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BSI Standards Publication

Gas meters — Smart Gas Meters

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National foreword

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Foreword

This document (CEN/TR 16061:2010) has been prepared by Technical Committee CEN/TC 237 "Gas meters", the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document is intended to be a precursor to a formal standard for Gas Meters that provide some additional functions beyond that required under the Measuring Instruments Directive (MID). It is noted that other CEN and CENELEC Technical Committees are active in the areas of metering communications – most relevant being CEN/TC 294 "Communication systems for meters and remote reading of meters", which covers automatic reading of Gas Meters in great detail. The functions described are mainly for use on Residential Utility meters, but may be equally applicable to meters used for commercial and industrial applications. A number of the requirements may be applicable to "add-on" devices to Gas Meters. However, it is outside the scope of the TC to standardise beyond Gas Metering devices.

1 Scope

This Technical Report outlines recommendations for "smart gas meters", specifies recommendations where there is clear consensus, and identifies areas where there are barriers to standardisation. It indicates how functions may be implemented in a harmonized way if they are selected. It does not seek to select which functions are to be implemented in a smart meter. The report covers simple to complex implementations of smart metering.

This Technical Report is applicable to 1st, 2nd and 3rd family gases according to EN 437.

2 Definitions, glossary

2.1 Glossary

MID	Measuring Instruments Directive, 2004/22/EC
AtEx	"Atmospheres Explosibles". A pair of EU Directives governing hazardous areas, 99/92/EC; and the equipment that can be used within hazardous areas, 94/9/EC
CEN	European Committee for Standardization: European standards body for non-electrical equipment
CENELEC	European Committee for Electrotechnical Standardisation: European standards body for electrical equipment
BSI	British Standards Institution
DLMS UA	The Device Language Message Specification User Association
Harmonised standard	European Standard adopted by a European standardisation body, made available to the public and that has been recognised as a method to demonstrate conformity to Essential Requirements of a European Directive
PED	Pressure Equipment Directive, 97/23/EC
WELMEC	Western European Legal Metrology Cooperation: an organisation of legal metrologists
ESCO	Energy End-Use Efficiency and Energy Services Directive, 2006/32/EC
Basic Meter	a meter that is safe and provides no function beyond that required by the MID
IT System	Information Technology System
AMR	Automatic Meter Reading. A technology that allows a meter to be read that does not require direct observation of the meter
AMM	Advanced Meter Management
AMI	Advanced Meter Infrastructure
Connector	a mechanical device, or pair of devices, that makes a semi-permanent circuit between the meter and a cable

Normative document	a document containing technical specifications adopted by the Organisation Internationale de Métrologie Légale (OIML), subject to the procedure stipulated in Article 16(1) of the MID
Standard	a technical specification approved by a recognised standardisation body for repeated or continuous application, with which compliance is not compulsory and which is one of the following: — International Standard: a standard adopted by an international standardisation organisation and made available to the public; — European Standard: a standard adopted by a European standardisation body and made available to the public; — national standard: a standard adopted by a national standardisation body and made available to the public
Base Condition	specific conditions to which the measured quantity of gas is converted[1)] EXAMPLES Temperature of 273,15 K and absolute pressure of 1,013 25 bar or temperature of 288,15 K and absolute pressure 1,013 25 bar.
Burst Data	this may be generated at the pulse outputs of electronic indexes and volume converters. To save power, electronic devices will only wish to switch on output circuits infrequently. Therefore, rather than emit a pulse as soon as one should be generated, the output circuit will only be switched on infrequently, and then a burst of pulses is transmitted
Gas Metering Day	for billing purposes, the "day" may not start at 00:00: it may start at some other time. This start time may also be subject to daylight savings time changes, leading to "days" with lengths other than 24 h
UTC	Coordinated Universal Time. This is a "world time", without daylight savings
Electronic Index Assembly	the register, electronics, and battery
Index Housing	an enclosure to contain the index assembly, where the index assembly is not contained in the body of the meter
Register	the display element + data store

2.2 Numerical list of standards

NOTE Other documents are listed in the Bibliography.

Body	Reference	Title	Note
CEN	EN 12261	Gas meters — Turbine gas meters	Standard for Turbine Meters, Harmonised with MID.

1) The calorific values of gas are expressed usually in megajoules per cubic metre (MJ/m³). The amount of gas in the determined volume, however, will depend on temperature and pressure. Therefore a nominated base condition is used. Volume conversion takes the volume of gas measured, then converts this to a volume of gas at the equivalent base condition. See EN 12480:2002, 3.1.9, and EN 12405-1.

Body	Reference	Title	Note
CEN	EN 12405-1	Gas meters — Conversion devices — Part 1: Volume conversion	Standard for Volume Converters. Harmonised with MID.
CEN	EN 12480:2002	Gas meters — Rotary displacement gas meters	Standard for Rotary Piston meters. Harmonised with MID.
CEN	EN 1359:1998	Gas meters — Diaphragm gas meters	Standard for diaphragm meters, Harmonised with MID.
CEN	EN 13757	Communication systems for and remote reading of meters	Multi-part document detailing communications formats
CEN	EN 13757-1	Communication system for and remote reading of meters — Part 1: Data exchange	OBIS-COSEM Application layer for Gas, etc. meters.
CEN	EN 13757-2	Communication systems for and remote reading of meters — Part 2: Physical and link layer	
CEN	EN 13757-3	Communication systems for and remote reading of meters — Part 3: Dedicated application layer	M-Bus Wired specification
CEN	EN 13757-4	Communication systems for and remote reading of meters — Part 4: Wireless meter readout (Radio meter reading for operation in the 868 MHz to 870 MHz SRD band)	M-Bus Radio specification
CEN	EN 14236:2007	Ultrasonic domestic gas meters	Standard for Ultrasonic meters. Harmonised with MID.
CEN	EN 13463	(In a number of parts) Non-electrical equipment for use in potentially explosive atmospheres	
CENELEC/IEC	EN 60079-10; IEC 60079-10	Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas	
CENELEC/IEC	EN 60079; IEC 60079	(In a number of parts) Electrical apparatus for explosive gas atmospheres	

Body	Reference	Title	Note
CENELEC	EN 62056-61	Electricity metering — Data exchange for meter reading, tariff and load control — Part 61: Object identification system (OBIS) (IEC 62056-61:2006)	For information. Sister document to EN13757-1
CENELEC	EN 62056-21	Electricity metering — Data exchange for meter reading, tariff and load control — Part 21: Direct local data exchange (IEC 62056- 21:2002)	For information. Electricity standard for opto-electrical ("flag") interface.
CENELEC/IEC	EN 60529:1991	Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)	

3 What is a Smart Meter?

3.1 General

A Smart Meter is one that is compatible with the MID and ESCO directives, and has communications capabilities.

The following sections detail the variations of functional complexity that are likely to make up smart meters or may form part of a smart metering system. The table below details some of the possible aims and methods that may form part of a smart meter.

Table 1 — Aims and methods for smart meters

Aim	Means	Possible methods
Reduction of costs for meter reading (in case frequent meter reading is obliged)	Remote meter reading	Minimum one way communication from meter
Reduction of complaints – improved quality of meter reading	Remote meter reading	Minimum one way communication from meter
Reduction of payment arrears	Prepayment, or shutting off customer supply	Remotely operated valve in meter; Two-way communication
Regular billing based on real consumption	Remote meter reading	Minimum one way communication from meter
Providing customer consumption information	Info on meter display (or home display unit)	Two-way Communication; Electronic Display
Advertising	Info on meter display (or home display unit)	Two-way Communication; Electronic Display

Aim	Means	Possible methods
Limitation of production capacity	Peak shaving by differential tariffs	Two way communication; Electronic Display; Interval data
Stop supply during shortage	Switching off customers	Remotely operated valve in meter; Two way communication
Safeguard for excess flow sensed at the meter	Switch off customers when there is a customer installation problem (e.g. caused by a leak)	Local control of valve in meter
Safeguard for network issues	Control signal for an area	Remotely operated valve in meter; Two way communication

3.2 Basic meter

It may be helpful, as a starting point, to observe that a "Basic" meter is one that is safe and provides no function beyond that required by the MID[2)]. It is worth noting the quotations from MID Annex 1, "Essential Requirements" that are contained in Annex A of this document.

It can be argued that prepayment meters that provide data back to the suppliers IT systems via a token are Smart. To try to clarify the different types of meter that are available, different categories are defined below.

3.3 Basic meter with output of pulses or data

3.3.1 General

A basic meter with output can be part of a smart (AMR) system. It may be possible for this system to meet the recommendations of ESCO.

3.3.2 Pulse output

The basic meter may have an integrated or a remotely equipped pulse output or a data output. The pulse is widely used as a method of providing data from a meter. The meter emits a pulse each time a fixed volume is measured.

The pulse value outputs are marked as 1 imp ≙ … m^3 (or dm^3) or 1 m^3 (or dm^3) ≙ … imp.

The most widely used method for pulse output is to use a magnet in one of the least significant wheels in the index. A reed switch is commonly used to detect the passage of the magnet.

3.3.3 Data output

Data outputs can be provided through serial interfaces. Data outputs should provide information on meter readings, meter identification and meter status. The index value (as read on the meter) is provided by the data output. Data outputs can be built-in or provided by add-on to an existing meter. Depending on the interface used, data encryption and access control has to be considered. Guidance on data outputs is detailed in WELMEC Software Guides 7.1 and 7.2.

2) Please note that meters with pre-MID approvals will also usually meet this recommendation.

3.4 AMR meter

An Automatic Meter Reading (AMR) meter can form part of a smart metering system. An AMR-equipped meter can provide data to an IT system. In its simplest form, it provides a current meter read without physical access to the meter. A number of technologies exist that can be used to collect and transfer the data – from inductive pad, where a meter reader needs to physically connect a reading device to a component connected to the meter, through walk-by and drive-by systems, to fixed wired or wireless networks with star or mesh topologies.

An AMR system can be built based on a basic meter with pulse or data output.

An AMR meter may or may not log data, and provide information about events[3)] and its status when it transmits data.

While it is possible for an AMR Meter to be truly one way, broadcasting data either continuously or at pre-set intervals, most systems are at least 1,5 way (which report when stimulated), and many are two way, and give answers to specific questions.

3.5 Prepayment meter

Prepayment, or "pay as you go", meters allow customers to make advanced payment for energy[4)]. In their simplest form, a mechanical token (or coin) is used to allow the valve within the meter to be opened until a measured quantity of gas has been consumed. State of the art prepayment meters use electronic tokens or SMS to add credit to the meter, set tariffs on the meter and provide data on consumption and events to the IT system. The latest meters can remotely manage the repayment of debts, and perform the calculations to consume the credit applied to the meter based on tariff and energy conversion data. They can manage change of retailer in a competitive retail market for energy, and some can even be switched to a mode where they function as a credit meter.

3.6 Smart meters

There are a number of terms, such as "AMI", "Smart", "AMM", where there is no commonly agreed definition.

A smart meter will have communications[5)] operating within acceptable timeframes and at least one additional function from the following list:

— Built-in Customer Display of time of use information (see 6.7);

— Local provision of time of use information (see 6.8);

— Shut-off Valve (see 6.9);

— Home Automation interface (see 6.8.1);

— Prepayment functionality (see 6.5, 6.6, 6.7 and 6.9);

— Remote update of configuration data[6)] (see 6.3);

3) The term "event" covers changes of status within the meter. Changes of status can occur when a meter senses something out of the ordinary (perhaps flow beyond the Q_{max} of the meter, or battery level falling to a pre-set level), when there is a tamper or fraud attempt, or if there is an error.

4) Energy Cost and transportation costs are accrued when the supplier collects money from the customer. Transportation charges may, in some cases, require meter reading data to be provided.

5) Communications in this context can be either wired or wireless.

6) Note that metrological parameters may not be updated under MID rules.

— Datalogging functionality (see 6.3).

Fraud and Tamper detection will be a feature of most smart meters. The levels of protection from fraud and tamper will be related to the complexity of the meter. Meters that include a valve will require high levels of protection and detection of fraud and tamper attempts. This is discussed further in 6.10.

The above is not intended to be an exhaustive list, and it is likely that there will be updates to this document on an ongoing basis as further additional functions become defined.

Firmware upgrade may be required in some situations. This is discussed in 6.4 of this Technical Report and the WELMEC Software Guide.

4 Smart metering system – The smart meter in its context

Meters form part of a system. The huge majority of gas meters are used simply as part of a chain that provides an invoice for energy to the energy customer.

In the simplest system, basic meters communicate via a "visual read" to a meter reader, who transmits the data into a meter read system, where the data is validated, and then passed through to the billing system, where volume conversion and energy calculation is performed.

A smart metering system performs the same functions with the meter reader eliminated. Basic AMR will eliminate the "eyeball" element of the read, and AMR into a fixed network will remove the need for the meter reader to visit site and thus provide the Wide Area Network (WAN) functionality. A meter with more functionality (or, in the case of industrial gas use, a Volume Conversion system) may be able to perform the volume conversion and the energy consumption calculation by applying values supplied by the IT system.

The tariff and energy conversion technology in prepayment meters can be applied to a smart meter which will lead to an ability to estimate energy usage and cost for the customer. In theory, this could be extended to the point where the bill is calculated on the meter, and the billing amount provided to the energy supplier via a communications channel, though provision of calorific value (CV), pressure and temperature is a significant issue in taking this approach. While there are technologies that can register energy directly, none have come to market in a way that delivers cost effective real-time energy calculation, except on large industrial applications. This adds a complexity to the accurate provision of energy consumption on the meter; either

— calorific value, pressure and temperature would have to be available in "real time"; or

— the meter would have to be capable of retrospectively recalculating the energy based on information when validated data becomes available.

It should be noted that the auditing of software capable of retrospective recalculation would be a very difficult task. It should also be noted that a gas meter that estimates the energy usage and the cost for the customer will, inevitably, provide information that differs from the invoice, and therefore some customers will query the difference. This difference is similar to that noted when electricity customers have "clip on" electricity monitors that estimate energy consumption.

A method that may be adopted to manage the difference between real time energy estimates and billed energy is to set the calorific value used for real time estimates a little higher than expected. This will mean that meters give a slightly high estimate of energy consumption, and it is expected that most energy customers will be unlikely to contact their energy supplier on this basis.

It should be noted that the end-to-end process of invoice generation is not changed by the application of smart meters, but smart meters will automate the data collection, and may push the energy and tariff calculation from the central system to the meter.

5 Basic recommendations – Apply to all Smart Gas Meters

5.1 General

Many of the recommendations below are applied to new meters being supplied today. Some recommendations are new, and need to be considered in detail when new meters are being developed.

5.2 Metrology

New meter designs have to be accurate. Several European Standards, EN 1359, EN 12405, EN 12261, EN 12480 and EN 14236 are applicable to Gas Meters and should be applied as they are "harmonised" standards. OIML recommendation R137-1 is identified as a normative document.

NOTE Current approvals continue until their natural expiry, or until October 2016. It is not therefore necessary that a "smart" meter is an "MID Approved" meter.

5.3 Safety recommendations

5.3.1 Gas containment

EN 1359 and EN 14236 include testing for pressure containing parts. At the time of writing, EN 12261 and EN 12480 are in the process of being harmonised to the PED, which will also validate pressure containing parts. EN 1359 and EN 14236 have optional recommendations for pressure containing parts for meters that must remain safe at high ambient temperatures.

5.3.2 Pressure absorption

EN 1359 and EN 14236 have requirements for the pressure absorption of the meter. Pressure at the appliance is very important to safe use of gas, especially where older appliances which may lack flame failure detection, or where flame failure detection sensors and/or valves may fail. Correct operation of valves and their impact on pressure absorption are discussed further in 6.9.2.

NOTE 1 There may be national or international standards that set recommendations for the pressure absorption of meter installations.

NOTE 2 Any valve incorporated within the meter should not cause the pressure absorption to be greater than that required by the appropriate standard while it is open.

5.3.3 Explosive atmospheres and electrical considerations

5.3.3.1 The environment around the meter

If there is a failure of the meter installation, it is possible for there to be an escape of gas. In rare circumstances this can lead to the presence of an explosive atmosphere. Guidance on the risks of explosive atmospheres can be found in EN 60079-10.

Because of this small risk, meters should be designed to minimise the risk of ignition. A level of protection against ignition with respect to the risk should be considered in the design process.

Electrical protection is covered by the EN 60079 series of standards. Protection for non-electrical aspects is covered by the EN 13463 series of standards.

5.3.3.2 The environment within the meter

There has been some discussion about the hazardous area zone that may exist within the meter. While it is being commissioned or decommissioned, explosive mixtures of gas may be present within a meter. The time that these explosive mixtures may be present is very small, in that it typically takes 5 min to purge a meter installation, and in most cases the meter will then stay in situ for many years. Further work is required to establish the level of risk and make further recommendations in this area. In the meantime, meter designers should attempt to minimise the energy and temperatures generated within the gas containing parts of the meter.

5.4 Environmental recommendations, EMC, vibration, temperature and humidity

Meters may be installed in a wide range of environments, and the underlying standard for the basic meter will have requirements for the environments likely to be faced.

Generally, meters with additional functions should meet the requirements for the underlying standard, and should be tested for EMC requirements in accordance with Clause 13 of EN 14236:2007, or 8.5 and 8.6 of EN 12405-1:2005.

NOTE If a field installable add-on unit is only connected by a single electrical multi-core cable, then the environmental requirements in EN 12405 should be considered.

5.5 Battery management

5.5.1 General

The Welmec Software Guide to the MID, 7.2 is one method of compliance with MID with respect to battery management.

Protection of the metrology part may be achieved using single or multiple batteries.

NOTE The life of the battery depends on the environmental conditions, flow rate, and number of operations of external communications devices. It is not therefore possible to determine battery life unambiguously. It is advisable for the meter designer to make a spreadsheet model of battery life for internal use.

5.5.2 Single battery

The battery should support all functions for more than five years.

NOTE Many purchasers will require battery life in excess of ten years.

It should be noted that some functions, for example communications circuits and valves may require an estimate of the use likely to be made, as exact figures are not obtainable. In this situation, the manufacturer should make clear these estimates, and determine measures put in place to protect the metrology in the event that more energy than estimated is used by these extra functions.

After 90 % of battery lifetime, the meter should provide information to the IT system of its condition.

The meter should show an indication that 90 % of the battery lifetime has been used.

Where a battery is intended for replacement in the field, then the meter should be resistant to unauthorised access of the battery. Where the battery is intended to operate for the full life of the meter, then there should be no access to the battery except by disassembly of the meter.

5.5.3 Multiple batteries

Where multiple batteries are used, the battery supporting the metrology should meet the recommendations in 5.5.2.

Any non-metrological batteries ideally also meet the recommendations in 5.5.2. However, in certain circumstances it may be advisable for the energy customer to change the non-metrological battery, and in this situation the access to this battery should be without specialist tools.

5.5.4 Implications of add-on devices (e.g. for communications) for batteries installed in meters

Battery management design in the device should be aware of the power demands that may be placed on the battery for external communications. It is recommended that power be prioritised as the battery nears end of life such that integrity is maintained in the following order of priority:

a) Safety;

b) Metrology;

c) Local datalogging and calculations;

d) Communications and valve operations.

NOTE The priorities here may differ slightly from those in the Welmec Software Guide, 7.2. This is because there is a possibility that a valve may present a hazard should the processor fail or power fail during the operation. Therefore safety is the highest priority.

5.5.5 Battery compartment

The battery should be integral with the meter.

The battery compartment(s) should be designed such that the battery is chemically isolated from the meter case.

If it is intended that the battery can be changed, then:

- the battery compartment, or compartments should be separate from any of the index circuitry, except for the wiring from the battery to the electronic index;
- the time to change the battery should be less than 5 min;
- the battery compartment(s) should be so designed that the battery can be replaced by authorized personnel without having to remove the meter from standard installations with access only to the aspect of the meter with the display visible;
- the battery compartment(s) should be capable of being sealed such that unauthorized interference is detectable, and such that the metrological authority seal should not be broken when replacing the battery;
- the battery compartment(s) should be fitted with a socket having a polarizing slot, or should be clearly marked to show the correct battery polarity (or polarities) for replacement purposes.

5.6 Battery powered electronic indexes

5.6.1 General

There are three possible scenarios for electronic displays on gas meters:

- electronic index with all functionality;
- mechanical index with electronic secondary display;
- electronic index with secondary display.

The recommendations below focus on a single electronic index giving both metrological and non-metrological information. The recommendations below may be appropriate for metrological only and non-metrological only displays but should be considered in the context of their use.

5.6.2 Recommendations

5.6.2.1 General

This section specifies recommendations and tests for meters provided with an electronic index assembly as the official indication of the volume or mass of gas passed by the meter. This display may also present additional information – defined as "preliminary energy consumption and time of use information".

5.6.2.2 Mechanical construction of the Electronic Index Assembly

5.6.2.2.1 Protection against penetration of dust and water

The meter should be tested using the method in EN 60529:1991 for IP54. During and after exposure to the IP54 test, the electronics should continue to function normally. The meter should not be subject to flow of gas during the test.

Procedure:

a) cap the gas inlet and outlet of the meter to prevent flow and ingress, and record the metrological register value(s);

b) expose meter to the EN 60529:1991 test. Inspect the register value(s) once during the test;

c) after the test is complete, inspect the register value(s);

d) after 24 h and one week at normal lab conditions, inspect the register value(s).

The test is passed if there is no change in the metrological value(s) on the display and within the electronic memory.

NOTE The EN 60529 test requires no ingress. This report does not recommend no ingress, it just states that the meter continue to function during the test and in the medium term.

5.6.2.2.2 Relative humidity

In the case of an ultrasonic meter, no further test is required other than that in 6.8.2 of EN 14236:2007.

For other meter types:

a) test the meter in accordance with EN 1359:1998, 5.1.2, c);

b) test the index for the effects of high relative humidity in accordance with EN 60068-2-30, under the following conditions:

   1) upper ambient temperature of (55 ± 2) °C;

   2) with no special precautions regarding the removal of surface moisture;

   3) a duration of test of two cycles;

c) on completion of this test, leave the meter in normal laboratory conditions for 24 h after which, whilst still at normal laboratory conditions, re-test the meter in accordance with EN 1359:1998, 5.1.2, c).

The meter errors should remain within the initial maximum permissible error limits specified in Table 2 of EN 1359:1998, and any markings on the meter should remain legible.

5.6.2.2.3 Resistance to storage temperature

The meter should be tested in accordance with the storage temperature test for the appropriate meter, for example EN 1359:1998, 6.4; EN 14236:2007, 6.10.

5.6.2.3 Electrical and electronic construction

5.6.2.3.1 Electrical

The meter may be designed for use in Zone 2 hazardous areas as defined in EN 60079-10:2003.

NOTE 1 Purchaser's recommendations may suggest different levels of approval are necessary.

NOTE 2 Where a meter is to be fitted with a wired "M-Bus" interface in accordance with EN 13757-2, there may be a conflict with this recommendation due to voltage and current levels, and therefore category 3 approval, required for Zone 2 use, may not be achievable.

NOTE 3 It may be desirable to omit the markings that demonstrate hazardous area compatibility from the meter. National and customer recommendations should be respected in this regard.

5.6.2.3.2 Electronics

NOTE These recommendations are drawn from EN 14236:2007. Therefore meters already approved to that standard will meet the recommendations in 5.6.2.3.2 by default.

Non volatile memory should meet 8.4 of EN 14236:2007.

Recording and storage of information should meet 8.1 of EN 14236:2007.

If the display is of the segmental or starburst type, then it should meet 8.3 of EN 14236:2007.

It is not necessary for the display always to be active, even if it is the metrological display. If the display is not always active, there should be a method of activating the supply without a tool. When the display is activated, it should stay active for a minimum of 30 s after last activation.

Where a display is segmental or starburst type, a display test mode with all segments on, all segments off is recommended.

The display should meet 8.5 of EN 14236:2007.

5.6.2.4 Performance

5.6.2.4.1 Voltage interruptions

When the voltage is disconnected for 6 h and restored, the meter should not have suffered degradation of its metrological characteristics. Ultrasonic meters should be tested in accordance with 12.2 of EN 14236:2007. Diaphragm or other meters should be tested as follows:

a) if possible, the meter calibration factor(s) within the electronics should be read out and recorded. If the calibration factor(s) is not accessible, then the meter should be tested in accordance with 5.1.2, c) of EN 1359:1998;

b) the battery should be disconnected for a minimum of 1 h, and then re-connected;

c) if possible, the meter calibration factor(s) should be read out and compared with the recorded values. If the calibration factor(s) are not accessible then the meter should be re-tested in accordance with 5.1.2, c) of EN 1359:1998.

If the meter calibration factor(s) are accessible, then they should remain unchanged. Otherwise the error of indication should remain within the initial MPE limits specified in Table 2 of EN 1359:1998 and each test point should have changed by less than 1/3 of MPE.

The index should be able to show the last correct indication after restoration of power following an 18 month power failure. This is demonstrated by compliance with 8.1 of EN 14236:2007.

5.6.2.4.2 Reading performance of the index

The meter index should be capable of accepting the total number of signals from the sensor(s), expected over the normal working life of the meter, without causing any significant error in the memory or display. Specifically, the meter should be able to record and display index values generated by 8 000 h of operation at Q_{max}.

The volume stored in memory should be identical to the volume displayed, but may have higher resolution.

The meter index should have sufficient resolution to allow for the meter to be tested in a reasonable time, see 6.3.2 for more information. This will usually be determined according to the appropriate European Standard for the meter.

The meter should bear the necessary inscriptions as required by the appropriate European Standard for the meter.

6 Additional Functions

6.1 General

Because there are so many potential combinations of functions that can apply to gas meters, it is clear that these functions are optional. This clause tries to set out where there are existing standards and practice that are already standardised and can be adopted for pan-European use.

6.2 Pulse output

The pulse output will either be provided via a connector or a fixed lead. Meters should be marked with the detail of making a connection to the pulse output unless there are only two poles on the connector or a fixed two-core cable is provided. If the pulse output is sensitive to the polarity of the attached equipment, this should be marked on the meter.

Most pulse outputs are in the form of a switch that opens and closes to provide the pulse.

NOTE 1 When installing equipment, care should be taken to respect the voltage and current conditions required by the manufacturer when making a connection to a pulse output.

In addition to a pulse, it is possible that there are other circuits present that are available through the connector/lead. These may include:

— tamper circuits;

— spare pulse outputs;

— high frequency pulse outputs; and/or

— other sensors.

Pulse outputs directly from meters tend to be generated in real time. However, pulses generated by other equipment, for example volume converters, can be provided in bursts. Bursts of pulses can cause apparent errors in comparison of information at the meter index and other datalogging equipment, see 6.3.2 below.

Pulse connections are generally capable of operating with 12 V terminal voltage when open circuit, and 10 mA when closed circuit. High voltages and currents can create arcs when mechanical switches are used, and these arcs will damage the switch over time. Most meters make available pulse outputs with maximum frequencies below 2 Hz. Care should be taken in the design of dataloggers to allow for variations of the duty cycle of the pulse over a range of values, and that a meter with no flow may have the switch closed for a long period of time.

NOTE 2 There are a number of European Standards in the EN 60079 series which cover all aspects of hazardous areas and suitable equipment. If the meter is installed in a hazardous area, then consideration should be given to the type of equipment to be used to connect to the pulse outputs. As most pulse outputs are a simple switch, they may, under certain circumstances, be treated as "simple apparatus" which simplifies the steps necessary in the design and implementation of a connection. Further information may be sought from national standards and professional bodies.

A number of connectors are in service for meters, with a number of different connection configurations. These have been dictated by national recommendations in the past, and there are differences between the recommendations for domestic and commercial meters, and meters with fixed or interchangeable pulse modules.

It should be possible to make the electrical connection to the meter without a specialized tool.

The electrical connection, once made, should have a feature to prevent accidental disconnection. This can take the form of a method of sealing the connector, or a "ratchet" arrangement.

Where an electronic register is secondary to a mechanical metrological register, it should be better than 99,98 % accurate. This should be established by testing over a range of flow rates, temperatures, humidities, and vibration conditions. If there is a likelihood of a time delay in the update of the electronic register, then this time delay should be considered in the test design.

6.3 Data recommendations

6.3.1 General

There are standards in place that cover meter object identification and IT methods and procedures, for example the EN 13757 series of documents. At the time of writing, EN 13757-1 is being updated by DLMS UA to provide control of smart meter functions.

A smart meter specification should contain a definition of a minimum data set. A minimum data set is defined in EN 13757-1 but does not include enough data for valve control. Further work is needed to define a more suitable minimum data set for smart meters.

It is anticipated that further co-operation on communications will help clarify data recommendations further.

6.3.2 Volume/mass

Either index values or consumption should be recorded. The direct measurement to be recorded will be either:

— Unconverted m^3;

— Volume at base conditions, m^3

— Temperature converted m^3;

— kg.

Register resolution should be as determined in EN 1359, EN 14236, EN 14280 or EN 12261 for volume as appropriate.

NOTE Register can be taken as the display, index or indicating device as appropriate to the specific standard.

For meters according to EN 1359, but with an electronic index, the resolution should be:

— 1 dm³ for meters with Q_{max} up to 10 m³/h inclusive;

— 10 dm³ for meters with Q_{max} 16 m³/h to 100 m³/h inclusive;

— 100 dm³ for meters with Q_{max} 160 m³/h.

There is currently no recommendation for the resolution of meters registering kilograms.

6.3.3 Time

6.3.3.1 General

A real time clock is required for time of use logging or tariff calculations in the meter.

It is recommended to log data based on UTC, but show information to the consumer in local time.

NOTE In metering systems each device needs to know the time basis of the whole system to do its own tasks effectively; for example, if a meter has a certain tariff scheme implemented then it is important that the tariff definitions downloaded from the head end system to the meter use the same time base as the meter. If in this case the time system applied differs between meter and head end the whole tariff scheme would be inconsistent and not traceable for the user.

Communication modules and systems often use a time synchronisation on a well defined time basis. For example, the Zigbee Smart Energy Profile Specification (5.11.1.1 ZCL Time Cluster and Time Synchronization) makes the following statement on using UTC:

> "The Smart Energy profile requires time synchronization between devices to properly support the coordination of Demand Response/Load Control events, price changes, and the collection of metered data. In order to simplify the understanding of time, the Smart Energy profile will leverage UTC as the common time base."

The tolerance of the clock will depend on whether real-time communications are available. The method of achievement of clock accuracy will depend on the necessary accuracy and the technology available in the meter. These include high accuracy local clocks, lower accuracy clocks controlled through the AMR system, or clocks controlled by radio time signals.

6.3.3.2 Datalogger time interval accuracy

A number of influences affect the accuracy of time at the meter:

a) Quality of clock design, including temperature range of clock

The design of the clock requires careful thought. If the clock is not reset more than once per month, then the performance of the clock should be checked at a number of temperatures. The table below indicates performance of the clock in PPM, percentage, and a range of other values.

Table 2 — Clock accuracy

ppm	%	s/day	s/week	s/month	min/week	min/month	min/year
10 000	1,000 000 %	864,000	6 048,000	26 784,000	100,800	446,400	5 259,600
5 000	0,500 000 %	432,000	3 024,000	13 392,000	50,400	223,200	2 629,800
2 000	0,200 000 %	172,800	1 209,600	5 356,800	20,160	89,280	1 051,920
1 000	0,100 000 %	86,400	604,800	2 678,400	10,080	44,640	525,960
500	0,050 000 %	43,200	302,400	1 339,200	5,040	22,320	262,980
200	0,020 000 %	17,280	120,960	535,680	2,016	8,928	105,192
100	0,010 000 %	8,640	60,480	267,840	1,008	4,464	52,596
50	0,005 000 %	4,320	30,240	133,920	0,504	2,232	26,298
20	0,002 000 %	1,728	12,096	53,568	0,202	0,893	10,519
10	0,001 000 %	0,864	6,048	26,784	0,101	0,446	5,260
5	0,000 500 %	0,432	3,024	13,392	0,050	0,223	2,630
2	0,000 200 %	0,173	1,210	5,357	0,020	0,089	1,052
1	0,000 100 %	0,086	0,605	2,678	0,010	0,045	0,526

b) Sophistication of communications channel

Resetting a clock is, by definition, a "real time" operation. It is often achieved by giving advance notice of a time, then transmitting a synchronising (pulse) signal. If a true real time connection is not made, for example where GPRS or similar is used, then complete precision is not attainable. It is possible, however, to determine the uncertainty of the clock in asynchronous systems by sending an instruction to update the clock, then waiting for an acknowledgement.

NOTE The uncertainty at the point of setting is the difference in the real time between transmission of the command and reception of the acknowledgement.

c) Regularity of communications

As the error in the current time on the device is governed by the uncertainty of the original setting combined with the drift, regularity of communications to update the clock and the error of the clock are closely associated.

In summary, the table below allows comparison of clock accuracy, required real time uncertainty, and time between updates. It does not compensate for the uncertainty in the clock setting procedure.

Table 3 — Time between clock adjustments

local clock accuracy		Permitted Uncertainty of real time clock							
ppm	%	10s	30s	1min	3min	10 min	30 min	1hr	3hrs
10000	1.000000%	0.01 days	0.03 days	0.07 days	0.21 days	0.69 days	2.08 days	4.17 days	12.50 days
5000	0.500000%	0.02 days	0.07 days	0.14 days	0.42 days	1.39 days	4.17 days	8.33 days	25.00 days
2000	0.200000%	0.06 days	0.17 days	0.35 days	1.04 days	3.47 days	10.42 days	20.83 days	62.50 days
1000	0.100000%	0.12 days	0.35 days	0.69 days	2.08 days	6.94 days	20.83 days	41.67 days	125.00 days
500	0.050000%	0.23 days	0.69 days	1.39 days	4.17 days	13.89 days	41.67 days	83.33 days	250.00 days
200	0.020000%	0.58 days	1.74 days	3.47 days	10.42 days	34.72 days	104.17 days	208.33 days	625.00 days
100	0.010000%	1.16 days	3.47 days	6.94 days	20.83 days	69.44 days	208.33 days	416.67 days	1250.00 days
50	0.005000%	2.31 days	6.94 days	13.89 days	41.67 days	138.89 days	416.67 days	833.33 days	2500.00 days
20	0.002000%	5.79 days	17.36 days	34.72 days	104.17 days	347.22 days	1041.67 days	2083.33 days	6250.00 days
10	0.001000%	11.57 days	34.72 days	69.44 days	208.33 days	694.44 days	2083.33 days	4166.67 days	12500.00 days
5	0.000500%	23.15 days	69.44 days	138.89 days	416.67 days	1388.89 days	4166.67 days	8333.33 days	25000.00 days
2	0.000200%	57.87 days	173.61 days	347.22 days	1041.67 days	3472.22 days	10416.67 days	20833.33 days	62500.00 days
1	0.000100%	115.74 days	347.22 days	694.44 days	2083.33 days	6944.44 days	20833.33 days	41666.67 days	125000.00 days

NOTE WELMEC WG11 is drafting a document at the moment that recommends that the accuracy of the time interval for dataloggers should be better than 1 %.

6.3.4 Temperature

A number of standards, specifically, EN 12405, EN 1359, and EN 14236 provide information about the accuracy of temperature measurement required and achievable in metering. It should be noted that sensor technologies should be chosen that will have very long term stability, to ensure that accuracies are maintained over the life of the meter. It is possible that a fixed factor for temperature can be supplied from the host system.

6.3.5 Pressure

EN 12405 provides information about the accuracy of pressure measurement required and achievable in metering. It should be noted that sensor technologies should be chosen that will have very long term stability, to ensure that accuracies are maintained over the life of the meter, and it is likely that the cost of such sensors may be prohibitive. It is possible that a fixed factor for pressure can be supplied from the host system.

6.3.6 Compressibility factor, Z

EN 12405 provides information about the accuracy of compressibility factor calculation required and achievable in metering. Compressibility is unlikely of interest where the meter is measuring at low pressures. It is possible that a fixed factor for compressibility can be supplied from the host system.

6.3.7 Calorific Value

Determination of Calorific Value is often governed by national legislation on billing. See 7.3 on energy calculation for more information. This data item will normally be supplied from the IT system.

NOTE CV for volume meters is usually expressed in megajoules per cubic metre (MJ/m³) or kilowatt hours per cubic metre (kWh/m³), and for mass meters CV is expressed in kilojoules per kilogram (kJ/kg) or kilowatt hours per kilogram (kWh/kg).

6.3.8 Logging

Data that is logged has to be accessed. There is much information in EN 13757-1 on this topic.

Datalogging should be over configurable time periods, unless this is under metrological control. There should be enough memory to store 10 000 readings.

Data should be time stamped. It is recommended that the time stamp within the logger use UTC.

Data should be retained in the event of battery failure

Consideration of time shifting of burst data[7)] should be made – data status can be recorded if this is an issue. Consideration of the time shift in proportion to the logging interval should be made. Users of the data should be made aware that this is a limitation of the technology.

Consideration of the affect of daylight savings time should be given. Datalogging on the basis of "Gas Metering Day" can cause issues with changes to daylight savings time, in that a gas metering day length of 23 h or 25 h occurs.

Consideration should be given to event logging. Events like CV changes, tariff changes, etc. can affect logging operations. The potential solutions are to record these events at the end of a logging interval, or to make an event log of the core data when an event occurs, along with details of the event that caused the event log to be created.

6.4 Firmware upgrade

The recommendations of the WELMEC software guide 7.2 should be followed if firmware upgrade is to be made when the meter is installed. Additionally, special consideration of the control of the valve should be made during the firmware upgrade process.

6.5 Energy calculation within the meter

6.5.1 General

This clause assumes that the meter does have all the factors for calculation of energy in real time. A large metering installation may have local sensors that are accessible in real time. This is covered in prEN 12405-2 in detail.

NOTE For gas meters, measurement results are normally expressed in cubic metres (m^3) or kilograms (kg).

A major consideration in the calculation of energy is whether it will only be carried out at the meter, or whether it will be carried out elsewhere for the purposes of billing.

Calorific value of gas in the network varies as a result of gas from differing sources being injected. This gas will take time to travel through the network, depending on the level of demand for gas. The time the gas takes to travel from the measurement location to the customer meter may also have a bearing on the validity of the Calorific Value being applied for a specific time period.

Determination of Calorific Value therefore needs to be carefully considered. Some current practice is based on frequent measurement of Calorific Value and flow rate into a specific part of a network, and aggregating these calorific values and flows to give a typical value for a given time period. Because this is an aggregate figure, it is expected that some customers may have received gas with differing values of CV. The time required to determine the aggregate values across a specific part of a network mean that this data cannot be "real time".

6.5.2 Calculation of energy as an approximation for the invoice

Where the meter displays approximate energy, there is risk that the information on the meter will not reflect the actual invoice, unless methods are put in place that ensure that the meter recalculates its approximation as gas condition data (including CV, pressure, and temperature as appropriate) becomes available. There is a strong chance that energy supply companies will receive calls from energy users unhappy that the invoice does not exactly match the values displayed by the meter. As the same meter will be displaying metrological information (the index value) and approximate information of energy consumption, consideration of the customers confidence in the validity of the meter should be made.

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7) Burst data may be generated at the pulse outputs of electronic indexes and volume converters. To save power, electronic devices will only wish to switch on output circuits infrequently. Therefore, rather than emit a pulse as soon as one should be generated, the output circuit will only be switched on infrequently, and then a burst of pulses is transmitted.

6.5.3 Calculation of energy as part of the invoicing process

Where the meter calculates the energy used for billing, there will not be a discrepancy between the energy information provided by the meter and the invoice, as the calculation is only performed once. However, this will mean that the meter will have to be able to respond to national methods of calculation of energy, and that there is a mechanism either to show that this calculation is always done in a systematic way, or that the datalogger records the calculation data so that the calculation can be repeated and verified for control purposes.

6.5.4 Meters that record in volume units

Volume conversion functions are covered in EN 12405-1. Most volume conversions for domestic applications are conducted with fixed values. Temperature compensated meters are covered in EN 1359, and their use may require different fixed values from an uncompensated meter, unless the base temperature for energy determination is the same as the base temperature of the meter.

Calculation from converted volume to energy is a simple multiplication, but it must be confirmed that the base values used for the volume conversion are the same as those for determining the calorific value.

If the data is not supplied to the calculator in real time, then retrospective calculation may be considered, as incoming parameters (CV, temperature, pressure, etc.) may be delayed.

Calculations for energy vary from country to country. CEN/TC 237/WG 4 is preparing work on Energy Conversion devices as EN 12405-2.

6.5.5 Meters that record in mass units

These are currently not widely used, and may be a potential area for future work.

6.6 Tariff Operations

Tariffs for gas can consist of any combination of a number of elements. Tariffs for gas always cover the price of the gas used which may include transportation and/or metering charges as elements of the tariff or they may be charged separately. Tariff constructions in regular use include:

— standing or capacity charges. A periodic charge of a fixed monetary amount. This may be related to meter Q_{max};

— simple consumption. A fixed charge per unit of volume/energy;

— block tariff. Consumption is charged at different prices depending on the gas used within a billing period.

Other constructions may include:

— flowrate or consumption tariff. Consumption is charged at different prices depending on the flowrate in a time window or peak flow;

— time-of-use tariff. Consumption is charged based on time of day/day of week. Time-of-use tariffs may require more precise real time clocks.

Electronic prepayment meters may be able to operate tariffs based on this list. Additionally, prepayment meters have a notion of available funds which are reduced according to the tariff. Prepayment meters may also have the ability to reduce the available funds to recover a debt owed to the energy supplier. When available funds are zero then the valve of the prepayment meter is likely to close, though some meters have functions to allow gas to continue to flow in these situations.

EN 13757-1 has much information on tariff data management, and recent updates to the DLMS Blue book are also helpful in this area.

If tariffs are applied on the meter as the primary method of creating financial information in the bill, then the meter should store sufficient data to allow the calculation to be duplicated should there be a challenge to the bill.

Tariff information supplied to the meter will need to be updated via the two way communications system. A method should be agreed between the energy supplier and the host system to transmit this data to the meter. To avoid large volumes of data being transmitted simultaneously, it is expected that some method of providing a tariff in advance with an activation time and date should be provided.

6.7 Display/human interface

There are limited recommendations of the basic functions of a display covered in EN 14236 and EN 12405-1.

5.6 of this document is a useful reference of technical considerations.

The WELMEC Software guide 7.2 provides advice if the display is the metrological register.

Selection of values to be displayed should be made without need for a tool.

Consideration of people with poor vision should be made. If practical, a font no smaller than Arial 14 point should be used.

Backlights can assist in some installation locations. However, they have a distinct and uncertain impact on battery life which should be considered in the design process.

The display may also provide information on the actual time of use of energy. Calculation of energy is covered in 6.5.

NOTE 1 The provision of information about the volume or mass of gas used is likely to be a suitable alternative to calculated estimates of the time of use of energy.

NOTE 2 Presentation of time of use information where gas is concerned may lead to some confusion, as a number of environmental variables will significantly affect consumption on a day to day basis, making it difficult to interpret customer action and effect. For example, the customer may see that energy consumption increases after reducing the room thermostat setting if the external temperature drops.

6.8 Communications

NOTE Communications for gas, water and heat meters are outside the scope of CEN/TC 237 and is covered by CEN/TC 294. CEN/TC 294 has issued the EN 13757 series of standards which provide a number of protocols and transport layers for meter communications for gas, water and heat meters. These standards are being updated for wider smart implementations. Other communication systems are being investigated, and more work will be needed for these to be brought into European Standards. Data security and privacy is an area where significant future work will be required, especially for valve control and/or deregulated markets. In any case, meters should have individual protection system for data security.

6.8.1 To devices in home

At the time of writing, there is little technology designed to receive information from gas meters. The exception is the Home Display Unit, or In-Home Display. It is unlikely that the gas meter will be used to switch gas appliances on or off, therefore communication between gas appliances and gas meters is unlikely. Communication to a home personal computer is much more likely. This may have an effect on the lifetime of the battery and the integrity of the meter. Measures should be taken to ensure the meter is not influenced by the connection to it of any additional devices. Communication may take place with wired or wireless communication. For wired connections, standardization of the connection is required. Options that may be considered include powered or non-powered connection and galvanic separation.

6.8.2 To host systems

There are a number of potential network architectures for smart meters to communicate with host systems. The four most likely are:

- Gas Meter <-> Home Multi-utility Communications Device[8)] <- > Host System;
- Gas Meter <-> Multi-residence Data Concentrator <-> Host System;
- Gas Meter <-> Electricity Meter <- > Host System;
- Gas Meter <-> Dedicated Communications Device <–> Host System.

The "<->" are likely to be bi-directional, and represent a number of possible data transports, for example, wire, point-to-point dedicated radio, mesh dedicated radio, PSTN, ISDN, GPRS, SMS, depending on the circumstances of the installation, and the required data reliability and rate.

6.9 Valve

6.9.1 General

The remote disconnection of a gas supply may be required for commercial reasons (non-payment of bill, pre-payment operation, change of occupancy), for the management of network events, or for environmental reasons (high temperature, earthquake).

The method of instructing a valve to close and cut off a gas supply should be very secure to prevent IT errors or hackers operating the valves on many meters.

A smart gas meter capable of this function will include a valve which can be remotely closed.

There is significant risk in remotely opening a valve and hence re-establishing a gas supply if this could lead to an uncontrolled escape of gas.

A smart meter valve that meets the recommendations below is not an isolation valve.

NOTE An isolation valve provides complete gas shut off.

A smart meter valve is not to be formally regarded as a thermal or safety shut off valve even if the meter closes the valve at specified temperatures or in case of abnormal conditions.

6.9.2 Valve design recommendations

6.9.2.1 General

The valve recommendations are intended to be appropriate for a valve for controlling supply of gas.

6.9.2.2 Recommendation for safe opening and closing

There is significant risk in remotely opening a valve and hence re-establishing a gas supply if this could lead to an uncontrolled release of gas. The valve opening function must therefore either:

a) incorporate a check for an uncontrolled release of gas which if present leads to the automatic re-closure of the valve; or

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8) It is possible that this device is also a home display of energy, and provides other data gateway services, for example; internet, appliance control, fire and intruder alarm systems.

b) require the presence of a person who enables the valve to open and is instructed to prevent an uncontrolled escape of gas; or

c) both a) and b).

The selection from these options is a matter for national industries to discuss and agree.

6.9.2.3 Hazardous areas

The elements of the valve within the gas-containing parts of the meter should be compatible with EN 60079-10. See also 5.3.3.2.

6.9.2.4 Design quality

The manufacturer should document a report that demonstrates that the risks associated with operation of the valve are as low as reasonably practicable.

NOTE 1 A method that can be used to document compliance is to use EN 13849 and EN 61508 (all parts) to determine a Safety Integrity Level (SIL), and show that the meter design achieves the level determined.

NOTE 2 The manufacturer should document a Failure Modes, Effects, and Controls Analysis. This should consider unexpected opening of the valve, and the possibility of a valve open or close process leaving the valve in a partially open condition.

6.9.2.5 Recommended type test plan

A recommended test plan is given in Annex C.

6.10 Fraud prevention

Fraud and tampering of meters is an inevitable consequence of metering. Fraud attempts can vary in complexity, and fall into two categories, that is attack on the meter in situ, or arranging flow of gas that bypasses the meter. It is very difficult to detect a bypass, except by monitoring meter data over a period of years to establish customer behaviour, and taking investigative action if there is a significant change in the consumption of gas. Fraud also takes place in non-domestic consumption of gas.

NOTE 1 Attempted fraud is dangerous, and is responsible for a number of gas fires and explosions each year.

The required level of resistance of a meter to fraud will depend on the functionality within the meter. Meters with valves used for prepayment require the highest levels of resistance. Meters which calculate the values for the bill will also require high levels of resistance.

It can be helpful to prepare a fraud analysis for a meter that records types of potential frauds, and the meters response.

Where a potential point of fraud attempt on the meter is identified, the response by the meter can take a number of forms. A meter with a valve may isolate supply when an attack is detected and should log the attack and report it to the host system where possible.

The meter should be designed such that fraud attempts that cannot be detected by the electronics leave clear physical indications on the meter that an attempt has taken place.

NOTE 2 The record by a meter that a tamper has taken place is unlikely by itself to satisfy a burden of proof for a prosecution.

Annex A
(informative)

Regulatory & Legislative framework

A.1 European Directives

European Directives are transposed into national laws. A primary aim of directives is to achieve free circulation of goods within the EEA. They are a method for European lawmakers to direct Member States to legislate in a consistent way. Thus, a directive should ensure consistency with the national laws in all Member States. While this sounds comparatively straightforward, anomalies arising from the recommendation for exact translations do occur.

A.2 Measuring Instruments Directive, 2004/22/EC ("MID")

The Measuring Instruments Directive ("DIRECTIVE 2004/22/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 31 March 2004 on measuring instruments") governs a number of types of measurement instruments including Gas Meters and Gas Volume Conversion Devices. All new meter approvals since October 2006 have been made with respect to the MID, and all pre-existing approvals under Member State national law or the previous European Directive, 71/318/EC will have ceased to have effect in October 2016. Meters may continue in service beyond this date to the end of their natural service lives. CEN standards for gas meters have been harmonised to the MID, and OIML is preparing normative documents. WELMEC has working groups that are preparing guidelines to assist in the interpretation of the Directive. The MID allows for additional functions, and is technology independent.

Section 10 of Annex 1, essential recommendations is included below.

Sections 10.2 and 10.5 are of most relevance to gas meters.

> *"10.* ***Indication of result***
>
> *10.1. Indication of the result should be by means of a display or hard copy.*
>
> *10.2. The indication of any result should be clear and unambiguous and accompanied by such marks and inscriptions necessary to inform the user of the significance of the result. Easy reading of the presented result should be permitted under normal conditions of use. Additional indications may be shown provided they cannot be confused with the metrologically controlled indications.*
>
> *10.3. In the case of hard copy the print or record should also be easily legible and non-erasable.*
>
> *10.4. A measuring instrument for direct sales trading transactions should be designed to present the measurement result to both parties in the transaction when installed as intended. When critical in case of direct sales, any ticket provided to the consumer by an ancillary device not complying with the appropriate requirements of this Directive should bear an appropriate restrictive information.*
>
> *10.5. Whether or not a measuring instrument intended for utility measurement purposes can be remotely read it should in any case be fitted with a metrologically controlled display accessible without tools to the consumer. The reading of this display is the measurement result that serves as the basis for the price to pay."*

A.3 Energy End-Use Efficiency and Energy Services Directive, 2006/32/EC ("ESCO")

For the purposes of this document, the clause of most relevance for smart gas meters is Article 13, which is reproduced below.

> *"Metering and informative billing of energy consumption*
>
> *1. Member States should ensure that, insofar as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use.*
>
> *When an existing meter is replaced, such competitively priced individual meters should always be provided, unless this is technically impossible or not cost-effective in relation to the estimated potential savings in the long term.*
>
> *When a new connection is made in a new building or a building undergoes major renovations, as set out in Directive 2002/91/EC, such competitively priced individual meters should always be provided.*
>
> *2. Member States should ensure that, where appropriate, billing performed by energy distributors, distribution system operators and retail energy sales companies is based on actual energy consumption, and is presented in clear and understandable terms. Appropriate information should be made available with the bill to provide final customers with a comprehensive account of current energy costs. Billing on the basis of actual consumption should be performed frequently enough to enable customers to regulate their own energy consumption.*
>
> *3. Member States should ensure that, where appropriate, the following information is made available to final customers in clear and understandable terms by energy distributors, distribution system operators or retail energy sales companies in or with their bills, contracts, transactions, and/or receipts at distribution stations:*
>
> *(a) current actual prices and actual consumption of energy;*
>
> *(b) comparisons of the final customer's current energy consumption with consumption for the same period in the previous year, preferably in graphic form;*
>
> *(c) wherever possible and useful, comparisons with an average normalised or benchmarked user of energy in the same user category;*
>
> *(d) contact information for consumers' organisations, energy agencies or similar bodies, including website addresses, from which information may be obtained on available energy efficien10cy improvement measures, comparative end-user profiles and/or objective technical specifications for energy-using equipment."*

This is a major driver to the provision of "smart meters" to energy users across Europe over the next several years, in that it requires consumers to be provided with time of use information, energy suppliers to provide "frequent" bills; and it requires them to provide comparative information on their consumption for the same period in the previous year. It should be noted that it is not completely clear that this requires a meter with additional functions.

A.4 "AtEx" Directives

The AtEx Directives 94/9/EC and 99/92/EC apply to non-domestic installations. The two directives govern workplace safety with respect to the presence of explosive atmospheres and equipment to be used in such environments.

AtEx covers many potential causes of ignition, not just electrical. Electrical protection is covered by the EN 60079 series of standards. Protection for non-electrical aspects is covered by the EN 13463 series of standards.

NOTE While a domestic meter in a domestic setting is outside the scope of AtEx, if the same meter is installed in a meter room in an apartment building it may be considered as being in a workplace, and therefore AtEx may apply. Some national standards and recommendations may also influence the recommendations for AtEx approval of meters and other equipment in the metering installation.

A.5 Battery Directive

The European Directive on Batteries "DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC" should be respected where it is relevant to meters. It is likely that there is a recommendation for battery types to be marked on the equipment, and there may be further considerations in the design of equipment, for example that a battery may be easily removed at the end of the life of a meter as part of a recycling process.

A.6 National projects across Europe

In order to implement these directives and to improve their energy system (flexibility, efficiency), many national energy regulators have studied smart metering, first for electricity (load and sourcing management) and recently for gas. Working groups including retailers, operators, final consumers are now trying to define the needs, functions and business model for smart metering. The Netherlands has also defined technical recommendation (NTA 8130), which is approved, but amendments are being discussed. The Italian "Authority for Electrical Energy and Gas" (AEEG) has ratified, by the end of October 2008, a new Act (ARG 155/08) that defines smart gas metering requirements and deployment schedules for the introduction of new metering devices to gas redelivery points. CIG, "Comitato Italiano Gas" is now defining the technical requirements of metering devices which have to be installed for the deployment of the AMM Gas System.

Proof of concept or products – add-on modules or integrated meters – are available in the offer of most of the meter providers.

Some retailers or network operators (Spain, France, UK, Germany) have also experimented or implemented smart metering (AMR), mainly for C&I customers, in order to improve their actual allocation, billing or meter reading operations.

At the time of writing, none of those projects has led to a large deployment (over 5 %) of smart meters for domestic customers.

Annex B
(informative)

Further Work

B.1 Further work in this document

This document is likely to be out-of-date very quickly, and it is likely that some of the changes that may be required have not yet been anticipated. However, there are specific areas where the committee recognises that more work is needed. These are:

a) Provision of ESCO information to the customer;

b) Calculation of energy for billing;

c) Datalogging;

d) Provision of CO_2 and carbon information to customers;

e) Calculation of bills;

f) AtEx within the gas enclosure of the meter.

B.2 Actions that other organisations may wish to consider

This task group have discussed what other parts of a smart meter may fall under metrological control. The current MID speaks only of Volume or Mass for Gas Meters, but there are some views that elapsed time and or real time, essential components of tariff structures, could be considered for control.

It is anticipated that this document will be helpful to those wishing to consider creating communications for smart meters. This task group is keen to work with other standards bodies active in this area, and we suggest that joint working groups between CEN/TC 237, CEN/TC 294, and CENELEC/IEC/TC 13 would be important in ensuring a minimum of duplication in meter communications work.

Annex C
(informative)

Tests – Recommended type test plan

NOTE This test plan has been proposed to test a valve intended to provide temporary disconnection of supply of occupied premises.

C.1 List of tests

The valve should be tested as part of a meter. Ideally, these tests should be made in conjunction with formal testing of the entire meter to the appropriate European Standard. There may, however, be situations where a valve design needs to be tested independently, and the tests below are recommended to be completed in full. Other tests may be proposed.

— Three meters (incorporating valves) should be subjected to C.2. All should pass.

— Meters (incorporating valves) required by the MID-compliant test plan should be subjected to C.3 and should pass.

— One meter (incorporating a valve) should be subjected to C.4 and should pass.

— One meter (incorporating a valve) should be subjected to C.5 and should pass.

— One meter (incorporating a valve) should be subjected to C.6 and should pass.

If, after testing one meter in accordance with C.4, one meter in accordance with C.5 and one meter in accordance with C.6, the meters are found to comply with the recommendations of those subclauses, the meters are deemed to be satisfactory.

C.2 Endurance test

The meter should be tested in accordance with C.7. The meter may then be filled with gas or air at the manufacturer's discretion. The valve within the meter should then be opened and closed a minimum of:

a) 200 cycles at test room temperature;

b) 200 cycles at the minimum temperature of the meter;

c) 1 200 cycles at test room temperature;

d) 200 cycles at maximum temperature of the meter; and

e) 200 cycles at test room temperature.

After each step, the meter should pass the tests in C.7.

C.3 Environmental Tests

The meter should be tested with a valve following a test plan for the requirements in the appropriate harmonized standard for the base meter to meet the requirements of sections 1.3 and 1.4.2 of Annex 1 of the MID.

The test method to be used should be the same as that proposed for a meter, except that the test outlined in C.7 should be followed whenever a test of accuracy is to be carried out.

C.4 Toluene/iso-octane test

C.4.1 General

Before carrying out the tests below the meter (incorporating a valve) should pass the test given in C.7.

At the end of Test 1 the meter (incorporating a valve) should pass the test given in C.7.

At the end of Test 2 the meter (incorporating a valve) should pass the test given in C.7.

C.4.2 Test 1

Pass through the meter (incorporating a valve) under test nitrogen to which has been added approximately 3 % by gaseous volume of a 30 % toluene/70 % iso-octane mixture (see C.4.6) for 42 days (1 008 h) at (20 ± 2) °C, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max} of the meter to which the meter is to be fitted.

NOTE It is important that, when removing the meter from the exercise rig in order to check its operation that the ports be sealed, to prevent the ingress of air, until the meter operation is about to be checked.

C.4.3 Test 2

After Test 1, exercise the meter (incorporating a valve) under test with air for a further period of seven days (168 h) at (20 ± 2) °C, (65 ± 10) % relative humidity and a flow rate of not less than 0,25 Q_{max} of the meter on which the meter is to be used. Check the operation of the meter as specified in C.7.

C.4.4 Example of a typical apparatus

Referring to Figure C.1, the apparatus consists of the following components:

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

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

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

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

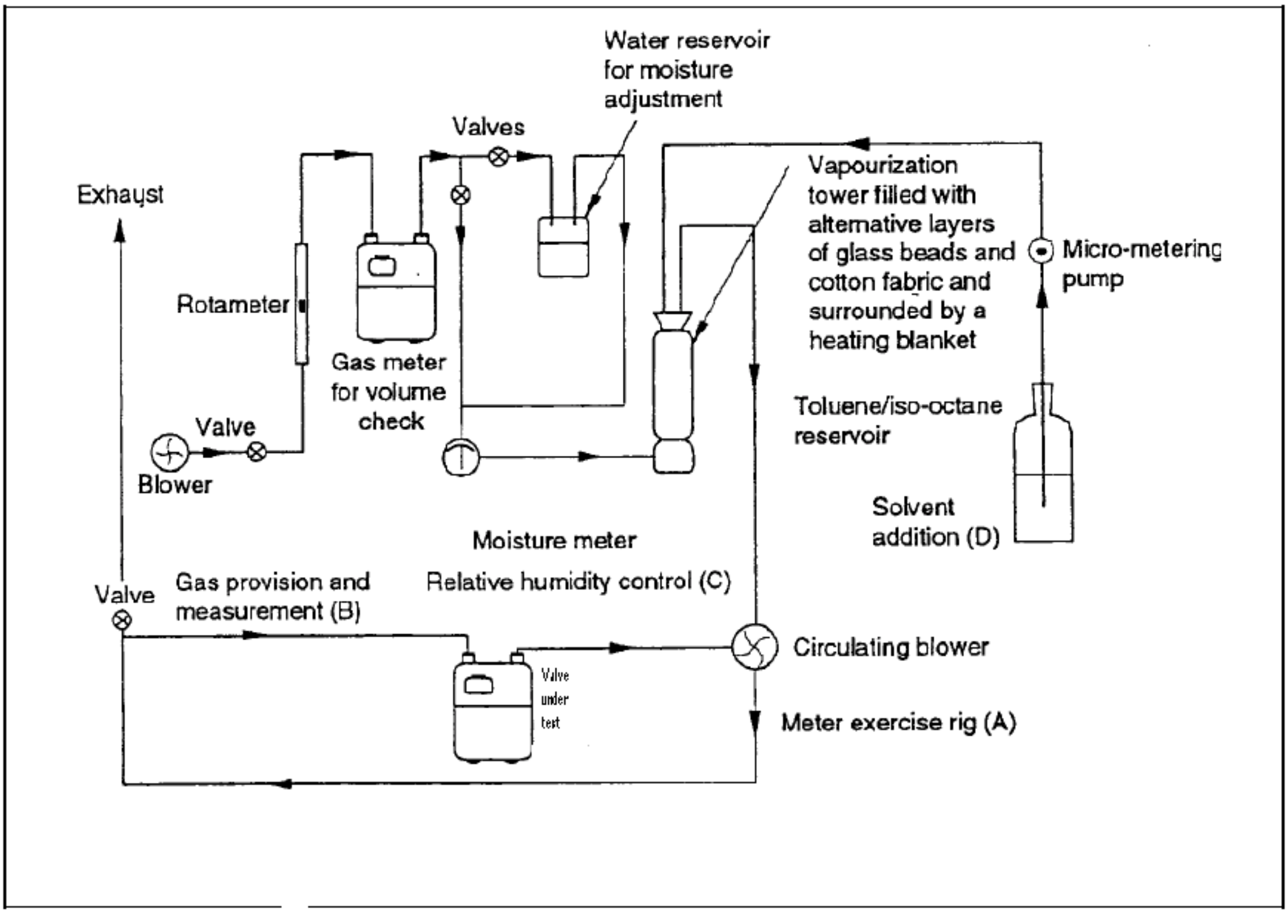

Figure C.1 — Diagram of toluene/iso-octane test apparatus

C.4.5 Procedure

Allow the toluene/iso-octane mixture (see C.4.6) to percolate down the tower and vaporize. Introduce the carrier gas, at a controlled flow rate, through the diffuser at the bottom of the tower where it picks up the vaporized solvent. Pass the gaseous mixture into the exercise rig where it is circulated through the meter under test. A fresh supply of solvent is continuously added to give a stable concentration.

C.4.6 Preparation of a 3 % by volume of a 30 % toluene/70 % iso-octane mixture with nitrogen

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

C.4.7 Calculation

Toluene has a molecular mass of 92,13 and a density of 0,866 94 g/ml.

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

92,13 g equalling 106 ml toluene will occupy 22,4 l at normal temperature and pressure (NTP).

114,23 g equalling 165 ml iso-octane will occupy 22,4 l at normal temperature and pressure (NTP).

A 3 % dosage of 30/70 toluene/iso-octane mixture will therefore require:

— 0,9 % toluene = 95,4 ml toluene per 2 240 l;

— 2,1 % iso-octane = 346,5 ml iso-octane of carrier gas.

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

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

C.5 Water vapour test

Check the operation of the meter (incorporating a valve) in accordance with C.7.

Connect the meter to the water vapour test rig (see Figure C.2).

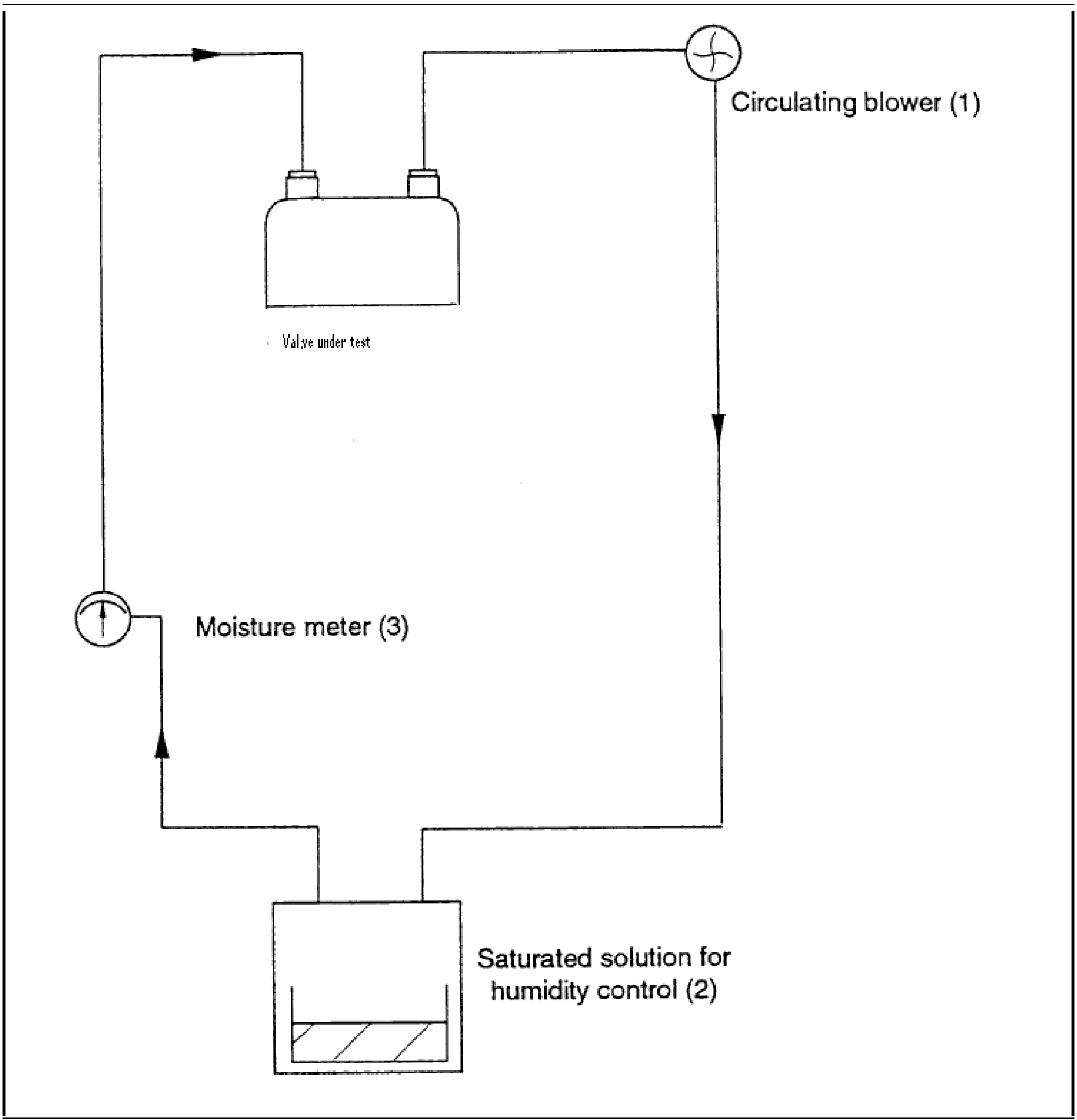

Figure C.2 — Example of a water vapour test apparatus

In Figure C.2, the meter is shown connected to a test rig which consists of a closed circuit containing a suitable circulating pump or blower (1), a chamber containing either a saturated solution of Potassium Acetate (CH3COOK) to give a relative humidity of 20 % at 20 °C, or a saturated solution of Potassium Hydrogen Sulphate (KHSO4) to give a relative humidity of 86 % at 20 °C (2), and a hair or paper hygrometer with a range of 0 % to 100 % relative humidity (3).

Pass air having a relative humidity of less than 20 % through the meter for seven days (168 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max} of the meter on which the meter is to be used. At this point check that the meter passes the test given in C.7.

On completion of this low humidity performance test, pass air having a relative humidity of (85 ± 5) % through the meter for 42 days (1 008 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max} of the meter on which the meter is to be used. At the end of this test check that the meter passes the test given in C.7.

Pass air having a relative humidity of less than 20 % for at least seven days (168 h) at (20 ± 2) °C and a flow rate of not less than 0,25 Q_{max} of the meter on which the meter is to be used. At the end of this test check that the meter passes the test given in C.7.

C.6 Ageing test

Check the operation of the meter (incorporating a valve) in accordance with C.7.

Pass air through the meter at any one of the temperatures given in Table C.1 at a regulated flow rate of between 0,2 Q_{max} and 0,3 Q_{max} of the meter on which the meter is to be used for the appropriate time period given in Table C.1.

The temperature at which the test is to be carried out is declared by the meter manufacturer.

On completion of the test, return the meter to normal laboratory temperature and check the operation of the meter in accordance with C.7.

Table C.1 — Temperature/times ageing periods

Temperature °C	**Time period** days
70 ± 2	50
60 ± 2	100
50 ± 2	200

C.7 Basic performance test procedure

NOTE The basic performance test is used repeatedly within the tests above as a standardised method to test meters containing valves.

The valve should be set to the open position, if it is not already in the open position.

The meter should be tested for tightness in accordance with the external tightness test for the appropriate meter standard, for example 6.2.2 of EN 1359:1998.

If the appropriate meter standard has a recommendation for pressure absorption, then the meter should be tested to the recommendations of that standard, for example 5.2 of EN 1359:1998.

The outlet of the meter should be connected to a throttle that will limit flow through the meter to Q_{max} with 20 mbar at the inlet.

The pressure at the inlet of the meter should be raised to 20 mbar.

The meter is to be instructed to close the valve in the way envisaged in normal operation. The valve should close normally.

The throttle may be removed. The flow rate through the meter should be less than 5 l/h.

The pressure at the inlet of the meter should be raised to the P_{max} of the meter over a period not exceeding 2 min. The flow rate through the meter should be less than 5 l/h.

The pressure at the inlet of the meter should be reduced to 50 mbar. The outlet of the meter should be connected to a throttle that will limit flow through the meter to Q_{max} with 50 mbar at the inlet.

The meter is to be instructed to open the valve in the way envisaged in normal operation. The valve should open normally.

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[3] OIML, R137-1, *Gas Meters — Part 1: Requirements*

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