.4 Performance tests (climatic)

## A.4.1 Static temperatures

| A.4.1.1 Dry heat (non condensing): influence test |  |    |
|---|--|----|
| Applicable standards                              | IEC 60068-2-2 (2007-07)  |    |
| Object of the test                                | Verification of compliance under conditions of high environmental temperature.   |    |
| Test procedure in brief                           | The test comprises exposure to the specified high temperature under atmospheric air for the time specified (the time specified is the time after the EUT has reached temperature stability).<br>The change of temperature shall not exceed 1 °C/min during heating up and cooling down.<br>The absolute humidity of the test atmosphere shall not exceed 20 g/m <sup>3</sup> .<br>When testing is performed at temperatures lower than 35 °C, the relative humidity shall not exceed 50 %. |    |
| Temperature                                       | upper temperature specified  | °C |
| Duration  | 2  | h  |

| A.4.1.2 Cold: influence test |   |
|------------------------------|---|
| Applicable standards         | IEC 60068-2-1 (2007-03)   |
| Object of the test           | Verification of compliance under conditions of low environmental temperature.   |
| Test procedure in brief      | The test comprises exposure to the specified low temperature under atmospheric air for the time specified (the time specified is the time |

|             |  |    |
|-------------|--|----|
|             | after the EUT has reached temperature stability).<br>The change of temperature shall not exceed 1 °C/min during heating up and cooling down.<br>The power to the EUT shall be switched off before the temperature is raised. |    |
| Temperature | lower temperature specified  | °C |
| Duration    | 2  | h  |

#### A.4.2 Damp heat

|  |  |      |
|--|--|------|
| A.4.2.1 Damp heat, steady-state (non condensing): influence test |  |      |
| Applicable standards   | IEC 60068-2-78 (2001-08)   |      |
| Object of the test   | Verification of compliance under conditions of high environmental humidity and constant temperature.   |      |
| Test procedure in brief  | <p>The test comprises exposure to the specified temperature and the specified constant relative humidity for a certain fixed period of time. The EUT shall be handled such that no condensation of water occurs on it.</p> <p>The gas meter shall be subjected 3 times to an accuracy test:</p> <ul style="list-style-type: none"> <li>- at reference conditions, before the increase of temperature;</li> <li>- at the end of the upper temperature phase;</li> <li>- at reference conditions, 24 hours after the decrease of temperature.</li> </ul> |      |
| Temperature  | Upper temperature specified  | °C   |
| Relative humidity (RH)   | 93   | %    |
| Duration   | 4  | Days |

|  |   |  |
|--|---|--|
| A.4.2.2 Damp heat, cyclic (condensing): disturbance test |   |  |
| Applicable standards                                     | IEC 60068-2-30 (2005-08)  |  |
| Object of the test                                       | Verification of compliance under conditions of high environmental humidity combined with cyclic temperature changes.  |  |
| Test procedure in brief                                  | <p>The test comprises exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature while maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at or above 93 % at the upper temperature phases.</p> <p>Condensation is expected to occur on the EUT during the temperature rise.</p> <p>The 24 hours cycle consists of:</p> <ul style="list-style-type: none"> <li>- Temperature rise during 3 hours.</li> <li>- Temperature maintained at upper temperature level until 12 hours from the start of the cycle.</li> <li>- Temperature lowered to the lower temperature level within a period of 3 to 6 hours, the rate of fall during the first hour and a half being such that the lower temperature level would be reached in 3 hours.</li> <li>- Temperature maintained at lower temperature level until the 24</li> </ul> |  |

|             |  |        |
|-------------|--|--------|
|             | <p>hours cycle is completed.</p> <p>The stabilizing period before and recovery period after the cyclic exposure shall be such that the temperature of all parts of the EUT is within 3 °C of its final value.</p> <p>During the test the instrument is switched on; gas flow is not required.</p> <p>The gas meter shall be subjected to an accuracy test both:</p> <ul style="list-style-type: none"> <li>- at reference conditions, before the increase of temperature and</li> <li>- at reference conditions, at least 4 hours after the last cycle.</li> </ul> |        |
| Temperature | upper temperature specified  | °C     |
| Duration    | 2  | cycles |

#### A.5 Performance tests (mechanical)

|  |  |
|--|--|
| A.5.1 Vibration (random): disturbance test |  |
| Applicable standards                       | IEC 60068-2-47(2005-04), IEC 60068-2-64 (2008-04)  |
| Object of the test                         | Verification of compliance under conditions of random vibration  |
| Test procedure in brief                    | <p>The test comprises exposure to the level of vibration for the time specified. The EUT shall, subsequently, be tested in three, mutually perpendicular axes mounted on a rigid fixture by its normal mounting means.</p> <p>The EUT shall normally be mounted in such a way that the gravity vector points in the same direction as it would do in normal use.</p> <p>Where, based on the metering principle the effect of gravitational force can be assumed negligible the EUT may be mounted in any position.</p> <p>During the test the instrument is not required to be powered up (switched on).</p> |
| Total frequency range                      | 10 Hz – 150 Hz   |
| Total RMS level                            | $7 \text{ m}\cdot\text{s}^{-2}$  |
| ASD level<br>10 Hz – 20 Hz                 | $1 \text{ m}^2\cdot\text{s}^{-3}$  |
| ASD level<br>20 Hz – 150 Hz                | -3 dB / octave   |
| Number of axes                             | 3  |
| Duration per axis                          | 2 minutes  |

|  |  |
|--|--|
| A.5.2 Mechanical shock: disturbance test |  |
| Applicable standards                     | IEC 60068-2-31 (2008-05)   |
| Object of the test                       | Verification of compliance under conditions of mechanical shocks   |
| Test procedure in brief                  | <p>The EUT, placed in its normal position of use on a rigid surface, is tilted towards one bottom edge and is then allowed to fall freely onto the test surface.</p> <p>The height of fall is the distance between the opposite edge and the test surface.</p> <p>However, the angle made by the bottom and the test surface shall not</p> |

|  |  |
|--|--|
|  | exceed 30°.<br>During the test the instrument is not powered up. |
| Height of fall                         | 50 mm  |
| Number of falls ( on each bottom edge) | 1  |

## A.6 Performance tests (electrical, general)

### A.6.1 Radio frequency immunity tests

|  |  |
|--|--|
| A.6.1.1 Radiated, RF, electromagnetic fields: disturbance test |  |
| Applicable standards   | IEC 61000-4-3 (2010-04)  |
| Object of the test   | Verification of compliance of the EUT while being exposed to RF electromagnetic fields.  |
| Test procedure in brief  | <p>The EUT is exposed to electromagnetic fields having the required field strength level specified and the field uniformity as defined in the referred standard.</p> <p>The EUT shall be exposed to the modulated wave field. The frequency sweep shall be performed only pausing to adjust the RF signal level or to switch RF-generators, amplifiers and antennas if necessary.</p> <p>Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value.</p> <p>The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 s.</p> <p>The expected most critical frequencies (e.g. clock frequencies) shall be analyzed separately.</p> |
| Frequency range  | 80 MHz – 3 GHz   |
| Field strength   | 10 V/m   |
| Modulation   | 80 % AM, 1 kHz, sine wave  |

|  |  |
|--|--|
| A.6.1.2 Conducted radio-frequency fields: disturbance test |  |
| Applicable standards                                       | IEC 61000-4-6 (2008-10)  |
| Object of the test   | Verification of compliance of the EUT while being exposed to RF electromagnetic fields   |
| Test procedure in brief                                    | <p>Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard.</p> <p>The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.</p> |
| RF amplitude (50 Ω)  | 10 V (e.m.f)   |
| Frequency range  | 0.15 MHz – 80 MHz  |
| Modulation   | 80 % AM, 1 kHz, sine wave  |

| A.6.2 Electrostatic discharge: disturbance test |  |      |
|---|--|------|
| Applicable standards                            | IEC 61000-4-2 (2008-12)  |      |
| Object of the test                              | Verification of compliance in case of direct exposure to discharging of electrostatic charged objects or persons on the EUT of such discharges in the neighborhood of the EUT.   |      |
| Test procedure in brief                         | <p>An ESD generator as defined in the referred standard shall be used and the test setup shall comply with the dimensions, materials used and conditions as specified in this standard.</p> <p>Before starting the tests, the performance of the generator shall be verified.</p> <p>At each pre-selected discharge location on the EUT at least 10 discharges shall be applied. The time interval between successive discharges shall be at least 1 second. For EUTs not equipped with a ground terminal, the EUT shall be fully discharged between the discharges applied using the ESD generator.</p> <p>Contact discharge is the preferred test method. Air discharges are less reproducible and therefore shall be used only where contact discharge cannot be applied.</p> <p>Direct application:</p> <p>In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT.</p> <p>In the air discharge mode on insulated surfaces, the electrode is approached to the EUT and the discharge occurs by spark.</p> <p>Indirect application:</p> <p>The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.</p> |      |
| Test voltage                                    | Contact discharge  | 6 kV |
|   | Air discharge  | 8 kV |

| A.6.3 Burst (transients) on signal , data and control lines: disturbance test |  |
|---|--|
| Applicable standards  | IEC 61000-4-4 (2012-04)  |
| Object of the test  | Verification of compliance of the EUT to conditions where electrical bursts are superimposed on I / O and communication ports.   |
| Test procedure in brief   | <p>A burst generator as defined in the referred standard shall be used.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>The test comprises the exposure to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 <math>\Omega</math> and 1000 <math>\Omega</math> load are defined in the referred standard.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>Both positive and negative polarity of the bursts shall be applied.</p> <p>The duration of the test shall not be less than 1 min for each amplitude and polarity.</p> <p>For the coupling of the bursts into the I / O and communication lines,</p> |

|              |  |       |
|--------------|--|-------|
|              | a capacitive coupling clamp as defined in the standard shall be used. The test pulses shall be continuously applied during the measuring time. |       |
| Test voltage | Amplitude (peak value)   | 1 kV  |
|              | Repetition rate  | 5 kHz |

|  |   |                      |                        |
|--|---|----------------------|------------------------|
| A.6.4 Surges on signal, data and control lines: disturbance test |   |                      |                        |
| Applicable standards   | IEC 61000-4-5 (2005-11)   |                      |                        |
| Object of the test   | Verification of compliance during conditions where electrical surges are superimposed on I/O and communication ports.   |                      |                        |
| Test procedure in brief  | <p>A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT.</p> <p>The test comprises exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard.</p> <p>At least 3 positive and 3 negative surges shall be applied.</p> <p>The applicable injection network depends on the kind of wiring the surge is coupled into and is defined in the referred standard.</p> <p>The test pulses shall be continuously applied during the measuring time.</p> |                      |                        |
| Test voltage   | Unsymmetrical lines   | Line to line: 0.5 kV | Line to ground: 1.0 kV |
|  | Symmetrical lines   | Line to line: N/A    | Line to ground: 1.0 kV |
|  | Shielded I/O and communication lines  | Line to line: N/A    | Line to ground: 0.5 kV |

#### A.7 Performance tests (electrical, mains power)

|  |  |
|--|--|
| A.7.1 DC mains voltage variation: influence test |  |
| Applicable standards                             | IEC 60654-2 (1979-01)  |
| Object of the test                               | Verification of compliance during conditions of DC mains network changes between upper and lower limit.  |
| Test procedure in brief                          | The test comprises exposure to the specified power supply condition for a period sufficient for achieving temperature stability and subsequently performing the required measurements.   |
| Test severity                                    | <p>The upper limit is the DC level at which the EUT is claimed and proven to have been manufactured to automatically detect high-level conditions.</p> <p>The lower limit is the DC level at which the EUT is claimed and proven to have been manufactured to automatically detect low-level conditions.</p> <p>The instrument shall comply with the specified maximum permissible</p> |

|  |  |
|--|--|
|  | error at supply voltage levels between the two levels. |
|--|--|

|  |   |                  |
|--|---|------------------|
| A.7.2 AC mains voltage variation: influence test |   |                  |
| Applicable standards                             | IEC/TR 61000-2-1 (1990-05)  |                  |
| Object of the test                               | Verification of compliance during conditions of AC mains network voltage changes between upper and lower limit.   |                  |
| Test procedure in brief                          | The test comprises exposure to the specified power condition for a period sufficient for achieving temperature stability and for performing the required measurements.  |                  |
| Mains voltage <sup>(1), (2)</sup>                | upper limit   | $U_{nom} + 10\%$ |
|  | lower limit   | $U_{nom} - 15\%$ |
| Notes  | <sup>(1)</sup> In the case of three-phase power supply, the voltage variation shall apply for each phase successively.<br><sup>(2)</sup> The values of $U$ are those marked on the measuring instrument. In case a range is specified, the “-” relates to the lowest value and the “+” to the highest value of the range. |                  |

|   |  |        |        |                   |                   |                    |       |
|---|--|--------|--------|-------------------|-------------------|--------------------|-------|
| A.7.3 AC mains voltage dips and short interruptions: disturbance test |  |        |        |                   |                   |                    |       |
| Applicable standards  | IEC 61000-4-11 (2004-03), IEC 61000-6-1 (2005-03), IEC 61000-6-2 (2005-01)   |        |        |                   |                   |                    |       |
| Object of the test  | Verification of compliance during conditions of short time mains voltage reductions.   |        |        |                   |                   |                    |       |
| Test procedure in brief   | <p>A test generator is to be used which is suitable to reduce the amplitude of the AC mains voltage for the required period of time. The performance of the test generator shall be verified before connecting the EUT.</p> <p>The mains voltage reduction tests shall be repeated 10 times with intervals of at least 10 seconds between the tests.</p> <p>The test pulses shall be continuously applied during the measuring time.</p> |        |        |                   |                   |                    |       |
| Test severity   |  | test a | test b | test c            | test d            | test e             | Unit  |
| Voltage reduction   | Reduction to   | 0      | 0      | 40                | 70                | 80                 | %     |
|   | Duration   | 0.5    | 1      | 12 <sup>(1)</sup> | 30 <sup>(1)</sup> | 300 <sup>(1)</sup> | cycle |
| Notes   | <sup>(1)</sup> These values are for 60 Hz.<br><sup>(2)</sup> All 5 tests (a, b, c, d and e) are applicable; it is possible that any of the tests fail while the other tests pass.  |        |        |                   |                   |                    |       |

|  |  |
|--|--|
| A.7.4 Voltage dips, short interruptions and voltage variations on DC mains power: disturbance test |  |
| Applicable standards   | IEC 61000-4-29 (2000-08)   |
| Object of the test   | Verification of compliance during conditions of DC mains voltage dips, variations and short time reductions. |
| Test procedure in brief  | A test generator as defined in the referred standard shall be used.  |

|                                    |                         |   |                        |
|------------------------------------|-------------------------|---|------------------------|
|                                    |                         | <p>Before starting the tests, the performance characteristics of the generator shall be verified.</p> <p>The EUT shall be exposed to voltage dips and short interruptions for each of the selected combinations of amplitude and duration, using a sequence of three dips/interruptions and intervals of at least 10 seconds between each test event.</p> <p>The most common operating modes of the EUT shall be tested three times at 10 second intervals for each of the specified voltage variations.</p> <p>If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.</p> |                        |
| Test severity level                |                         | The following levels shall be applied:  | Unit                   |
| Voltage dips                       | Amplitude               | 40 and 70   | % of the rated voltage |
|                                    | Duration <sup>(1)</sup> | 10; 30; 100   | ms                     |
| Short interruptions <sup>(1)</sup> | Test condition          | High impedance and/or low impedance   |                        |
|                                    | Amplitude               | 0   | % of the rated voltage |
|                                    | Duration <sup>(1)</sup> | 1; 3; 10  | ms                     |
| Voltage variations                 | Amplitude               | 85 and 120  | % of the rated voltage |
|                                    | Duration <sup>(1)</sup> | 0.1; 0.3; 1; 3; 10  | s                      |
| Notes                              |                         | <sup>(1)</sup> all intervals are to be tested.  |                        |

|   |   |
|---|---|
| A.7.5 Burst (transients) on AC and DC mains: disturbance test |   |
| Applicable standards  | IEC 61000-4-4 (2012-04)   |
| Object of the test  | Verification of compliance during conditions where electrical bursts are superimposed on the mains voltage.   |
| Test procedure in brief                                       | <p>A burst generator as defined in the referred standard shall be used.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>The test comprises exposure to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 <math>\Omega</math> and 1000 <math>\Omega</math> loads are defined in the referred standard.</p> <p>Both positive and negative polarity of the bursts shall be applied.</p> <p>The duration of the test shall not be less than 1 min for each amplitude and polarity.</p> <p>The injection network on the mains shall contain blocking filters to prevent the burst energy from being dissipated in the mains.</p> <p>The test pulses shall be continuously applied during the measuring time.</p> |
| Amplitude (peak value)  | 2 kV  |
| Repetition rate   | 5 kHz   |

| A.7.6 Surges on AC and DC mains: disturbance test |   |                      |                        |
|---|---|----------------------|------------------------|
| Applicable standards                              | IEC 61000-4-5 (2005-11)   |                      |                        |
| Object of the test                                | Verification of compliance during conditions where electrical surges are superimposed on the mains voltage.   |                      |                        |
| Test procedure in brief                           | <p>A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT.</p> <p>The test comprises exposure to electrical surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and the minimum time interval between two successive pulses are defined in the referred standard.</p> <p>At least 3 positive and 3 negative surges shall be applied.</p> <p>On AC mains supply lines, surges shall be synchronous with the AC supply frequency and shall be repeated such that injection of surges on all the 4 phase shifts with 0°, 90°, 180° and 270° with the mains frequency is covered.</p> <p>The injection network circuitry depends on the applicable conductors the surge is coupled into and is defined in the referred standard.</p> <p>The test pulses shall be continuously applied during the measuring time.</p> |                      |                        |
| Test voltage                                      | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;">Line to line: 1.0 kV</td> <td style="width: 50%; text-align: center;">Line to ground: 2.0 kV</td> </tr> </table>  | Line to line: 1.0 kV | Line to ground: 2.0 kV |
| Line to line: 1.0 kV                              | Line to ground: 2.0 kV  |                      |                        |

| A.7.7 Ripple on DC mains power: disturbance test    |  |
|---|--|
| Applicable standards                                | IEC 61000-4-17 (2009-01)   |
| Object of the test                                  | Verification of compliance during conditions where electrical surges are superimposed on the mains voltage.  |
| Test procedure in brief                             | <p>A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified.</p> <p>The test comprises subjecting the EUT to ripple voltages such as those generated by traditional rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources.</p> <p>The frequency of the ripple voltage is the applicable power frequency or its multiple (2, 3 or 6), dependent on the rectifier system used for the mains. The waveform of the ripple, at the output of the test generator, has a sinusoid linear character.</p> <p>The test shall be applied for at least 10 min or for the time period necessary to allow a complete verification of the EUT's operating performance.</p> |
| Percentage of the nominal DC voltage <sup>(1)</sup> | 2  |
| Notes   | <sup>(1)</sup> The test levels are a peak-to-peak voltage expressed as a percentage of the nominal DC voltage.   |

|  |   |
|--|---|
|  | ( <sup>2</sup> ) This test does not apply to instruments connected to battery charger systems incorporating switch mode converters. |
|--|---|

#### A.8 Performance test (battery powered instrument)

|  |   |
|--|---|
| A.8.1 Low voltage of internal battery (not connected to the mains power): influence test |   |
| Applicable standards   | There is no reference to standards for this test.   |
| Object of the test   | Verification of compliance during low battery voltage conditions.   |
| Test procedure in brief  | <p>The test comprises exposure of the EUT to the specific low battery level condition during a period sufficient for achieving temperature stability and for performing the required measurements.</p> <p>The maximum internal impedance of the battery and the minimum battery supply voltage level (<math>U_{bmin}</math>) are to be specified by the manufacturer of the instrument.</p> <p>In case of simulating the battery by using an alternative power supply source such as in bench testing, the internal impedance of the specified type of battery shall also be simulated.</p> <p>The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage.</p> <p>The test sequence is as follows:</p> <ul style="list-style-type: none"> <li>- Let the power supply stabilize at a voltage as defined within the rated operating conditions and apply the measurement and/or loading condition.</li> <li>- Record: <ul style="list-style-type: none"> <li>(a) the data defining the actual measurement conditions including date, time and environmental conditions;</li> <li>(b) the actual power supply voltage.</li> </ul> </li> <li>- Perform measurements and record the error(s) and other relevant performance parameters.</li> <li>- Verify compliance with the requirements.</li> <li>- Repeat the above procedure with actual supply voltage at <math>U_{bmin}</math> and again at <math>0.9 U_{bmin}</math>.</li> <li>- Verify compliance with the requirements.</li> </ul> <p>The maximum internal impedance of the battery is to be specified by the manufacturer of the instrument.</p> |
| Lower limit of the voltage   | The lowest voltage at which the instrument functions properly according to the specifications.  |
| Number of cycles   | At least one test cycle for each functional mode.   |

## Annex B

### Type- evaluation tests of safety performance and electromagnetic compatibility performance for diaphragm gas meter with micro computer

#### B.1 General

This annex specifies the construction, safety performance and electromagnetic compatibility performance requirements and test methods for diaphragm gas meters with micro computer.

#### B.2 Construction

A diaphragm gas meter with micro computer is composed of a measurement unit and a safety reference detection control unit. The safety reference detection control unit is composed of a flow sensor, a shut-off valve, a pressure sensor, an seismic sensor, a micro computer motherboard for the abnormal state judgment reference, and a lithium battery.

The gas meter is connected to two external circuits. One of which can be connected to a gas leakage alarm device, an incomplete combustion alarm device, etc.; the other can be connected to a communication interface.

The gas meter housing is equipped with a restoration device or an alarm display device. Its structural diagram is shown in Figure B.1.

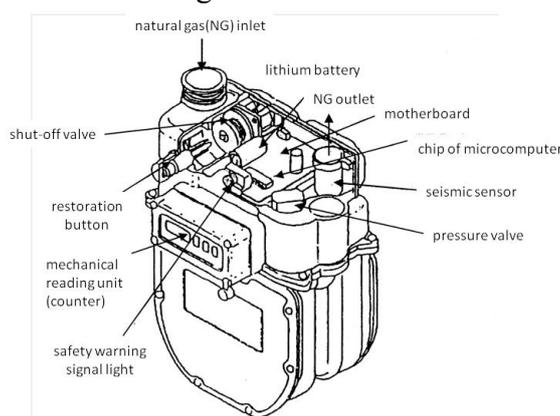


Figure B.1 Structural diagram of a diaphragm gas meter with micro computer

#### B.3 Function

##### B.3.1 General function

- (1)When the flow rate exceeding 2 times of the maximum flow rate is detected, the gas supply will be cut off immediately.
- (2)When there is gas flowing in the gas meter and the gas pressure is continuously detected to be lower than 0.2 kPa, the gas supply will be cut off immediately.
- (3)When there is gas flowing in the gas meter and an earthquake of 250 gal is detected at the installation site of the gas meter, the gas supply will be cut off immediately.
- (4)When the gas meter detects leakage from the pipelines, valves or appliances

connected to the outlet, it can display a leakage alarm.

B.3.2 Safety function: when the measurement unit of the diaphragm gas meter with micro computer is running, it can continuously monitor the gas usage status. If there is an abnormal state, the safety function can be activated, and the gas supply will be automatically cut off and the display will give an alarm. These abnormal states include:

- (1) Excessive gas flow.
- (2) Use gas for too long.
- (3) Seismic sensor actuation.
- (4) Gas pressure is too low.
- (5) A linking-up of the connected gas leakage alarm device, etc.
- (6) A gas leakage status of the downstream piping system of the gas meter is automatically detected during a restoration operation.

It can continuously and automatically detect whether there is gas leakage in the downstream piping system of the gas meter, and when it is determined that there is a gas leakage, the display will continue to give alarms until there is no gas leakage.

B.3.3 Communication function: when the communication interface of the diaphragm gas meter with micro computer is connected to an external communication circuit of the gas meter, it has the following functions:

- (1) Two-way communication of meter reading.
- (2) One-way communication of automatic notification and alarm.
- (3) Notify the gas usage status.
- (4) Central remote control.

#### B.4 Performance

B.4.1 Watertight resistance performance: the gas meter housing shall be made of metal or non-metal such as synthetic resin, and can prevent the infiltration of water.

B.4.2 Performance of marking/warning light: the marking/warning light shall be displayed in an unambiguous way, and the reason for its action shall be clearly displayed.

B.4.3 Display performance of shut-off valve action status

B.4.3.1 Being able to confirm and display the open and closed status: the gas meter should have a marking device to display the open or closed status of the shut-off valve. However, this does not apply when the shut-off valve is closed due to a battery voltage drop.

B.4.4 Joint performance: the joint of the screw thread with the gas pipeline shall meet the requirements of Section B.6.4.

B.4.5 Vibration resistance performance: a final product shall be able to withstand the vibration during transportation.

B.4.6 Pressure resistance performance: for gas meters with a maximum working pressure

of less than 10 kPa, the gas passing part shall be able to withstand a pressure of 15 kPa; gas meters with a maximum working pressure of more than 10 kPa shall be able to withstand 1.5 times maximum working pressure.

#### B.4.7 Airtight resistance performance

B.4.7.1 External airtight resistance performance: the gas flowing part shall be airtight, and its leakage rate shall be equal to or less than 0.07 L/h when subjected to the specified pressure.

B.4.7.2 Internal airtight resistance performance: the shut-off valve shall be airtight, and its leakage rate shall be equal to or less than 0.55 L/h when subjected to the specified pressure.

#### B.4.8 Durability

B.4.8.1 Gas meter: the gas meter shall have a service life that can withstand normal use circumstances.

B.4.8.2 Shut-off valve: under the pressure of 1.5 kPa, the shut-off valve shall be able to withstand repeated operations for 500 times and still function as well as originally.

B.4.9 Explosion resistance performance: the live part in contact with the gas shall be explosion-proof.

B.4.10 Magnetic fields resistance performance: under normal use circumstances, the flow detection function shall not be affected by magnetic fields.

B.4.11 Mains voltage dips: no obstacle to use due to mains voltage dips.

#### B.4.12 Leakage detection performance

B.4.12.1 Leakage detection capability: a leakage at the connection part of the gas outlet of the gas meter shall be detected while leakage rate equal to or more than 0.003 m<sup>3</sup>/h.

B.4.12.2 Leakage detection activation capability: when the leakage rate at the connection part of the gas outlet of the gas meter exceeds 0.003 m<sup>3</sup>/h and continues to leak within 30 days, it shall be able to automatically display an alarm signal.

B.4.12.3 Leakage alarm display and restoration capability: it shall have the inner pipe leak alarm and restoration function. The alarm can only be eliminated and restored through special tools or operative setting. For those with automatic restoration functions, they shall not automatically restore if small leakages are being detected continually.

B.4.13 Resistance to temperature changes: the gas meter shall not be affected by the temperature changes under normal use environment.

B.4.14 Resistance to humidity changes: the gas meter shall not be affected by the humidity changes under normal use environment.

#### B.4.15 Abnormal flow rate shut-off performance

B.4.15.1 Shut-off of abnormally large flow rate: under normal use circumstances, when the combined gas flow rate of gas appliances is twice as the maximum flow

rate(abnormally large flow rate), the gas meter shall be shut off within 2 minutes and an alarm shall be displayed.

B.4.15.2 Shut-off of individual maximum flow rate: under normal use circumstances, when the individual gas flow rate of gas appliances is greater than the maximum flow rate of the gas meter, the gas meter shall be shut off within 2 minutes and an alarm shall be displayed.

B.4.15.3 Shut-off of overtime use: under normal use circumstances, when the continuous use time (distinguished by different gas appliances and amount of gas consumption) reaches the limited time, the gas meter shall be shut off and an alarm shall be displayed.

#### B.4.16 Shut-off performance

B.4.16.1 Earthquake sensing shut-off performance: under normal use circumstances, when an earthquake occurs near the gas meter, the gas meter shall be shut off and an alarm shall be displayed before the earthquake intensity reaches 250 gal.

B.4.16.2 Shut-off performance of gas pressure drop: under normal use circumstances, when the gas pressure drops to 0.2 kPa, the gas meter shall be shut off and an alarm shall be displayed.

B.4.16.3 Linking-up shut-off performance of a gas leakage alarm device, etc.: under normal use circumstances, when the gas meter is connected to a gas leakage alarm device or other devices, the device can be linked up to the gas meter to shut off the gas supply and display an alarm.

B.4.16.4 Shut-off testing performance: shut-off testing can be performed using special tools.

B.4.17 Restoration action and restoration confirmation performance: the gas meter shall have the function of confirming restoration and be able to restore reliably.

B.4.18 Bursts resistance performance: the gas meter shall not be affected by voltages of bursts generated under normal use circumstances.

B.4.19 Electrostatic discharges resistance performance: the gas meter shall not be affected by voltages of electrostatic discharges generated under normal use circumstances.

B.4.20 Electromagnetic fields resistance performance: the gas meter shall not be affected by electromagnetic fields generated under normal use circumstances.

B.4.21 Connection signal performance: the signal connection line shall have sufficient strength and polarity identification; no abnormality shall occur after being short-circuited and then reconnected.

B.5 Test conditions: if the test method in this annex does not specify its specific test conditions, the following conditions shall be followed.

B.5.1 Temperature requirements of test laboratory: during the test, the temperature changes shall be within  $\pm 5^{\circ}\text{C}$ , and the temperature shall be kept within the range of  $20^{\circ}\text{C} \pm 15^{\circ}\text{C}$ .

B.5.2 Humidity requirement of test laboratory: the relative humidity shall be kept within the range of  $60\% \pm 25\%$ .

B.5.3 Normal use circumstances: when a gas meter is tested, the connecting pipes on the inlet side and the outlet side are straight pipes with a length of 8 to 10 times of the connecting diameter in principle. If the volume of the detected part is easily affected by the inner pipe volume, it shall be tested with the maximum inner pipe volume. The pressure tapping hole is located at a position of 2 to 3 times of the length of the inlet/outlet diameter of the gas meter, and the inner surface of the pressure tapping hole shall be smooth. The installation position of the standard gas meter shall be at upstream or downstream of the straight pipe, depending on the test items. The test layout diagram is shown in Figure B.2.

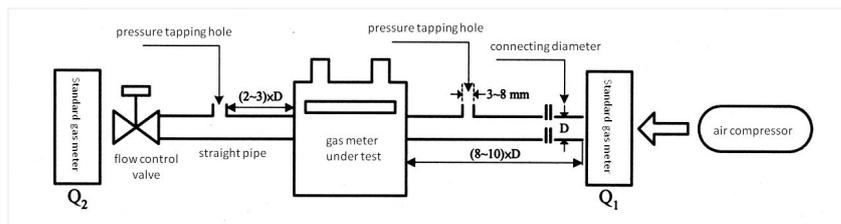


Figure B.2 Gas meter test layout diagram

B.5.4 Test range: the gas meter body and its external circuits (communication interface excluded) are shown as the range surrounded by dotted line in Figure B.3.

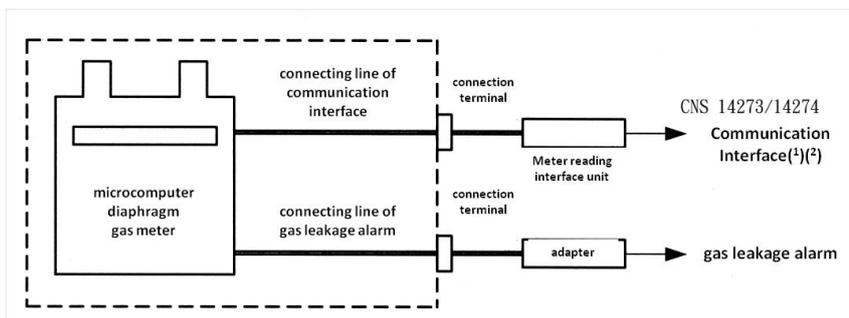


Figure B.3

Note(1) CNS 14273 “Meter interface units for communications in automatic meter reading systems”

Note(2) CNS 14274 “Meter interface unit for automatic meter reading system via wireless communication network”

B.6 Test

B.6.1 Watertight resistance test: the enclosure structure shall be free from obvious defects by visual inspection, and shall comply with the provisions in Section 14.2.4 IPX4 of CNS 14165 “Degrees of protection provided by enclosures (IP code)”.

B.6.2 Marking/warning light performance test

B.6.2.1 For light-emitting diodes (LED) display: the indicated state can be clearly identified visually at a position of 3 m in front of the main body of the marking/warning light in a room with an illuminance of 300 lx.

If reasons for marking/warning actions are provided, confirm them according to the specified methods described in the manufacturer's specification.

- B.6.2.2 For liquid crystal (LCD) display: measure the size of the displayed texts or numbers with a vernier caliper, etc., and these texts or numbers shall have a height of equal to or more than 4 mm.

If reasons for marking/warning actions are provided, confirm them according to the specified methods described in the manufacturer's specification.

- B.6.3 Test for confirmation of the operating status of the shut-off valve: after operating the opening and closing of the shut-off valve, visually check the open and closed status of the shut-off valve. If only one status can be displayed, the closed status shall be displayed.

However, this does not apply when the shut-off valve is closed due to battery voltage dips.

- B.6.4 Performance test of connection with pipe

- B.6.4.1 Screw thread joints: check with CNS 12753 “Gauges for Taper Pipe Threads”, and the screw thread shall meet the requirements of CNS 495 “Taper Pipe Threads”.

- B.6.5 Vibration resistance performance test: fix the gas meter on the vibration testing machine in the shipping package status, and perform vibration of 600 times per minute and full amplitude of 5 mm for 20 minutes in each of the up and down, front and rear, and left and right directions. And then perform Section B.6.7 Airtight test and Section B.6.19 Restoration action and restoration confirmation test to confirm that there is no abnormality.

- B.6.6 Pressure resistance test: close the outlet side, and continuously introduce air with 1.5 times the maximum working pressure from the inlet side for 1 minute (if the maximum working pressure is below 10 kPa, apply 15 kPa pressure). Then visually check that there is no crack, damage, obvious deformation, or other abnormalities.

- B.6.7 Airtight test

- B.6.7.1 External airtight test: close the outlet side, continuously introduce 10 kPa air from the inlet side for 1 minute, and the leakage rate shall be equal to or less than 0.07 L/h.

- B.6.7.2 Internal airtight test: with the shut-off valve operating in the “closed” status as shown in Figure B.2, introduce air of 0.5 kPa and 4.2 kPa from the inlet side respectively. Then the leakage rate(Q) is measured by a flow meter and converted to the leakage rate (Q<sub>0</sub>) of the standard state (0 °C, 101.325 kPa), and confirm that it is equal to or less than 0.55 L/h.

$$Q_0 = Q \times \frac{273.15}{273.15 + t} \times \frac{B + P}{101.325}$$

Where Q<sub>0</sub>: leakage rate (L/h) of standard state (0 °C, 101.325 kPa)

t: Test lab room temperature (°C)

B: Atmospheric pressure in the laboratory (kPa)

P: Applied meter pressure (kPa)

#### B.6.8 Service life performance test

B.6.8.1 Durability test using the maximum flow rate: run at the maximum flow rate of the gas meter by gas or air, and accumulate the volume corresponding to 2000 hours in a continuous or intermittent way within 100 days. After completion, perform the leakage detection performance test in Section B.6.14 to confirm compliance with the requirements.

B.6.8.2 Durability test of electrical components: use the temperature and humidity test device to perform 10 temperature and humidity cycles, where each cycle is 24 hours. After that place it in the atmosphere for 2 hours, and then perform the shut-off test in Section B.6.18.4 and restoration action and restoration confirmation test in Section B.6.19 to confirm that each function is normal.

Any 5 cycles among the 1st to 9th cycles shall include low temperature (i.e. a cycle of 24-hour with low temperature), and the remaining 4 cycles and the last cycle shall not be implemented at low temperature (i.e. a cycle of 24-hour without low temperature).

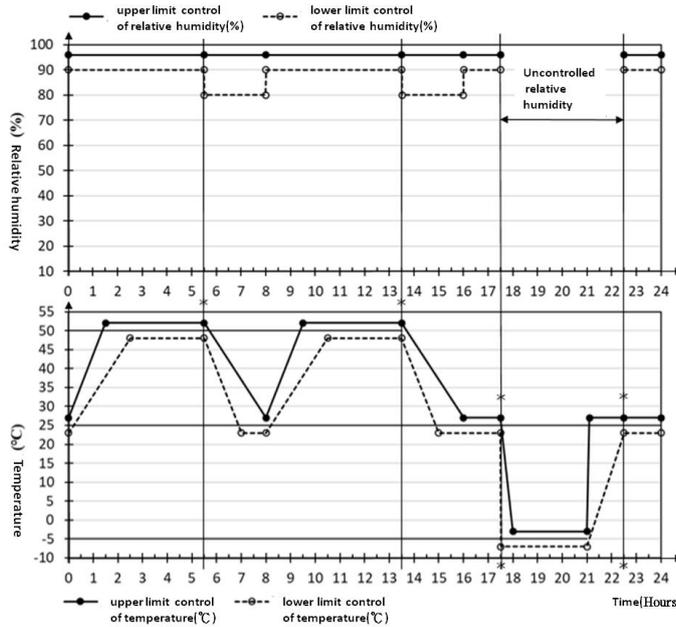
##### B.6.8.2.1 24-hour cycle with low temperature (refer to Figure B.4.1)

- (1) Set the temperature of the test device to  $25\text{ °C} \pm 2\text{ °C}$ , and set the relative humidity to  $93\% \pm 3\%$ .
- (2) Continuously increase the temperature of the test device to  $50\text{ °C} \pm 2\text{ °C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at  $93\% \pm 3\%$ .
- (3) Maintain the temperature at  $50\text{ °C} \pm 2\text{ °C}$  and the relative humidity at  $93\% \pm 3\%$  until 5.5 hours since the cycle starts.
- (4) Decrease the temperature to  $25\text{ °C} \pm 2\text{ °C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.
- (5) 8 hours after the cycle starts, continuously increase the temperature to make it reach  $50\text{ °C} \pm 2\text{ °C}$  within 1.5 to 2.5 hours and stabilize it while maintaining the relative humidity at  $93\% \pm 3\%$ .
- (6) Maintain the temperature at  $50\text{ °C} \pm 2\text{ °C}$  and the relative humidity at  $93\% \pm 3\%$  until 13.5 hours since the cycle starts.
- (7) Decrease the temperature to  $25\text{ °C} \pm 2\text{ °C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.
- (8) Maintain the temperature at  $25\text{ °C} \pm 2\text{ °C}$  and the relative humidity at  $93\% \pm 3\%$  for 1.5 to 2.5 hours.
- (9) Decrease the temperature after 17.5 hours from the start of the cycle, and make the temperature to  $-5\text{ °C} \pm 2\text{ °C}$  before 18 hours from the start of the cycle.

- (10) After 18 hours from the start of the cycle, maintain the temperature at  $-5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  for 3 hours while the relative humidity is not controlled.
- (11) Increase the temperature after 21 hours from the start of the cycle, and make the temperature to  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  before 22.5 hours from the start of the cycle.
- (12) Maintain the temperature at  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  until the end of the 24-hour cycle while maintaining the relative humidity at  $93\% \pm 3\%$ .

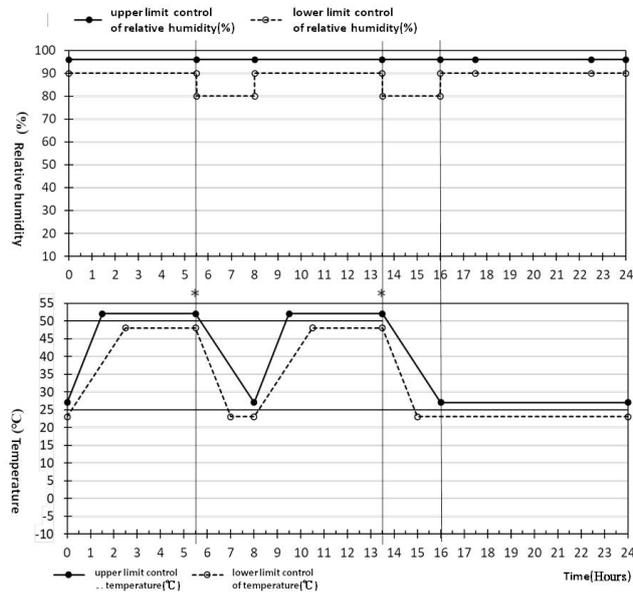
#### B.6.8.2.2 24-hour cycle without low temperature (refer to Figure B.4.2)

- (1) Set the temperature of the test device to  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ , and set the relative humidity to  $93\% \pm 3\%$ .
- (2) Continuously increase the temperature of the test device to  $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at  $93\% \pm 3\%$ .
- (3) Maintain the temperature at  $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  and the relative humidity at  $93\% \pm 3\%$  until 5.5 hours since the cycle starts.
- (4) Decrease the temperature to  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.
- (5) 8 hours after the cycle starts, continuously increase the temperature to make it reach  $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  within 1.5 to 2.5 hours and stabilize it while maintaining the relative humidity at  $93\% \pm 3\%$ .
- (6) Maintain the temperature at  $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  and the relative humidity at  $93\% \pm 3\%$  until 13.5 hours after the cycle starts.
- (7) Decrease the temperature to  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.
- (8) Maintain the temperature at  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  until the end of the 24-hour cycle while maintaining the relative humidity at  $93\% \pm 3\%$ .



\*: Indicates that the permissible error at this point is  $\pm 5$  minutes

Figure B.4.1 24-hour cycle with low temperature



\*: Indicates that the permissible error at this point is  $\pm 5$  minutes

Figure B.4.2 24-hour cycle without low temperature

B.6.9 Durability test of repetitive operation

B.6.9.1 Structure without connecting lines of gas alarm devices, etc.: introduce 1.5 kPa air from the inlet side as shown in Figure B.2, and perform the shut-off test in Section B.6.18.4 for 500 times. Then confirm the shut-off valve does have the function of shut-off and restoration.

- B.6.9.2 Structure with connecting lines of gas alarm devices, etc.: introduce 1.5 kPa air from the inlet side as shown in Figure B.2, and perform the linking-up shut-off test with gas alarm devices, etc. in Section B.6.18.3 and shut-off test in Section B.6.18.4 for 500 times (at least one of them, the shut-off and restoration safety confirmation action is carried out in the way of linking-up shut-off with gas alarm devices, etc., to confirm its connection function. The restoration operation shall be carried out under the condition of differential pressure). Then confirm that the shut-off valve does have the function of shut-off and restoration.
- B.6.10 Explosion resistance test: place the gas meter in the explosion proof tester, and inject a mixed gas with a hydrogen concentration between 19% and 23%. Keep the gas meter in the energized operation status for 1 hour, then implement linking-up shut-off test with gas alarm devices, etc. in Section B.6.18.3 or implement shut-off test in Section B.6.18.4 to confirm that there is no detonation.
- B.6.11 Electromagnetic susceptibility and electromagnetic interference test: Electromagnetic susceptibility test shall be in accordance with CNS 14675 "Information technology equipment - Immunity characteristics - Limits and methods of measurement", and the test results shall conform to the requirements stipulated in the Judgment Criterion A of the standard. And the electromagnetic interference test is in accordance with the provisions of CNS 13438 "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".
- B.6.12 Magnetic fields resistance test of the flow detection unit: use a permanent magnet with a surface magnetic density of 0.3 T (Tesla) as close as to the position of the upper cover of the magnetic induction lead-switch sensor, etc of the flow detection unit, and confirm that the contact points of the magnetic induction lead-switch sensor, etc. are not closed.
- B.6.13 Mains voltage dips test: perform and pass the electromagnetic susceptibility test in Section B.6.11 first. Then perform the shut-off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19. After confirming that the aforementioned functions are normal, decrease the specified voltage and confirm that there is a display corresponding to the action or a shut-off action.
- B.6.14 Leakage detection performance test
- B.6.14.1 Leakage detection capability (start-up flow) test: maintain the pressure on the outlet side of the gas meter at 1.5 kPa as shown in Figure B.2, and slowly increase the gas flow rate from "0" to 0.003 m<sup>3</sup>/h. Gas leakage can be detected by output of pulse signals or mechanical actions.
- B.6.14.2 Leakage detection actuation test: maintain the pressure on the outlet side of the gas meter at 1.5 kPa as shown in Figure B.2. When the gas continues to flow through the gas meter at a flow rate of 0.003 m<sup>3</sup>/h or more, confirm an alarm signal can be automatically displayed after passing the time limit set by the manufacturer (the longest is 30 days).
- If the gas meter is equipped with communication functions, confirm that the

display of the alarm signal is actually performed on the communication.

B.6.14.3 Leakage alarm signal restoration test: after implementing the leakage detection actuation test in Section B.6.14.2, the alarm signal can be eliminated by using a special tool (provided by the manufacturer of the diaphragm gas meter with micro computer).

For those with the function of automatically eliminating the alarm signal, after implementing the leakage detection actuation test in Section B.6.14.2, adjust the gas flow rate on the outlet side to the "0" state. The gas meter shall continue to display the alarm signal within 1 hour and clear the alarm signal in-between 1 to 2 hours.

#### B.6.15 Ambient temperature test

B.6.15.1 Low temperature test: place the gas meter in a test device with a temperature of  $-5\text{ }^{\circ}\text{C}$ , and maintain the temperature for 1 hour. Under the temperature condition, implement the linking-up shut-off test with gas alarm devices, etc. in Section B.6.18.3 or the shut-off test in Section B.6.18.4. Then carry out the restoration action and restoration confirmation test in Section B.6.19 to confirm that the shut-off and alarm functions are correct.

Those with communication functions shall confirm that their communication operations are actually executed.

B.6.15.2 High temperature test: place the gas meter in a test device with a temperature of  $55\text{ }^{\circ}\text{C}$  and a relative humidity of  $40\% \pm 10\%$ , and maintain these conditions for 1 hour. Under the temperature and humidity conditions, carry out the linking-up shut-off test with gas alarm devices, etc. in Section B.6.18.3 or the shut-off test in Section B.6.18.4. Then carry out restoration action and restoration confirmation test in Section B.6.19 to confirm that the shut-off and alarm functions are correct.

Those with communication functions shall confirm that their communication operations are actually executed.

B.6.16 Humidity test: place the gas meter in a test device with a temperature of  $40\text{ }^{\circ}\text{C}$  and a relative humidity of over 90%, and maintain these conditions for 1 hour. Under these conditions, carry out the linking-up shut-off test with gas alarm devices, etc. in Section B.6.18.3 or the shut-off test in Section B.6.18.4. Then perform the restoration action and restoration confirmation test in Section B.6.19 to confirm that the shut-off and alarm functions are correct.

Those with communication functions shall confirm that their communication operations are actually executed.

#### B.6.17 Abnormal flow rate shut-off performance test

B.6.17.1 Shut-off test of abnormally large flow rate: under normal use circumstances as shown in Figure B.2, if the flow rate reaches 2 times of the maximum flow rate of the gas meter (an abnormally large flow rate), confirm that the shut-off function will activate within 2 minutes and an alarm signal will be displayed.

Those with communication functions shall confirm that their communication

operations are actually executed.

B.6.17.2 Shut-off test of individual maximum flow rate

- (1) Under normal use circumstances as shown in Figure B.2, set the gas meter flow rate as twice as of 5% of the maximum flow rate, and maintain it for more than 2 minutes under the pressure of 2.5 kPa. Then a multiple flow rate of the individual maximum flow rate specified by the gas meter manufacturer's manual is rapidly increased and passes through the gas meter, confirm that the shut-off valve is shut off within 2 minutes and an alarm signal will be displayed. However, after a 0.9 times flow rate of the individual maximum flow rate is rapidly increased and passes through the gas meter under the pressure of 2.5 kPa, the gas meter shall not be shut off and an alarm signal shall not be displayed within 5 minutes.
- (2) In this test, when the flow rate used for the test exceeds the abnormally large flow rate of the gas meter, the 5% setting of the test method in the preceding paragraph can be changed to 1% and the 2 minutes setting can be changed to 5 minutes.

B.6.17.3 Shut-off test of overtime use: under normal use circumstances as shown in Figure B.2, the corresponding flow rates (under 2.5 kPa pressure) are distinguished according to the gas consumption specified in the gas meter manufacturer's specification. Select a medium flow rate and a large flow rate respectively, continue to flow through the gas meter, and confirm that the shut-off valve is indeed shut off and an alarm signal is displayed within the specified shut-off time.

B.6.18 Shut-off function test

B.6.18.1 Shut-off test of earthquake sensing

- (1) Adjust the pressure on the inlet side of the gas meter to 1.5 kPa under normal use circumstances, and let the gas flow at a test flow rate specified in Table B.1. Apply horizontal vibrations to all directions of the gas meter with a vibration testing device. The period of the vibrations ranges from 0.3 seconds to 0.7 seconds, the acceleration is increased from 9 gal at a rate of 11 gal per second. When reaching 250 gal, the seismic detection unit of the gas meter shall indeed detect it and make the shut-off valve shut off, and an alarm signal shall be displayed.
- (2) This test is carried out in the horizontal direction X and direction Y with periods of 0.3 seconds (+), 0.5 seconds and 0.7 seconds (-).

Table B.1

| Maximum flow rate                         | Test flow rate         |
|---|------------------------|
| Less than or equal to 6 m <sup>3</sup> /h | 0.06 m <sup>3</sup> /h |
| Greater than 6 m <sup>3</sup> /h          | 0.09 m <sup>3</sup> /h |

B.6.18.2 Shut-off test of gas pressure drop: adjust the air pressure on the inlet side to 1.5

kPa as shown in Figure B.2 under normal use circumstances, and let the gas flow at a test flow rate specified in Table B.1. Slowly decrease the pressure to 0.4 kPa ~ 0.2 kPa, the shut-off valve can be shut off and an alarm signal shall be displayed.

B.6.18.3 Linking-up shut-off test with gas alarm devices, etc.: when gas alarm devices, etc. designated by the gas-fuel company are connected to the gas meter under normal use circumstances, the shut-off valve can be shut off and an alarm signal can be displayed within 2 minutes upon the gas meter receiving the transmission of signal from the gas alarm devices.

Those with communication functions shall confirm that their communication operations are actually executed.

B.6.18.4 Shut-off test: when a special tool is used to perform a shut-off operation on the gas meter under normal use circumstances, the shut-off valve can be reliably shut off.

#### B.6.19 Restoration action and restoration confirmation test

B.6.19.1 Restoration action test: introduce 1.5 kPa air into the inlet side of the gas meter as shown in Figure B.2, and continue to give air according to the test flow rate specified in Table B.1. After closing the shut-off valve, carry out the restoration operation and the gas meter shall be shut off within 3 minutes.

B.6.19.2 Restoration confirmation test: when there is no leakage on the downstream side of the shut-off valve as shown in Figure B.2 and the shut-off valve is kept open, introduce 1.5 kPa air at the inlet side of the gas meter. Close the shut-off valve and the supply source of gas, then carry out the restoration operation. After the gas meter displays a completion message of self-checking, introduce 1.5 kPa air into the inlet side of the gas meter again, and the shut-off valve should remain open.

Note: for a gas meter using pressure detection methods, the volume on the outlet side of the gas meter under test shall be set to be equal to or less than 0.02 m<sup>3</sup> when performing the restoration action test in Section B.6.19.1 and the restoration confirmation test in Section B.6.19.2.

B.6.20 Bursts resistance test: after passing the test according to the requirements of CNS 14676-4 "Electromagnetic compatibility(EMC) – Testing and measurement techniques – Part 4: Electrical fast transient/burst immunity test", then implement the shut-off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19 to confirm that all operations are correct and not affected.

Those with communication functions shall confirm that their communication operations are actually executed.

B.6.21 Electrostatic discharges resistance test: after passing the test according to the requirements of CNS 14676-2 "Electromagnetic compatibility (EMC) – Testing and measurement techniques – Part 2: Electrostatic discharge immunity test", then implement the shut-off test in Section B.6.18.4 and the restoration action and

restoration confirmation test in section B.6.19 to confirm that all operations are correct.

Those with communication functions shall confirm that their communication operations are actually executed.

#### B.6.22 Electromagnetic fields resistance test

(1) After passing the test according to the requirements of CNS 14676-3 "Electromagnetic compatibility (EMC) – Testing and measurement techniques – Part 3: Radiated, radio-frequency, electromagnetic field immunity test", then perform the shut-off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19 to confirm that all operations are correct.

Those with communication functions shall confirm that their communication operations are actually executed.

(2) Test conditions: the communication and external alarm lines are extended with a length of 3 m, and the distance between the body of the gas meter and the transmission antenna is 1 m. Confirm that the strength of the electric field in front of the body of the gas meter body is 3 V/m, and use the frequency scan increment change method with its increment not exceeding 1% of the basic frequency [referring to the frequency of each stage less than the frequency of the previous stage multiplied by 1.01 (with 1 % stage specification)]. In this state, scan from 26 MHz to 1 GHz to confirm that the communication or display is correct. Then carry out the shut off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19 without the electric field strength to confirm that all operations are correct.

#### B.6.23 Connection signal performance test

(1) Confirmation of lead wire polarity

If the lead wire has polarity, its polarity shall be identifiable.

(2) Confirmation of lead wire strength

After applying a force of 30 N to the lead wire in the vertical direction of the lead-out surface for 15 seconds, visually inspect it to confirm that there is no abnormality. Then implement the shut-off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19 to confirm that all operations are correct.

Those with communication functions must confirm that their communication operations are actually executed.

(3) Lead wire short-circuit test

After the lead wire being lapped into a short circuit and then returned to normal, carry out the shut-off test in Section B.6.18.4 and the restoration action and restoration confirmation test in Section B.6.19 to confirm that all operations are correct.

Those with communication functions must confirm that their communication

operations are actually executed.

## Annex C

The requirements of additional tests for diaphragm gas meters with maximum working pressure more than 10 kPa

### C.1 General

In case the nominal maximum working pressure of the gas meter is more than 10 kPa, the pressure concerned performance tests shall be conducted in sequence of initial error test under ambient pressure, initial error test under elevated pressure, durable operation under elevated pressure, the final error test under elevated pressure and the final error test under ambient pressure.

### C.2 Initial error test under ambient pressure

The metrological performance of the gas meter is determined at five flow rates, which are  $Q_{\max}$ ,  $0.46 Q_{\max}$ ,  $0.2 Q_{\max}$ ,  $0.1 Q_{\max}$  and  $0.05 Q_{\max}$ , under ambient pressure.

Each flow rate shall be tested at least six times independently to decide the errors while varying the flow rate between each consecutive measurement. The metrological performance of each flow rate shall comply with the requirements laid down in Section 3.3 to Section 3.6.

### C.3 Initial error test under elevated pressure

The metrological performance of the gas meter is determined at five flow rates, which are  $Q_{\max}$ ,  $0.46 Q_{\max}$ ,  $0.2 Q_{\max}$ ,  $0.1 Q_{\max}$  and  $0.05 Q_{\max}$ , under nominal maximum working pressure.

Each flow rate shall be tested at least six times independently to decide the errors while varying the flow rate between each consecutive measurement. The metrological performance of each flow rate shall comply with the requirements laid down in Section 3.3 to Section 3.6.

### C.4 Durable operation under elevated pressure

The gas meter is flowed with air at maximum flow rate under nominal maximum working pressure.

The duration of the operation is 500 hours. The operation may be discontinuous but shall be completed within 35 days.

### C.5 Final error test under elevated pressure

The metrological performance of the gas meter is determined at five flow rates, which are  $Q_{\max}$ ,  $0.46 Q_{\max}$ ,  $0.2 Q_{\max}$ ,  $0.1 Q_{\max}$  and  $0.05 Q_{\max}$ , under nominal maximum working pressure.

Each flow rate shall be tested at least two times independently to decide the errors while varying the flow rate between each consecutive measurement.

The error curve shall meet the following requirements:

- the maximum permissible errors as specified in Table 2 for in-service.
- for flow rates from  $Q_t$  up to  $Q_{\max}$  a fault of less than or equal to 1.0 times the maximum

permissible error applicable for class 1.5, or 0.5 times the maximum permissible error applicable for class 1.0.

#### C.6 Final error test under ambient pressure

The metrological performance of the gas meter is determined at five flow rates, which are  $Q_{\max}$ ,  $0.46 Q_{\max}$ ,  $0.2 Q_{\max}$ ,  $0.1 Q_{\max}$  and  $0.05 Q_{\max}$ , under ambient pressure.

Each flow rate shall be tested at least two times independently to decide the errors while varying the flow rate between each consecutive measurement.

The error curve shall meet the following requirements:

- the maximum permissible errors as specified in Table 2 for in-service.
- for flow rates from  $Q_t$  up to  $Q_{\max}$  a fault of less than or equal to 1.0 times the maximum permissible error applicable for class 1.5, or 0.5 times the maximum permissible error applicable for class 1.0.

## Annex D

### Type evaluation of a family of gas meters (Mandatory)

#### D.1 General

This Annex describes the criteria to be applied by the evaluating authority in deciding whether a group of gas meters can be considered to be from the same family for type evaluation purposes, for which only selected samples of meter sizes are to be tested.

#### D.2 Definition

A family of meters is a group of gas meters of different sizes and/or different flow rates, in which all the meters shall have the following characteristics:

- (1) the same manufacturer;
- (2) geometric similarity of the parts in contact with the gas;
- (3) the same metering principle;
- (4) the same accuracy class;
- (5) the same temperature range;
- (6) the same electronic device for each meter size;
- (7) a similar standard of design and component assembly;
- (8) the same metrological software routines (if applicable) and the same materials for those components that are critical to the performance of the meter;
- (9) the same installation requirements relative to the meter size;
- (10) roughly the same ratios  $Q_{\max}/Q_{\min}$  and  $Q_{\max}/Q_t$ .

#### D.3 Meter selection

When considering which sizes of a family of gas meters should be tested, the following rules shall be followed:

- (1) the evaluating authority shall declare the reasons for including and omitting particular meter sizes from testing;
- (2) the smallest meter in any family of meters shall always be tested;
- (3) meters which have the most extreme operating parameters within a family shall be considered for testing, e.g. the largest flow rate range, the highest peripheral speed of moving parts, etc;
- (4) if practical, the largest meter in any family of meters should always be tested. However, if the largest meter is not tested, then any meter having a  $Q_{\max} > 2 \times Q_{\max}$  of the largest meter tested shall not be considered part of the family concerned;
- (5) durability tests shall be applied to meters where the highest wear is expected;
- (6) for meters with no moving parts in the measurement transducer, the smallest size shall be selected for durability tests;
- (7) all performance tests relating to influence quantities shall be carried out on one size

from a family of meters;

- (8) the family members underlined in Figure D.1 may be considered as an example for testing (each row represents one family, meter 1 being the smallest).

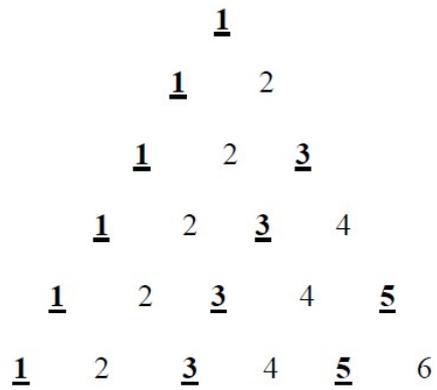


Figure D.1: Family of meters pyramid