	Technical Specification for Type Approval of Ultrasonic Gas Meters	S/N	CNPA 137-1
		Rev.	1

1. This Technical Specification is established in accordance with Paragraph 3 of Article 25 of the Weights and Measures Act.

2. The dates of promulgation, reference numbers, dates of enforcement, and summaries of amendments of this Technical Specification are as follows:

Rev	Date of Promulgation	Reference Number	Date of Enforcement	Summary of Amendments
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3. The standards referenced in this Technical Specification are as follows:

OIML R 137-1 & 2 Gas meters	(2012)
OIML R 31 Diaphragm gas meters	(1995)
CNS 14741 Diaphragm type gas meter with micro computers for nature gas use	(2007)

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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 Specification applies to domestic ultrasonic gas meters used to measure natural gas (NG) and liquefied petroleum gas (LPG). These meters determine flow velocity by measuring the difference between the transit times of ultrasonic signals transmitted in the downstream and upstream directions through the pipeline. The flow rate is obtained by multiplying the flow velocity by the cross-sectional area of the flow passage, and the cumulative volume is determined by integrating the flow rate over time. This Specification also covers ancillary (electronic) devices attached to the gas meter that influence the metrological performance.

The ultrasonic gas meters covered by this Specification are accuracy class 1.0 or 1.5 meters with a maximum working pressure (gauge pressure) not exceeding 10 kPa, a maximum flow rate from 2.5 m^3/h to 16 m^3/h, a rated ambient temperature range from −5 °C to 55 °C, and are powered by batteries.

2. Definition

2.1 Gas meter and constituents

2.1.1 Gas meter

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, and
- 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 Ultrasonic gas meter

A gas meter which comprises a metrological unit and a safety detection and control unit, with the former consisting of components related to the ultrasonic gas meter, and the latter consisting of a flow sensor, a shut-off valve, a pressure sensor, a seismic sensor, a microcomputer main board for abnormal condition determination, and a 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 Error

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

2.2.4 Weighted mean error (*WME*)

The weighted mean error (*WME*) within the scope of this 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 $Q_i \leq 0.7 Q_{max}$

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

where:

k_i = weighting factor at the flow rate Q_i;
E_i = the error at the flow rate Q_i.

2.2.5 Intrinsic error

Error determined under reference conditions.

2.2.6 Fault

Difference between the error of indication and the intrinsic error of a measuring instrument. In practice it 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.

2.2.7 Maximum permissible error (MPE)

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

2.2.8 Accuracy class

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

2.2.9 Durability

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

2.2.10 Measurement precision

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

2.2.11 Repeatability

Measurement precision under a set of repeatability conditions of measurement.

2.2.12 Repeatability of error

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

2.2.13 Reproducibility

Measurement precision under reproducibility condition of measurement.

2.2.14 Reproducibility of error

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

2.2.15 Operating conditions

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

2.2.16 Rated operating conditions

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.

2.2.17 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.

2.2.18 Test element

Device to enable precise reading of the measured gas quantity.

2.2.19 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.

2.2.20 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, ΔP

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

2.3.10 Working density, ρ_w

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

2.3.11 Pressure absorption

With air of a density of 1.2 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 being defined 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 ℃ to +55 ℃
(2)	Ambient relative humidity	at least up to 93 %
(3)	Vibration less than	total frequency range:10 Hz - 150 Hz； total RMS level:1.6 ms^{-2} ； ASD level 10 Hz~20 Hz:0.05 m^2s^{-3} ； ASD level 20 Hz~150 Hz:-3 dB/octave
(4)	Flow rate range	Q_{min} to Q_{max} inclusive
(5)	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} m^3/h	Upper limit of Q_t m^3/h	Upper limit of Q_{min} m^3/h

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

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 maximum permissible errors 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 maximum permissible errors 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 approval and verification (During inspection)	
	Accuracy class	
	1.0	1.5
$Q_{min} \leq Q < Q_t$	± 2 % (± 4 %)	± 3 % (± 6 %)
$Q_t \leq Q \leq Q_{max}$	± 1 % (± 2 %)	± 1.5 % (± 3 %)

3.3.4 Calculation of error

The measurement error of the instrument shall be expressed as a percentage relative to the reference value; i.e., the ratio of the deviation between the indicated value of the gas meter and standard value derived from the standard element, divided by the standard value derived from the standard element:

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

3.4 Weighted mean error (WME)

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

Table 3

Accuracy class	1.0	1.5
WME	± 0.4 %	± 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 maximum permissible errors for the gas meter shall be fulfilled within the rated working pressure range.

3.8 Working temperature

The requirements of accuracy class and maximum permissible errors 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 an air flow of density 1.2 kg/m^3, at a flow rate equal to Q_{max}, shall not exceed the values given in Table 4.

Table 4

Flow rate (m^3/h)	Maximum permissible values for average total pressure absorption (Pa)
2.5 to 10 inclusive	242
16	330

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 2,000 hours (the test may be discontinuous but shall be completed within 100 days):

- the maximum permissible errors as specified in Table 2 for inspection, 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 application of the following vibrations and shocks to a gas meter 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 ms^{-2}

ASD level 10 Hz – 20 Hz: 1 m^2s^{-3}

ASD level 20 Hz – 150 Hz: –3 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 Flow disturbance

For ultrasonic gas meters of which the accuracy is affected by flow disturbances, the manufacturer shall specify the piping arrangements in which only mild flow disturbances occur. The shift of the error due to such disturbances shall not exceed one third of the maximum permissible error.

3.13.2 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).

3.13.3 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	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 (1)
1	Damp heat, cyclic (condensing)	upper temperature specified 93 % relative humidity	1/2 MPE / NSFa
2	Vibrations (random)	Total frequency range: 10 Hz ~ 150 Hz Total RMS level: 7 ms^{-2}	1/2 MPE / NSFa

		ASD level 10 Hz~20 Hz: 1 m^2s^{-3} 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 8 kV air discharge	1/2 MPE / NSFa
7	Bursts (transients) on signal, data and control lines	Amplitude 1 kV Repetition rate 5 kHz	1/2 MPE /NSFd
8	Surges on signal, data and control lines	unsymmetrical lines: line to line 0.5 kV line to ground 1.0 kV symmetrical lines: line to line NA line to ground 1.0 kV shielded I/O and communication lines: line to line NA line to ground 0.5 kV	1/2 MPE /NSFd
(1) NSFa: No significant fault shall occur after the disturbance. NSFd: No significant fault shall occur during the disturbance.			

4. Technical requirements

4.1 Construction

4.1.1 Materials

The materials of outer shell and internal components of the gas meter that are in direct contact with gas shall be corrosion-resistant or treated with an anti-corrosive treatment, and shall comply with the requirements given in Section 4.1.3.

4.1.2 Impact resistance

Materials used for the fuel-gas-supplying connection shall withstand the external impact during 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 shall be set up in accordance with CNS 8886 “Methods of salt spray testing”. After the metallic components have been continuously sprayed with neutral salt solution for 24 hours under the salt spray chamber conditions prescribed in CNS 8886, their corrosion area ratio shall correspond to a rating number between 9.8 and 9 as listed in that standard.

4.1.3.2 Non-Metallic material test

Three samples of same part shall be taken and weighted individually, and

then immersed in n-pentane for 72 hours at a temperature between 5 ℃ and 25 ℃. The samples shall then be removed and left in the atmosphere for 24 hours before being weighed individually again. The mass change rate for each part, calculated according to the following formula, shall be less than 20%, and no degradation or deformation shall be observed.

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

4.1.4 Impact resistance test

The gas meter shall be connected to the gas pipe joint and screwed in at one half of the corresponding torque for the nominal diameter shown in Table 7. An impact torque corresponding to the nominal diameter shown in Table 8 shall be applied to the center of the joint connecting the gas meter and the gas pipe, as shown in Figure 1. Visual inspection shall confirm that there are no cracks, damage or significant deformation. For ultrasonic gas meters, the shut-off test in Section B.6.18.4 shall subsequently be performed, followed by the restoration action and restoration confirmation test in Section B.6.19, to confirm that the shut-off and alarm functions operate correctly. When the impact force is applied from the front, the steel plate with a thickness of 5 mm shall be fixed at the position of the gas meter's measuring window, and the surface of the steel plate shall then 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

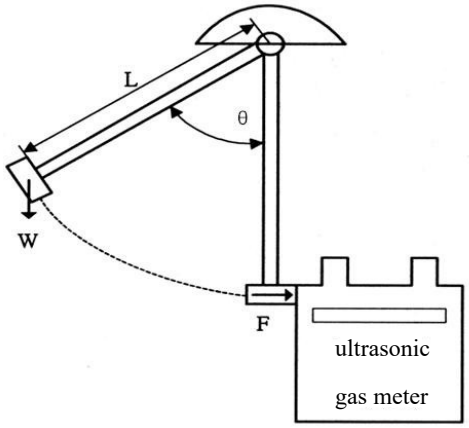


Figure 1 Impact test

Note: impact torque is calculated as follows

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

Where F is the impact torque (N·m)

θ is the hammer raise angle

W is the mass of the hammer (kg)

G is the gravitational acceleration (m/s2)

L is the distance from the center line of the hammer rotation axis to the center of gravity

4.1.5 Indicating device

The indicating device may be connected directly to the meter body or installed 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 a safety device that shuts off the gas flow in emergencies, such as an earthquake or fire. A safety device may be connected to the gas meter, provided that it does not affect the metrological integrity of the meter and complies with the requirements of Annex B, “Type approval tests of safety performance and electromagnetic compatibility performance for ultrasonic gas meters”.

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 the gas meter shall be indicated by a method which is clearly understood.

4.2.2 Function to prevent operation in an unauthorized direction

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.

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.

4.3.2 Indicating range

The indicating device shall be able to record and display the indicated quantity of gas corresponding to at least 1,000 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: "× 10" (or "× 100", or "× 1,000", etc.),

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

4.3.4 Electronic indicating device

The continuous display of the quantity of gas during the period of measurement is not mandatory. The electronic indicating device shall be provided with a display test mode or verification mode.

4.3.5 Remote indicating device

If an indicating device is used remotely, the associated gas meter shall be clearly identified by its serial number. The integrity of 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

For an electronic indicating device, the last digit is used as the integral test element. A specific test mode may be entered by physical or electronic means, in which the number of digits can be increased or an alternative method can be applied to achieve the required 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, 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 are powered by non-replaceable power sources.

4.6.2 Non-replaceable power source

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

4.7 Software

For the purposes of this document, the requirements for application software related to gas meters are as follows.

4.7.1 General requirements

4.7.1.1 Software identification

The legally relevant parts of the software of a gas meter and/or its constituents shall be clearly identified by the software version or another identifier, which shall be specified in the type approval certificate.

After production of the gas meter, the software shall not be changeable, except

where a change requires replacement of the hardware or a hardware component.

The software identification and the means of identification shall be stated in the type approval certificate.

4.7.1.2 Correctness of algorithms and functions

The measuring algorithms and functions of the gas meter shall be verified by metrological tests.

4.7.1.3 Software protection (against fraud)

The legally relevant software shall be secured against unauthorized modification.

Software protection shall include appropriate sealing so that an unauthorized intervention impossible is either impossible or evident.

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) name of the gas to be measured;

(5) accuracy class (other than class 1.5);

(6) maximum flow rate: expressed as Q_{max} = …m^3 / h;

(7) minimum flow rate: expressed as Q_{min} = …m^3 / h;

(8) transitional flow rate: expressed as Q_t = …m^3 / h, other than being equal to 0.1 Q_{max};

(9) working temperature range: expressed as t_{min} – t_{max} = … - …℃ or t_m = … - …℃;

(10) working pressure range: expressed as P_{min} – P_{max} = … - …kPa or P_m = … - …kPa;

(11) pulse values of HF and LF outputs: expressed as L / pulse (dm^3 / pulse or m^3 / pulse) or pulse / L (pulse / dm^3, or pulse / 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 maximum permissible pressure deviation between meter inlet and outlet: expresses as ΔP_{max} = …Pa (or kPa);

(15) the nominal diameter (inside diameter of the inlet and outlet): expressed in mm.

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 embrittlement. The embossing text shall 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 the 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 approval, 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 approval, 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 approval

9.1 General provision

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

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

9.2 Documentation

Applications for type approval 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 a brief explanation of their operation, if applicable;
- a description of the type and location for verification marks and seals or other protective methods;
- 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 approval.

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

Depending on the testing needs, the authority responsible for the type approval may request additional 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 approval 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 approval 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 %

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:

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

Where $i = 1$ to $i = N\text{-}1$, 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 approval tests

During the type approval, 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 the 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. 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 working pressure conditions shall be carried out in accordance with the requirements specified in Section 3.7, and the requirements shall be fulfilled 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 error requirements for the accuracy class of the gas meter.

9.6.6 Durability

Ultrasonic gas meters shall be subjected to a 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 approval 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, and the same reference equipment shall be used before and after the test.

The authority responsible for the type approval 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 C (C.2) the selection of meters is to be performed according to C.3.

Table 9 Number of meters to be tested

Maximum volume flow rate [m^3/h]	Number of meters to be tested	
	Option 1	Option 2
$Q_{max} \leq 25$	3	6

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

Ultrasonic gas meters shall be subjected to an overload flow test. 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 Flow disturbance

Gas meters of which the accuracy is affected by flow disturbances shall be submitted to the tests as specified in Annex D. During the tests, the meters shall be installed according to the manufacturer's specifications.

If such gas meters are specified and marked not to be installed in piping arrangements that produce severe disturbances, they shall be tested only in accordance with Annex D D2 (Mild flow disturbances).

The piping arrangements as presented in Table D.1a-d are considered to produce only mild flow disturbances.

The requirements as laid down in Section 3.13.1 are applicable.

9.6.10 Gas meters containing electronic components

For ultrasonic gas meters containing electronic components, additionally the requirements as described in Section 3.13.2 are applicable. Performance tests shall be executed using the test methods described in Section 8 "Metrological controls" and Section 9 "Type approval". 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.

In all cases, auxiliary devices may be tested separately.

The tests as indicated in Table 5 and Table 6 shall 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.

9.6.11 Influences from ancillary devices

The effect of all functions of ancillary devices shall be 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.

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 shall carry 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). The change of temperature shall not exceed 1 ℃/min during heating up and cooling down. The absolute humidity of the test atmosphere shall not exceed 20 g/m^3. (For example: 50 °C, with a relative humidity not exceeding 24%.) When testing is performed at temperatures lower than 35 ℃, the relative humidity shall not exceed 50 %.	
Temperature	upper temperature specified	℃
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). The change of temperature shall not exceed 1 °C/min during heating up and cooling down. 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	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. The gas meter shall be subjected 3 times to an accuracy test: - at reference conditions, before the increase of temperature; - at the end of the upper temperature phase; - at reference conditions, 24 hours after the decrease of temperature.	
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	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. Condensation is expected to occur on the EUT during the temperature rise. The 24 hours cycle consists of: - Temperature rise during 3 hours. - Temperature maintained at upper temperature level until 12 hours from the start of the cycle. - 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. - Temperature maintained at lower temperature level until the 24 hours cycle is completed. 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 ℃ of its final value. During the test the instrument is switched on; gas flow is not required. The gas meter shall be subjected to an accuracy test both: - at reference conditions, before the increase of temperature and - at reference conditions, at least 4 hours after the last cycle.	
Temperature	upper temperature specified	℃
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	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. 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. Where, based on the metering principle the effect of gravitational force can be assumed negligible the EUT may be mounted in any position. During the test the instrument is not required to be powered up (switched on).
Total frequency range	10 Hz – 150 Hz
Total RMS level	7 $m \cdot s^{-2}$
ASD level 10 Hz－20 Hz	1 $m^2 \cdot s^{-3}$
ASD level 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	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. The height of fall is the distance between the opposite edge and the

	test surface. However, the angle made by the bottom and the test surface shall not exceed 30°. 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	The EUT is exposed to electromagnetic fields having the required field strength level specified and the field uniformity as defined in the referred standard. 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. Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value. 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.
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	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. The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.
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	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. Before starting the tests, the performance of the generator shall be verified. 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. Contact discharge is the preferred test method. Air discharges are less reproducible and therefore shall be used only where contact discharge cannot be applied. Direct application: In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT. In the air discharge mode on insulated surfaces, the electrode is approached to the EUT and the discharge occurs by spark. Indirect application: The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.	
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	A burst generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. 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 Ω and 1000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. For the coupling of the bursts into the I / O and communication lines,

	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	A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. 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. At least 3 positive and 3 negative surges shall be applied. The applicable injection network depends on the kind of wiring the surge is coupled into and is defined in the referred standard. The test pulses shall be continuously applied during the measuring time.		
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 test (battery powered instrument)

A.7.1 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	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. The maximum internal impedance of the battery and the minimum battery supply voltage level (U_{bmin}) are to be specified by the manufacturer of the instrument. 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. The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage.

	The test sequence is as follows: - Let the power supply stabilize at a voltage as defined within the rated operating conditions and apply the measurement and/or loading condition. - Record: (a) the data defining the actual measurement conditions including date, time and environmental conditions; (b) the actual power supply voltage. - Perform measurements and record the error(s) and other relevant performance parameters. - Verify compliance with the requirements. - Repeat the above procedure with actual supply voltage at U_{bmin} and again at 0.9 U_{bmin}. - Verify compliance with the requirements. The maximum internal impedance of the battery is to be specified by the manufacturer of the instrument.
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-approval tests of safety performance and electromagnetic compatibility performance for ultrasonic gas meters

B.1 General

This Annex specifies the construction, safety performance, and electromagnetic compatibility performance requirements and test methods for ultrasonic gas meters.

B.2 Construction

An ultrasonic gas meter consists of a measurement unit and a safety reference detection control unit. The safety reference detection control unit consists of a flow sensor, a shut-off valve, a pressure sensor, a seismic sensor, a microcomputer motherboard for abnormal-condition determination, and a lithium battery.

The gas meter may be connected to external devices, such as a gas leakage alarm device, an incomplete combustion alarm device, and a communication interface.

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

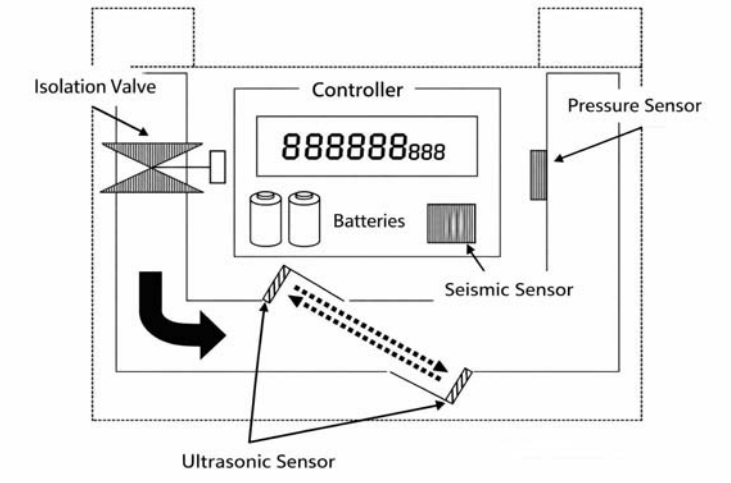


Figure B.1 Structural diagram of an ultrasonic gas meter

B.3 Function

B.3.1 General function

(1)When a flow rate exceeding 2 times of the maximum flow rate is detected, the gas supply shall be cut off immediately.

(2)When gas is flowing through 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 gas is flowing through 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 shall be capable of displaying a leakage alarm.

B.3.2 Safety function: when the measurement unit of the ultrasonic gas meter with a microcomputer is operating, it shall continuously monitor the gas usage status. If an abnormal condition occurs, the safety function can be activated, the gas supply shall be automatically cut off, and the display shall issue an alarm. These abnormal conditions include:

(1) Excessive gas flow.

(2) Gas use for an excessive duration.

(3) Seismic sensor actuation.

(4) Gas pressure is too low.

(5) Interlinked actuation of a connected gas leakage alarm device or similar devices.

(6) Gas leakage in the downstream piping system of the gas meter is automatically detected during a restoration operation.

The gas meter shall continuously and automatically detect whether gas leakage exists in the downstream piping system. When gas leakage is determined to exist, the display shall continue to issue alarms until no gas leakage is detected.

B.3.3 Communication function: when the communication interface of the ultrasonic gas meter with a microcomputer is connected to an external communication circuit of the gas meter, the following functions shall be provided:

(1) Two-way communication of meter reading.

(2) One-way communication of automatic notification and alarm.

(3) Notification of gas usage status.

(4) Centralized remote control.

B.4 Performance

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

B.4.2 Marking/warning-light performance: the marking/warning light shall be displayed unambiguously, and the reason for its actuation shall be clearly displayed.

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

B.4.3.1 Capability to confirm and display open and closed status: the gas meter shall have a marking device that displays 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 threaded joint connected to the gas pipeline shall meet the requirements of Section B.6.4.

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

B.4.6 Pressure-resistance performance: all gas-flow parts of the gas meter shall withstand a pressure of 15 kPa.

B.4.7 Airtightness performance

B.4.7.1 External airtightness performance: the gas-flow path 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 airtightness 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 suitable for normal conditions of use.

B.4.8.2 Shut-off valve: The shut-off valve shall withstand an applied air pressure of 1.5 kPa (NG meters) or 2.8 kPa (LPG meters). Following 500 operating cycles for NG meters or 1,000 operating cycles for LPG meters, the shut-off valve shall maintain its original functional performance without malfunction, deformation, or loss of sealing capability.

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

B.4.10 Resistance to magnetic fields: under normal conditions of use, the flow detection function shall not be affected by magnetic fields.

B.4.11 Mains voltage dips: mains voltage dips shall not impair operation.

B.4.12 Leakage detection performance

B.4.12.1 Leakage detection capability: leakage at the connection part of the gas outlet of the gas meter shall be detected when the leakage rate is equal to or greater than 0.003 m^3/h.

B.4.12.2 Leakage detection actuation capability: when the leakage rate at the connection part of the gas outlet of the gas meter exceeds 0.003 m^3/h and leakage continues for up to 30 days, the gas meter shall be able to automatically display an alarm signal.

B.4.12.3 Leakage alarm display and restoration capability: the gas meter shall have an internal-pipe leak alarm and restoration function. The alarm shall be cleared and restored only by special tools or operational settings. For gas meters with automatic restoration functions, automatic restoration shall not occur if small leakages are continuously detected.

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

B.4.14 Resistance to humidity changes: the gas meter shall not be affected by the humidity changes under the 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 conditions of use, when the combined gas flow rate of gas appliances is twice 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 conditions of use, 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 conditions of use, when the continuous use time, distinguished by different gas appliances and gas consumption amounts, reaches the time limit, 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 conditions of use, 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 conditions of use, 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 Interlinked shut-off performance of a gas leakage alarm device or similar devices: under normal conditions of use, when the gas meter is connected to a gas leakage alarm device or other devices, the device shall be capable of being interlinked with 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 a restoration-confirmation function 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 conditions of use.

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

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

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

B.5 Test conditions: if a test method in this Annex does not specify particular test conditions, the following conditions shall apply.

B.5.1 Temperature requirements of the test laboratory: during the test, the temperature variation shall be within ±5°C, and the temperature shall be maintained within the range of 20°C ± 15°C.

B.5.2 Humidity requirement of the test laboratory: the relative humidity shall be maintained within the range of 60% ± 25%.

B.5.3 Normal conditions of use: when a gas meter is tested, the connecting pipes on the inlet side and the outlet side shall, in principle, be straight pipes with a length of 8 to 10 times the connecting diameter. If the volume of the detected part is easily affected by the inner pipe volume, the test shall be conducted 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 upstream or downstream of the straight pipe, depending on the test item. The test layout diagram is shown in Figure B.2.

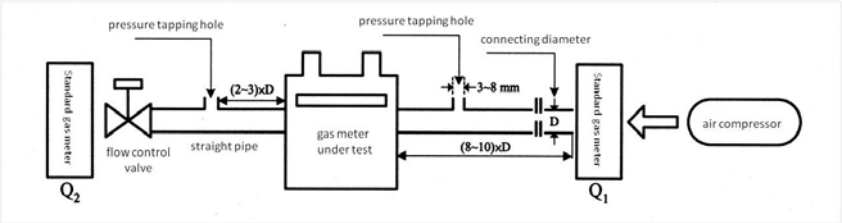


Figure B.2 Gas meter test layout diagram

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

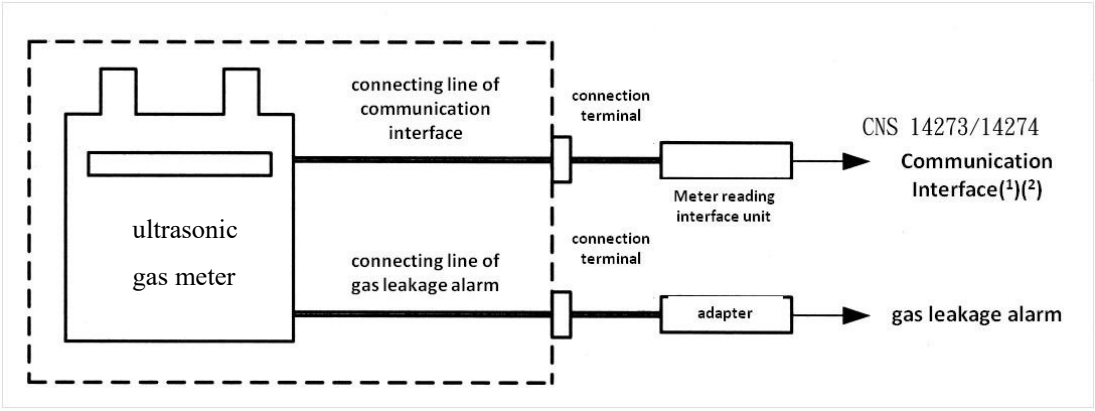


Figure B.3

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 Watertightness test: visual inspection shall confirm that the enclosure structure is free from obvious defects, and the enclosure 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 a liquid crystal display (LCD): measure the size of the displayed text or numerals using a vernier caliper or equivalent instrument; the text or numerals shall have a height of at least 4 mm.

If reasons for marking/warning actions are provided, they shall be confirmed according to the specified methods described in the manufacturer's specifications.

B.6.3 Test for confirmation of the operating status of the shut-off valve: after opening and closing 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 Pipe-connection performance test

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

B.6.5 Vibration resistance performance test: fix the gas meter on the vibration testing machine in its shipping package, and apply vibration at 600 cycles per minute with a full amplitude of 5 mm for 20 minutes in each of the vertical, front-rear, and left-right directions. Then perform the airtightness test in Section B.6.7 and the restoration action and restoration confirmation test in Section B.6.19 to confirm that there is no abnormality.

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

B.6.7 Airtightness test

B.6.7.1 External airtightness 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 airtightness test: with the shut-off valve in the “closed” status as shown in Figure B.2, introduce air at 0.5 kPa and 4.2 kPa from the inlet side, respectively. The leakage rate (Q) shall then be measured using a flow meter and converted to the leakage rate (Q_0) of the standard conditions (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_0: leakage rate (L/h) of standard conditions (0 ℃, 101.325 kPa)

t: Test laboratory room temperature (℃)

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: operate the gas meter at its maximum flow rate using gas or air, and accumulate the volume corresponding to 2,000 hours of operation continuously or intermittently 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, each lasting 24 hours. Afterwards, place the gas meter in the atmosphere for 2 hours, and 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 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 include a low temperature phase (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 ℃ ± 2 ℃, and set the relative humidity to 93% ± 3%.

(2)Continuously increase the temperature of the test device to 50 °C ± 2 °C within 1.5 to 2.5 hours while maintaining the relative humidity at 93% ± 3%.

(3)Maintain the temperature at 50 °C ± 2 °C and the relative humidity at 93% ± 3% until 5.5 hours after the cycle starts.

(4)Decrease the temperature to 25 °C ± 2 °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 °C ± 2 °C within 1.5 to 2.5 hours and stabilize it while maintaining the relative humidity at 93% ± 3%.

(6)Maintain the temperature at 50 °C ± 2 °C and the relative humidity at 93% ± 3% until 13.5 hours after the cycle starts.

(7)Decrease the temperature to 25 °C ± 2 °C within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.

(8)Maintain the temperature at 25 °C ± 2 °C and the relative humidity at 93% ± 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 reach -5 °C ± 2 °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 °C ± 2 °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 reach 25 °C ± 2 °C before 22.5 hours from the start of the cycle.

(12)Maintain the temperature at 25 °C ± 2 °C until the end of the 24-hour cycle while maintaining the relative humidity at 93% ± 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 ℃ ± 2 ℃, and set the relative humidity to 93% ± 3%.

(2)Continuously increase the temperature of the test device to 50 °C ± 2 °C within 1.5 to 2.5 hours while maintaining the relative humidity at 93% ± 3%.

(3)Maintain the temperature at 50 °C ± 2 °C and the relative humidity at 93% ± 3% until 5.5 hours after the cycle starts.

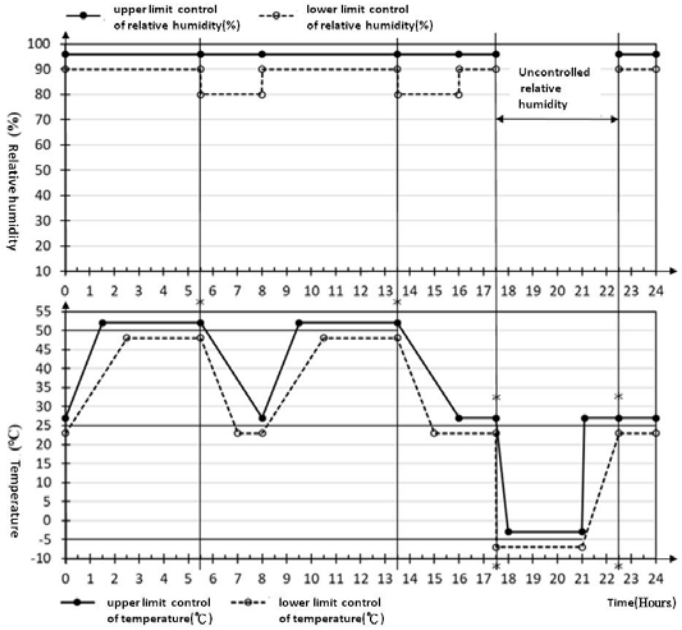
(4)Decrease the temperature to 25 °C ± 2 °C within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.

(5)8 hours after the cycle starts, continuously increase the temperature to make it reach 50 °C ± 2 °C within 1.5 to 2.5 hours and stabilize it while maintaining the relative humidity at 93% ± 3%.

(6)Maintain the temperature at 50 °C ± 2 °C and the relative humidity at 93% ± 3% until 13.5 hours after the cycle starts.

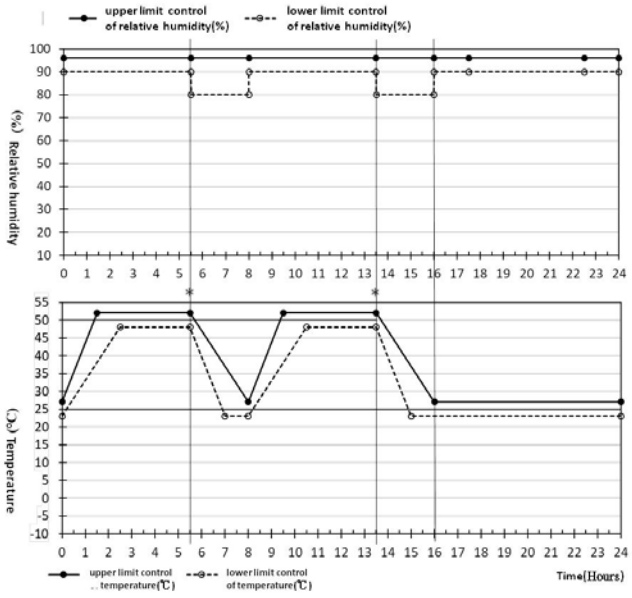
(7)Decrease the temperature to 25 °C ± 2 °C within 1.5 to 2.5 hours while maintaining the relative humidity at 80% to 96%.

(8)Maintain the temperature at 25 °C ± 2 °C until the end of the 24-hour cycle while maintaining the relative humidity at 93% ± 3%.



*: Indicates that the permissible error at this point is ±5 minutes

Figure B.4.1 24-hour cycle with low temperature



*: Indicates that the permissible error at this point is ±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 or similar devices: introduce air at 1.5 kPa 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 has shut-off and restoration functions.

B.6.9.2 Structure with connecting lines of gas alarm devices or similar devices: introduce 1.5 kPa air from the inlet side as shown in Figure B.2, and perform the interlinked shut-off test with gas alarm devices or similar devices in Section B.6.18.3 and shut-off test in Section B.6.18.4 for 500 times (at least once, the shut-off and restoration safety confirmation action shall be carried out by interlinked shut-off with gas alarm devices or similar devices to confirm the connection function. The restoration operation shall be carried out under the condition of differential pressure). Then confirm that the shut-off valve has function shut-off and restoration functions.

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 the interlinked shut-off test with gas alarm devices, or similar devices in Section B.6.18.3 or implement shut-off test in Section B.6.18.4 to confirm that no detonation occurs.

B.6.11 Electromagnetic susceptibility and electromagnetic interference test: the electromagnetic susceptibility test shall be conducted 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. The electromagnetic interference test shall be conducted in accordance with 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 possible to the position of the upper cover of the magnetic induction lead-switch sensor or similar component of the flow detection unit, and confirm that the contact points of the magnetic induction lead-switch sensor or similar component 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 a corresponding display indication or a shut-off action occurs.

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 (NG meters) or 2.8 kPa (LPG meters) as shown in Figure B.2, and slowly increase the gas flow rate from "0" to 0.003 m^3/h. Gas leakage shall be detectable by pulse-signal output 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 (NG meters) or 2.8 kPa (LPG meters) as shown in Figure B.2. When the gas continues to flow through the gas meter at a flow rate of 0.003 m^3/h or more, confirm that an alarm signal can be automatically displayed after the time limit set by the manufacturer has elapsed (the maximum time limit is 30 days).

If the gas meter is equipped with communication functions, confirm that the alarm signal is actually transmitted through the communication function.

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 cleared using a special tool (provided by the manufacturer of the ultrasonic gas meter).

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 for 1 hour and shall clear the alarm signal between 1 to 2 hours after the flow rate is adjusted to zero.

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 °C, and maintain the temperature for 1 hour. Under this temperature condition, implement the interlinked shut-off test with gas alarm devices or similar devices 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.

For gas meters with communication functions, confirm that the 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 °C and a relative humidity of 40 % ± 10 %, and maintain these conditions for 1 hour. Under the temperature and humidity conditions, carry out the interlinked shut-off test with gas alarm devices or similar devices 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.

For gas meters with communication functions, confirm that the communication operations are actually executed.

B.6.16 Humidity test: place the gas meter in a test device at a temperature of 40 °C and a relative humidity of over 90%, and maintain these conditions for 1 hour. Under these conditions, carry out the interlinked shut-off test with gas alarm devices or similar devices 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.

For gas meters with communication functions, confirm that the 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 conditions of use as shown in Figure B.2, if the flow rate reaches 2 times the maximum flow rate of the gas meter (an abnormally large flow rate), confirm that the shut-off function activates within 2 minutes and that an alarm signal is displayed.

For gas meters with communication functions, confirm that the communication

operations are actually executed.

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

(1) Under normal conditions of use as shown in Figure B.2, set the gas meter flow rate to twice 5% of the maximum flow rate, and maintain it for more than 2 minutes under the pressure of 2.5 kPa. Then rapidly increase the flow through the gas meter to the multiple of the individual maximum flow rate specified in the gas meter manufacturer's manual, and confirm that the shut-off valve closes within 2 minutes and that an alarm signal is displayed. However, after the flow is increased to 0.9 times the individual maximum flow rate and passes through the gas meter under the pressure of 2.5 kPa, the gas meter shall not 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 conditions of use 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 flow through the gas meter, and confirm that the shut-off valve closes 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 (NG meters) or 2.8 kPa (LPG meters) under normal conditions of use, 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 vibration period shall range from 0.3 seconds to 0.7 seconds, the acceleration shall be increased from 9 gal at a rate of 11 gal per second. When 250 gal is reached, the seismic detection unit of the gas meter shall detect it, the shut-off valve shall close, 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^3/h	0.06 m^3/h
Greater than 6 m^3/h	0.09 m^3/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 conditions of use, 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 shall close and an alarm signal shall be displayed.

B.6.18.3 Interlinked shut-off test with gas alarm devices and similar devices: when gas alarm devices and similar devices designated by the gas-fuel company are connected to the gas meter under normal conditions of use the shut-off valve shall close and an alarm signal shall be displayed within 2 minutes after the gas meter receives a signal transmitted by the gas alarm devices.

For gas meters with communication functions, confirm that the 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 conditions of use, 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 (NG meters) or 2.8 kPa (LPG meters) air into the inlet side of the gas meter as shown in Figure B.2, and continue supplying 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 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 (NG meters) or 2.8 kPa (LPG meters) air at the inlet side of the gas meter. Close the shut-off valve and the gas supply source, and then carry out the restoration operation. After the gas meter displays a completion message of self-checking, introduce 1.5 kPa (NG meters) or 2.8 kPa (LPG meters) air into the inlet side of the gas meter again, and the shut-off valve shall 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^3 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 in accordance with 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 unaffected.

For gas meters with communication functions, confirm that the communication operations are actually executed.

B.6.21 Electrostatic discharges resistance test: after passing the test in accordance with 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.

For gas meters with communication functions, confirm that the communication operations are actually executed.

B.6.22 Electromagnetic fields resistance test

(1)After passing the test in accordance with 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.

For gas meters with communication functions, confirm that the 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 electric field strength in front of the body of the gas meter body is 3 V/m, and use a frequency-scan increment method with increments 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 applying the electric field 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, the polarity shall be identifiable.

(2)Confirmation of lead wire strength

After applying a force of 30 N to the lead wire perpendicular to 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.

For gas meters with communication functions, confirm that the communication operations are actually executed.

(3)Lead wire short-circuit test

After the lead wire is short-circuited 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.

For gas meters with communication functions, confirm that the communication operations are actually executed.

Annex C

Type evaluation of a family of gas meters (Mandatory)

C.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 approval purposes, for which only selected samples of meter sizes are to be tested.

C.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.(Each flow rate shall comply with the requirements specified in Table 1 of Section 3.2.)

C.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 C.1 may be considered as an example for testing (each row represents one family, meter 1 being the smallest).

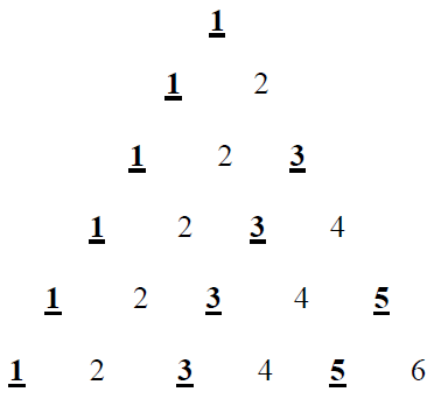


Figure C.1: Family of meters pyramid

Annex D

Flow disturbance tests (Mandatory)

D.1 General

D.1.1 The test specified in this Annex shall be carried out with air at atmospheric pressure, at flow rates of $0.21Q_{max}$, $0.46Q_{max}$ and Q_{max}.

D.1.2 If the design of the type of the gas meter is similar for all pipe sizes, it is sufficient to perform the full set of tests on the one size which is considered as worst case situation for the meter family

Tests are also to be performed on other sizes if considered necessary.

D.2 Mild flow disturbances

D.2.1 Flow disturbance tests shall be executed using each of the applicable piping configurations as presented in Table D.1, mounted upstream of the meter, whereby the meter is installed according to the manufacturer's mounting specifications.

D.2.2 All other test conditions in Table D.1 apply regardless of the environment (both residential and non-residential).

D.2.3 During each of the tests mentioned in D.2.1 the shift of the error curve of the gas meter shall meet the requirement as stated in Section 3.13.1.

D.2.4 If a specific minimum length of straight upstream piping L_{min} is necessary to meet the requirement as indicated in D.2.3 this L_{min} shall be applied during the tests and its value shall be stated in the type approval certificate.

D.2.5 For ultrasonic gas meters the requirements as stated in Section 3.13.1 shall be met as well when adding an extra 10D straight pipe length to the minimum length of straight upstream piping L_{min} for each test mentioned in D.2.1.

Table D.1 Piping Configurations for flow disturbances

Test		Test Condition	Description
a		Reference condition	At least 10D straight line
b		A single 90° bend	radius elbow: 1.5D
c		Double out-of-plane bend	Rotating right; radius elbows: 1.5D
d		Double out-of-plane bend	Rotating left; radius elbows: 1.5D