

BS EN 1776:2015



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Gas infrastructure — Gas measuring systems — Functional requirements

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National foreword

This British Standard is the UK implementation of EN 1776:2015. It supersedes BS EN 1776:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/33/-/5, Gas Measurement (Revision of EN 1776).

A list of organizations represented on this committee can be obtained on request to its secretary.

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Anforderungen

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 1776:2015) has been prepared by Technical Committee CEN/TC 234 “Gas infrastructure”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2016, and conflicting national standards shall be withdrawn at the latest by June 2016.

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 supersedes EN 1776:1998.

This document has been prepared under the mandate M/017 given to CEN by the European Commission and the European Free Trade Association.

This version of the standard comprises a major revision of EN 1776:1998. The scope of the standard is expanded and now includes also gas measuring systems in light industry, commercial as well as residential use. For this purpose the document has been restructured and amended.

This European Standard has in part been developed in response to the work of the European Standards Organisations (CEN/CENELEC/ETSI) under the Commission Mandate M/441. The standard should be read in conjunction with CEN/CLC/ETSI TR 50572, *Functional Reference Architecture for Communications in Smart Metering Systems* and EN 16314, *Gas meters – Additional functionalities* (often referred to as a smart gas meter).

Directive 2009/73/EC concerning common rules for the internal market in natural gas and the related Regulation (EC) No 715/2009 on conditions for access to the natural gas transmission networks also aim at technical safety (security) including technical reliability of the European gas system. These aspects are also in the scope of CEN/TC 234 standardization. In this respect CEN/TC 234 evaluated the indicated EU legislation and amended this technical standard accordingly, where required and appropriate.

This European Standard covers the environmental aspects relevant to the design, construction, operation, and maintenance and commissioning/decommissioning of gas measuring systems, where appropriate, in accordance with CEN Guide 4 and CEN/TR 16388.

In preparing this European Standard, a basic understanding of gas infrastructure by the user has been assumed.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard specifies different classes of measuring systems, each having their own specific requirements.

By nature, a measuring system is an aggregate of several components. In this European Standard, it is assumed that each component is in full compliance with applicable CEN or ISO standards, if any.

This European Standard allows the user to choose between different accuracy classes of measuring systems, the choice of which can be justified on economic grounds.

1 Scope

This European Standard specifies functional requirements for the design, construction, testing, commissioning/decommissioning, operation, maintenance and, where appropriate, calibration, together with suitable documented provisions for all new gas measuring systems and any major changes of existing systems.

This European Standard also specifies accuracy classes of measuring systems and thresholds applicable to these classes. Demonstration of compliance is achieved through the selection, installation and operation of appropriate measurement instruments, together with suitable documented provisions for calculations. Examples of demonstration of compliance are provided for each accuracy class; however, they are not prescriptive solutions.

This European Standard is applicable for gases of the 2nd family as classified in EN 437. It is also applicable for treated non-conventional combustible gases complying with EN 437 and for which a detailed technical evaluation of the functional requirements (such as injected biomethane) is performed ensuring there are no other constituents or properties of the gases that can affect the metrological and physical integrity of the measuring systems.

This European Standard can also be used as a guideline for 1st and 3rd family gases as classified in EN 437; however additional considerations should be taken with regard to the different constituents and physical characteristics of the gas family.

This European Standard is not applicable for raw or sour gases.

This European Standard is not applicable for gas measurement in CNG filling station.

This European Standard gives guidelines when designing, installing and operating gas meters with additional functionalities (smart gas meters).

Communication protocols and interfaces for gas meters and remote reading of gas meters are outside the scope of this European Standard and are covered by the appropriate parts of EN 13757, which provide a number of protocols for meter communications. Supervisory control and data acquisition protocols (SCADA) are also not covered by this European Standard.

Unless otherwise specified all pressures used in this European Standard are gauge pressures.

For associated pressure regulating systems the requirements of EN 12186 and/or EN 12279 apply.

For requirements on design, housing, lay-out, materials for components, construction, ventilation, venting and overall safety of gas measuring systems within the scope of this European Standard, EN 15001, EN 12186, EN 12279 and/or EN 1775 apply additionally, where relevant.

This European Standard specifies common basic principles for gas infrastructure. Users of this European Standard should be aware that more detailed national standards and/or codes of practice may exist in the CEN member countries.

This European Standard is intended to be applied in association with these national standards and/or codes of practice setting out the above mentioned basic principles.

In the event of conflicts in terms of more restrictive requirements in national legislation/regulation with the requirements of this European Standard, national legislation/regulation takes precedence as illustrated in CEN/TR 13737-1 and CEN/TR 13737-2.

CEN/TR 13737 (all parts) gives:

- clarification of all legislation/regulations applicable in a member state;
- if appropriate, more restrictive national requirements;
- a national contact point for the latest information.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1359, *Gas meters — Diaphragm gas meters*

EN 1594, *Gas infrastructure — Pipelines for maximum operating pressure over 16 bar — Functional requirements*

EN 1775, *Gas supply — Gas pipework for buildings — Maximum operating pressure less than or equal to 5 bar — Functional recommendations*

EN 12186, *Gas infrastructure — Gas pressure regulating stations for transmission and distribution — Functional requirements*

EN 12261, *Gas meters — Turbine gas meters*

EN 12279, *Gas supply systems — Gas pressure regulating installations on service lines — Functional requirements*

EN 12327, *Gas infrastructure — Pressure testing, commissioning and decommissioning procedures — Functional requirements*

EN 12405-1, *Gas meters — Conversion devices — Part 1: Volume conversion*

EN 12405-2, *Gas meters — Conversion devices — Part 2: Energy conversion*

EN 12405-3, *Gas meters — Conversion devices — Part 3: Flow computers*

EN 12480, *Gas meters — Rotary displacement gas meters*

EN 13463-1, *Non-electrical equipment for use in potentially explosive atmospheres — Part 1: Basic method and requirements*

EN 15001-1, *Gas Infrastructure — Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations — Part 1: Detailed functional requirements for design, materials, construction, inspection and testing*

EN 15001-2, *Gas infrastructure — Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations — Part 2: Detailed functional requirements for commissioning, operation and maintenance*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1)*

EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14)*

EN 60079-17, *Explosive atmospheres — Part 17: Electrical installations inspection and maintenance (IEC 60079-17)*

EN 61000 (all parts), *Electromagnetic compatibility (EMC)*

EN ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements (ISO 5167-1)*

EN ISO 5167-2, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 2: Orifice plates (ISO 5167-2)*

EN ISO 6141, *Gas analysis — Contents of certificates for calibration gas mixtures (ISO 6141)*

EN ISO 6142-1, *Gas analysis — Preparation of calibration gas mixtures — Part 1: Gravimetric method for Class I mixtures (ISO 6142-1)*

EN ISO 6143, *Gas analysis — Comparison methods for determining and checking the composition of calibration gas mixtures (ISO 6143)*

EN ISO 6975, *Natural gas — Extended analysis — Gas-chromatographic method (ISO 6975)*

EN ISO 10715, *Natural gas — Sampling guidelines (ISO 10715)*

EN ISO 10723, *Natural gas — Performance evaluation for analytical systems (ISO 10723)*

EN ISO 12213-1, *Natural gas — Calculation of compression factor — Part 1: Introduction and guidelines (ISO 12213-1)*

EN ISO 15970, *Natural gas — Measurement of properties — Volumetric properties: density, pressure, temperature and compression factor (ISO 15970)*

ISO 2186, *Fluid flow in closed conduits — Connections for pressure signal transmissions between primary and secondary elements*

ISO 10790, *Measurement of fluid flow in closed conduits — Guidance to the selection, installation and use of Coriolis flowmeters (mass flow, density and volume flow measurements)*

ISO 17089-1, *Measurement of fluid flow in closed conduits — Ultrasonic meters for gas — Part 1: Meters for custody transfer and allocation measurement*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

accuracy of measurement

closeness of the agreement between the result of a measurement and a true value of the measurand

3.2

additional components

elements or devices, required to ensure correct measurement or intended to facilitate the measuring operations, or which could in anyway affect the measurement

EXAMPLE Additional components can be

- a) filter;
- b) flow conditioning device;
- c) branch or by-pass line;

- d) valves;
- e) pressure reduction devices located upstream or downstream of the meter;
- f) sampling systems;
- g) piping.

3.3 **authorized person**

person who is appointed to fulfil a given task on gas measuring systems

3.4 **availability**

probability, at any time, that the measuring system, or a measuring instrument forming a part of the measuring system, is functioning according to specifications

3.5 **base conditions**

specified conditions to which the measured quantities of gas are converted

Note 1 to entry: Operating and base conditions relate to the volume of gas to be measured or indicated only and should not be confused with “rated operating conditions” and “reference conditions” which refer to influence quantities.

3.6 **bias**

systematic difference between the true value of measurand and its determined value

3.7 **calorific value determination device CVDD**

measuring instrument for obtaining the calorific value of gas

3.8 **competent person**

person who is qualified, trained and experienced to perform activities to gas measuring systems

3.9 **compression factor Z**

ratio of the volume of an arbitrary mass of gas, at a specified pressure and temperature to the volume of the same mass of gas under the same conditions as calculated from the ideal-gas law

Note 1 to entry: The compression factor (Z) indicates the extent to which gas deviates from ideal gas behaviour.

3.10 **conversion device**

3.10.1 **conversion device**

device that converts a quantity at metering conditions to a quantity to base conditions or energy

3.10.2

energy conversion device

device which calculates, integrates and displays energy using quantity at base conditions and the calorific value and/or the gas composition

3.10.3

volume conversion device

device that converts the quantity measured at measuring conditions into a quantity at base conditions

3.11

custody transfer

change in responsibility for the conveyance of gas, this may or may not involve a change of ownership of the gas

3.12

documented provisions

provisions established by the operator of a gas measuring system in order to give confidence that operations are performed according to metrological expectations

3.13

drift

slow change of a metrological characteristic of a measuring instrument

3.14

energy determination

quantitative determination of the amount of energy of a quantity of gas based either on measurement or calculation using measured values or attributed values

3.15

fail-safe

characteristic of a device to go to a safe operating condition when a failure occurs

3.16

gas measuring installation

complete set of measuring instruments and additional components assembled to carry out specified measurements

3.17

gas measuring station

measuring station consists of one or more gas measuring installation(s) and includes its housing, compound, the inlet and outlet pipework as far as the isolating valves

Note 1 to entry: Measuring station does not normally apply for gas measuring installation for residential and commercial use, even if there is housing.

3.18

gas measuring system

consists of a gas measuring installation, documented provisions and where appropriate a gas measuring station

3.19

gas measuring system operator

natural or legal person who is responsible for the operation and maintenance of the measuring system

Note 1 to entry: The gas measuring system operator is referred to be the operator.

3.20

gas meter

instrument designed to measure, memorise and display the quantity of gas (volume or mass) that has passed it

3.21

gross calorific value

GCV

amount of heat, determined on molar, mass or volume basis, which would be released by the complete combustion in air of a specified quantity of gas, in such a way that the pressure at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature as that of the reactants, all of these products being in the gaseous state except for water formed by combustion, which is condensed to the liquid state at this specified temperature

Note 1 to entry: GGCV is often referred to as H_s in other standards.

3.22

hazardous area

area in which an explosive or flammable gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

[SOURCE: EN 60079-10-1:2009]

3.23

housing

cabinet or meter compound external to the building

3.24

installation effect

difference in performance of the measuring instrument between the calibration conditions and actual conditions of use

Note 1 to entry: This difference can be caused by different flow conditions due to velocity profile, perturbations, or by different working regimes (pulsation, intermittent flow, alternating flow, vibrations, etc.).

3.25

maximum permissible error

MPE

extreme absolute value of error permitted by specification

Note 1 to entry: Conformity with an MPE is based on calibration results for individual instruments and on statistical methods for measuring systems.

3.26

measuring conditions

conditions of the gas at which the quantity is measured at the point of measurement (temperature and pressure of the measured gas)

3.27

measuring instrument

device intended to be used for measurements, alone or in conjunction with supplementary device(s)

EXAMPLE Gas meter, calorific value determination device.

3.28

metering temperature

absolute gas temperature to which the indicated quantity of gas is related

3.29

pressure

3.29.1

absolute pressure

pressure of the gas measured with the reference to an absolute vacuum

3.29.2

gauge pressure

difference between the absolute pressure of the gas and the atmospheric pressure at the place and time of the measuring

3.29.3

design pressure

DP

pressure on which design calculations are based

Note 1 to entry: A part of a measuring installation designed for a design pressure DP can comprise components designed for a different maximum allowable pressure PS.

3.29.4

maximum incidental pressure

MIP

maximum pressure which a system can experience for a short time, limited by the safety device(s)

3.29.5

maximum operating pressure

MOP

maximum pressure at which a system can be operated continuously under normal operating conditions

Note 1 to entry: Normal operating conditions are: no fault in any device or stream.

3.29.6

metering pressure

P_m

absolute pressure at which the volume of gas is measured

3.29.7

temporary operating pressure

TOP

pressure at which a system can be operated temporarily under control of the regulating device(s)

3.30

representative calorific value

individual calorific value or a combination of calorific values that is considered to be, according to the constitution of the measuring system, the most appropriate calorific value to be associated with the metered quantity in order to calculate the energy

3.31

responsible person

person who is responsible for design, construction, commissioning, operation and maintenance of the measuring installation and/or system

3.32

sensor

instrument for measuring certain measurands which are characteristic of the gas (temperature, pressure, calorific value, etc.)

3.33

smart meter

meter with additional functionalities one of which is data communication

3.34

stability

ability of a measuring system, or a measuring instrument, to perform its functions for a specified period of time

3.35

stripped gas

natural gas from which large amounts of easily liquefiable components have been removed

3.36

traceability

property of the result of a measurement or a value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties

3.37

uncertainty

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[SOURCE: ISO/IEC Guide 98-3]

4 General requirements

4.1 General

When considering the design, construction, operation and maintenance of a gas measuring system, the requirements of the relevant national authority shall be taken into account.

All parties involved shall exchange all appropriate information to ensure effective design, installation, commissioning and operation of the measuring system.

4.2 Safety and environment

The gas measuring system shall be designed and constructed such that it operates in a safe manner. The owner/operator shall have safety procedures describing how the installation including the housing is managed.

Safety is a management responsibility which requires that all personnel involved in design, installation, testing, commissioning, operation and maintenance of the gas measuring system shall be competent

and have adequate safety training. The management shall ensure that all areas of responsibility are clearly defined.

During normal operation, the gas measuring system shall comply with locally established environmental noise limits.

The owner/operator of the measuring system shall make information available to the consumer or the person responsible for the property of any risks associated with the system.

EXAMPLE Instructions stating the precautions to be taken if the smell of gas persists.

NOTE 1 For further guidance, see EN 1775.

NOTE 2 This may be achieved by the affixing of appropriate warning notices.

All works shall be conducted in accordance with national health, safety and environmental legislation.

4.3 Quality system for gas measuring system

The operator shall have a quality system and use it to manage the measurement system for its entire lifetime.

The quality system shall be applied to the complete gas measuring system including all activities undertaken for the purpose of energy determination in accordance with this European Standard. Reference should be made to ISO 10012 and/or EN ISO 9000- series of standards or to equivalent quality system standards.

This quality system shall also include the gas measuring installation which shall be applied to the design, construction and testing activities in accordance with this European Standard also considering the requirements for commissioning, operation and maintenance.

NOTE 1 National regulations may constitute compliance with the requirement for a quality system.

NOTE 2 National regulations may require that some inspection and testing of the measuring accuracy have to be witnessed and accepted by an authorized and competent person.

5 Basic requirements for measuring systems

5.1 General

The output of the gas measuring system is energy (kWh or MJ), that is the product of gas volume at base conditions or mass and gross calorific value.

NOTE Differing physical principles are used to determine gas volume or mass passing through the meter. The most commonly used techniques are mentioned in this European Standard. Other methods can be used.

Involved parties shall ensure that the method of energy determination is traceable, reliable and satisfies the basic gas and energy measurement requirements such as accuracy, security as well as economic criteria.

The chosen method shall deliver a calorific value with accuracy in line at least with legal requirements. The method shall be sufficiently accurate to reduce random and systematic errors to such a level that contractual obligations are fulfilled and that it can be justified on technical or economic considerations. Energy determination shall be based on measured or attributed values of gas composition of the gas passing through the gas meter. The quantity of gas is the volume at base condition or its mass. The equations for calculating the volume or mass into energy are given in Annex C.

Possible methods for determining the quantities of energy are described in EN ISO 15112 and EN 12405-2.

5.2 Approach to energy measurement

When designing an energy measuring system the following two steps should be undertaken:

- a) classification of measuring system according to its accuracy class (see 5.3)

NOTE 1 The introduction of accuracy classes serves two main purposes. Firstly, it offers a means of ensuring minimum accuracy requirements are met (i.e. appropriate accuracy of measurement is employed). Secondly, it permits installation of a cost-effective measuring system (i.e. not at excessive cost).

- b) identification of separate modules of the measuring system (see 5.4)

NOTE 2 Each module performs a specific function within the global energy measurement process. Each module could be either an instrument (e.g. a meter or a calorific value determining device) or a calculation or functional process (e.g. assignment of a calorific value, or conversion of quantity of gas to energy using a representative calorific value).

The methodology how to combine the modular accuracies to derive overall accuracy is given in Clause 6 and Annex E.

NOTE 3 A number of examples are offered in Annex E for clarification of the approach set out in this clause. However, these examples are informative and cannot be taken as evidence that any particular equipment or provisions meet a particular accuracy requirement.

5.3 Classification of the measuring system

5.3.1 General

The accuracy class of the measurement system shall be defined as an expanded uncertainty on energy determination over the billing period:

- a) Class A gas measuring system with an in-service uncertainty less than or equal to 1,2 %.
- b) Class B gas measuring system with an in-service uncertainty greater than 1,2 % and less than or equal to 2,5 %.
- c) Class C gas measuring system with an in-service uncertainty greater than 2,5 % and less than or equal to 3,5 %.
- d) Class D gas measuring system with an in-service uncertainty greater than 3,5 % and less than or equal to 8,0 %.

Based on the four accuracy Classes A to D, the responsible person shall choose the most appropriate class for the measuring system under consideration.

The choice shall be based at least on:

- type of installation;

EXAMPLE 1 Location on the gas network, etc.

NOTE Typical locations of gas measuring installations are given in Annex G.

- capacity of the installation;

EXAMPLE 2 Flow rate or annual volume.

- measuring instrument MPE required;

EXAMPLE 3 Legislative, regulatory requirements or economic considerations.

- gas pressure and temperature (and hence the value of the compression factor);
- economic considerations;
- quality of the gas.

See EN ISO 15112 for further details on energy determination.

Accurate and reliable energy determination can be undertaken by using the various modules a) to f) described in 5.4 below.

5.3.2 Minimum requirements Class A and Class B

For Class A and Class B gas measuring installations, the pressure (P), temperature (T), compression factor (Z) conversion (PTZ conversion) shall be carried out from the on-line pressure, temperature measurements.

Minimum requirements in Class A gas measuring installation:

- a) The on-line gas composition shall be measured by at least one local CVDD and which is used for the PTZ conversion and the energy determination.
- b) Depending on the capacity of the gas measuring installation a second CVDD and duplicated gas meters in series and/or pressure and temperature conversion shall be considered. Parties shall define criteria for deciding whether duplicate measurement in series is needed. When duplicated instruments are installed, the average value between the two systems should be used for energy determination.

Minimum requirements for Class B gas measuring installation are:

- c) This class of installation shall have installed a volume conversion device using pressure and temperature measurements. Depending on the metering pressure compression factor (Z) should be determined on-site or attributed as a fixed factor.
- d) Calorific value shall be determined using one of the following methods:
 - 1) continuous sampling on site;
 - 2) periodical sampling on site;
 - 3) determined remotely;
 - 4) attributed fixed factors in accordance with documented provisions.
- e) The PTZ-conversion is assumed to be carried out most of the time from a declared fixed gas composition, so basically no CVDD is installed in the gas measuring installation. The determination of energy can be performed locally or remotely and is carried out from this same declared GCV or from an on line CVDD.

When no CVDD is installed in the gas measuring installation the PTZ conversion is carried out from a declared fixed gas composition.

For both determination of energy and PTZ conversion the same GCV and/or gas composition shall be used. Exceptions may be possible in the following cases:

- economical reason, minimum capacity requirements;

- in the case of two or more sources of supply with different gas qualities, either a CVDD shall be installed or documented provisions shall provide a representative gas quality.

Corrections should be made retrospectively between the declared fixed gas composition and assessed actual composition.

5.3.3 Minimum requirements Class C and Class D

The attributed gross calorific value (GCV) for that charging area should be calculated by using the method contained within the documented provisions. The GCV should be averaged over a pre-determined time period (daily, monthly or annually).

If an area is supplied by more than one entry point, a flow weighted average GCV should be calculated from gas flows at each entry point. Different approaches on this subject are given in EN ISO 15112.

For temperature, pressure and compressibility reference is made to 6.6.

5.4 Gas measuring system modules

When considering a measuring system individual modules shall be identified. Examples are given in Annex E.

When combining the modules of the measuring system they all shall be under the same base conditions.

NOTE At the individual module level, the error associated with the module can depend on the value of one or more input parameters, e.g. error in volume at metering conditions and/or error in calorific value of a CVDD.

Some of these modules can be assumed, attributed or derived whilst others are measured in accordance with 5.3.

Consideration should be given to the following essential gas measuring system modules:

- gas volume/mass: this measurement is at measuring conditions.
- gas pressure: the absolute pressure within the meter is required for conversion of the volume measured to the same base condition. Gas pressure can be measured on site (gauge or absolute) or attributed.
- gas temperature: the absolute temperature within the meter is required for conversion of the volume measured. This can be measured on site or attributed.
- compression factor: for low metering pressures the compression factor has no significant influence and can therefore be attributed the value of 1. Depending on the measuring system accuracy required, for higher pressure systems, the compression factor is based on measurement and/or calculated.
- representative gross calorific value: It can be expressed in mass or in volume using the same base conditions. For installations of Class C and Class D it is derived by using documented provisions.
- density: this value is needed to convert the calorific value in volume to the calorific value in mass or vice versa.

6 Energy Determination

6.1 General

When designing a gas measuring system it shall be ensured that the calorific value is determined at the measuring installation or upstream on the network.

If the gas composition and calorific value are not determined at the gas measuring installation, the CVD shall be installed in appropriate location of the network to be representative for the gas passing through the gas measuring installation. The positioning of the sampling points of a CVDD shall be representative of the gas passing through the meter runs.

The method used to determine the GCV by the measuring system shall be included within the documented provisions.

For a Class A system, the GCV shall be determined at the measuring installation.

For a Class B system, an assessment shall be made on how representative the actual calorific value is of the gas composition passing through the measuring installation.

For a Class C system or Class D system attributed values for the gross calorific value shall be used, as described in the documented provisions. The gross calorific value shall be measured in different locations to provide a representative sample at the gas measuring installation. The tolerance in attributed calorific values shall comply with national requirements or company specifications.

Accuracy characteristics of the selected instruments shall be sufficient to allow the energy determination in measuring system, as defined by national requirements.

For the chosen accuracy class no error in energy shall exceed the MPE for the specified accuracy class over the operational range for the measuring system (flow rates, compositions, etc.).

Energy determination shall be carried out using one of the methods described in 6.3 to 6.7.

NOTE For the overall measuring system, the error in energy for the measuring system depends upon all of the input parameters that affect the errors arising from each module of the measuring system. A measuring system therefore shows a distribution of errors in energy from a combination of distributions of errors arising within the individual modules.

6.2 Requirements for measurements used in energy determination

6.2.1 Base conditions

All parties should employ the same base conditions when comparing measurements of volume, calorific value and energy. Factors for conversion between different base conditions are provided in EN ISO 13443.

6.2.2 Flow measurement

The involved parties shall ensure that the method used for determining gas volume flow rate or mass flow rate

- is traceable and reliable;
- satisfies the basic gas and energy measurement requirements, such as safety and economics;
- meets the accuracy requirements of the selected class.

Meters based on different physical principles can be used. The most commonly-used techniques are included in 7.6.3 and Annex A.

6.2.3 Gross calorific value (GCV)

6.2.3.1 General considerations

The GCV of the gas shall be determined by measurement or by attribution of an appropriate representative value.

NOTE 1 The measurement techniques can be divided into three groups:

- based on composition measurement according to EN ISO 6976;
- based on combustion calorimetry according to EN ISO 15796;
- correlative techniques (limited range and accuracy).

When determining GCV based on composition, the existence of components not determined by the chosen analytical technique should be taken into account.

Where GCV measurement by a local CVDD is not economically justified, the GCV shall be calculated based on one or more measurements at representative points on the pipeline.

NOTE 2 Among these kinds of calculations, the gas quality tracking system is a special assignment method for the calculation of gas qualities at any time and at any place in a pipeline or a grid, by means of a grid simulation or a state reconstruction based on gas qualities measured at all supplying points on the pipeline. See EN ISO 15112.

The accuracy of the GCV determination shall be sufficient to ensure that the overall accuracy of the measuring system is within the MPE of the selected accuracy class.

6.2.3.2 Calorific value determination device (CVDD)

The accuracy of the CVDD shall be determined.

NOTE 1 CVDDs can generally be characterized into three types:

- those in which calorific value is determined by measurement using non-separative means and for which guidance on selection and operation is provided in ISO 15971;
- those in which calorific value is determined by calculation using EN ISO 6976 from a gas composition measured using a suitable separative technique, such as gas chromatography;
- those in which calorific value is determined from correlations of calorific value with other properties (such as speed of sound, thermal conductivity, dielectric permittivity, carbon dioxide content, hydrocarbon content) that are measured by suitable means.

NOTE 2 GCV determination can be subject to national legal requirements and controls, which may specify a particular technique or instrument and the manner of its operation.

Gas chromatographs should be set up to carry out analysis according to EN ISO 6974 (all parts). The operating conditions for the gas chromatographs shall be based on a performance evaluation complying with EN ISO 10723.

When assessing the accuracy of a CVDD at least the following factors shall be taken into account:

- a) sampling and conditioning;
- b) speed of response of CVDD;
- c) uncertainty on the composition of any working calibration gas;
- d) in case of separative techniques presence of components not analysed;
- e) absence of contamination;
- f) linearity of the instrument over the composition range;
- g) ambient conditions;
- h) low limit detection.

NOTE 3 The areas associated with non-linearity of the CVDD can be reduced by requiring the calibration gas to be close to the expected composition of the gas sampled from the line, or by using a multi-point calibration.

NOTE 4 In the case of gas chromatographs, areas associated with non-linearity can be determined by performance evaluation according to EN ISO 10723.

When constituents not detected by the CVDD are present at a significant level, adequate corrective calculation shall be carried out according to EN ISO 6975. The traceability of the calibration gas shall be established.

Limits shall be set on the total un-normalized molar concentrations for a gas chromatography analysis. Data acceptance criteria shall be set at values which are within or equal to any legal metrology or contractual limits.

6.3 Calculation method of energy using assigned GCV and P, T, Z values

The actual volume shall be converted to volume at base conditions using attributed T, P and Z. The totalized volume shall be converted to energy using an attributed GCV.

6.4 Calculation method of energy using an on-site CVDD and on-site PTZ-Conversion

The actual flow-rate shall be converted to flow-rate at base conditions using a measured T, P and Z (PTZ-conversion) and then shall be converted to energy flow by multiplication by a live GCV. Energy shall be totalized, typically using a flow computer. Z shall be calculated from live T, P and gas composition.

6.5 Calculation method of energy using an assigned GCV and PTZ-conversion

The actual flow-rate shall be converted to flow-rate at base conditions using a measured T, P and Z (PTZ-conversion) and then shall be totalized. The totalized volume shall be converted to energy using an attributed calorific value. Z shall be calculated from live T and live P assuming a defined gas composition.

6.6 Calculation method of energy using PT-Conversion and assigned GCV and Z value

The actual flow-rate shall be converted to flow-rate at base conditions using a measured T and P (PT-conversion) and then shall be totalized using an assigned Z. The totalized volume shall be converted to energy using an attributed GCV.

6.7 Calculation method of energy using T-Conversion and assigned GCV, and P, Z values

The actual flow-rate shall be converted to flow-rate at base conditions using a measured T and then totalized using assigned P and Z values. The assigned P value should take into account the altitude, lock-up pressure zone as well as the accuracy class of the pressure regulator and the supply pressure when appropriate. The totalized volume is then converted to energy using an attributed GCV.

NOTE Lock-up pressure zone and accuracy class are specified in EN 334.

6.8 Gas temperature conversion

In order to convert volume at operating conditions to base conditions, the gas temperature shall be measured at a location that ensures that it is representative of the temperature of the gas being metered.

Recommendations for temperature measurement are provided in EN ISO 15970 or in the relevant parts of EN 12405.

6.9 Gas pressure conversion

In order to convert pressure at operating conditions to base conditions, the pressure shall be measured at a location that ensures that it is representative of the pressure of the gas being metered.

Recommendations for pressure measurement are provided in EN ISO 15970, or the relevant parts of EN 12405

6.10 Compressibility conversion

When volume at operating conditions is converted to base conditions, using a Z calculated for the gas at operating conditions, the calculation shall be performed in accordance with EN ISO 12213-1.

When the gas is fed on-line to a gas chromatograph and at high pressure for (re-vaporized) LNG and stripped gases EN ISO 12213-2 should be applied

When only the GCV, relative density, hydrogen and carbon dioxide content are known, together with the relevant pressures and temperatures EN ISO 12213-3 should be applied.

NOTE The EN ISO 12213-3 is only applicable for a limited range of physical characteristics.

6.11 PTZ-conversion

Conversion techniques used shall have proven accuracy and shall be suitable for the measuring conditions (see 7.10).

NOTE P, T and Z can be determined simultaneously by a single device

6.12 Uncertainty of energy determination

The uncertainty in energy determination should be assessed according to:

- ISO/IEC Guide 98-1 and ISO/IEC Guide 98-3,
- ISO/IEC Guide 98-3 Supplement 1 and 2,
- ISO/IEC Guide 98-4 or ISO 5168,
- JCGM 106,
- JCGM 107.

NOTE 1 The text of the ISO/IEC Guide 98- series equates to JCGM 100 series (JCGM = Joint Committee for Guides in Metrology); JCGM 105, JCGM 106 and JCGM 107 are in preparation to be transferred into the series of ISO/IEC Guide 98.

Bias should be identified and reduced to acceptable levels.

NOTE 2 In some applications it can be appropriate to do so by specifying a maximum permissible bias.

NOTE 3 Using the series of ISO/IEC Guide 98-3 and ISO/IEC Guide 98-1 and JCGM 105 and JCGM 107 the bias can be taken into account by enlarging the “uncertainty” attributed to the result, instead of applying it to the reported result of a measurement.

The assessment of the conformity of the metrological performance of a measuring system is carried out according to ISO/IEC Guide 98-4, “Uncertainty of measurement – Part 4: Role of measurement uncertainty in conformity assessment”. Annex D indicates how such conformity assessment can be carried out in the context of an energy measurement system.

Annex E provides some examples of conformity assessments.

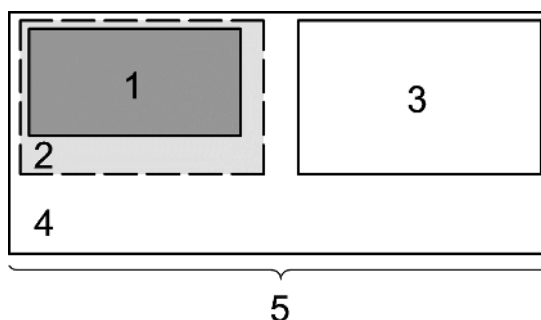
7 Design of gas measuring system

7.1 General

A gas measuring system shall comprise:

- a gas measuring installation;
- documented provisions; and
- where appropriate, a gas measuring station.

Figure 1 illustrates a typical gas measuring system.



Key

- 1 gas measuring installation
- 2 gas measuring station
- 3 documented provisions
- 4 gas measuring system
- 5 output: energy

Figure 1 — Illustration of gas measuring system

The accuracy requirement for the system (i.e. the maximum permissible error) shall be determined applying 5.3. The system shall then be designed in such a way that the required accuracy is achieved by validating against 6.12 and confirming it meets the requirements for the selected class.

When requested, the achieved accuracy of the system shall be available to involved parties to demonstrate compliance with the selected class.

Annex D provides a general approach to demonstrating compliance in accordance with 6.12.

The gas measuring installation should be located in a building, a compound, a cabinet or a shelter. Unless it unduly affects their integrity, operation, or accuracy some higher capacity gas measuring installations may also be installed in open air.

When selecting the location, the advice of the manufacturer and operator of the installation shall be sought.

7.2 Safety provision

7.2.1 General

When designing a gas measuring system, safety provisions shall be integrated to ensure its safe access, egress, construction, operation, inspection and maintenance and located such that risk and nuisance to the environment and its operation are kept within acceptable limits.

The designer of the gas measuring installation and station shall ensure that proper care is taken to prevent noise generated hazards.

The gas measuring installation and station shall have at least one inlet valve to allow it to be safely isolated and to undertake any maintenance. For higher accuracy installations an outlet valve should be fitted.

As part of the design of the installation and station the electrical safety shall be considered. All electrical installations shall comply with the applicable European Standards.

7.2.2 Hazardous area classification

The possible hazardous area in any housing, station and installation shall be assessed and classified according to EN 60079-10-1.

For any non-electrical equipment with its own potential ignition source reference shall be made to EN 13463-1.

A risk assessment should be made according to EN 1127-1.

Any electrical installation in a hazardous area shall comply with 8.6.

7.3 Housing

All meter housings shall be well ventilated and be adequate in size, layout and design to undertake all installation, commissioning and maintenance requirements.

The design of a measuring station, including the layout, housing and materials for the housing, shall comply with the relevant requirements of EN 12186, EN 12279 or EN 15001, where applicable.

For measuring installations without pressure regulation the most relevant standards shall be chosen depending on inlet pressure and capacity.

7.4 Gas measuring station

A measuring station shall comprise:

- a measuring installation (see 7.6);
- additional components (see 7.13, 7.16 and following);
- where appropriate a housing (see 7.3).

Any additional components shall be installed in accordance with the installation requirements and shall not adversely affect the measurement results.

7.5 External influences

The performance of the gas measuring installation and housing when used in its specified operating conditions shall not be adversely affected by any expected external influences, such as but not limited to:

- mechanical influences;
- electromagnetic influences;
- weather conditions, ambient temperature;
- humidity.

7.6 Gas measuring installation

7.6.1 General

The design of the installation varies according to its required accuracy.

The measuring installation shall comprise a gas meter and one or more of the following components:

- a) conversion device;
- b) change-over equipment to select the appropriate number of meter runs to meet the actual load of the station;
- c) CVDD;
- d) valves, pipes, gaskets and joints;
- e) lagging for thermal insulation and noise reduction;
- f) filters and separators;
- g) electrical installation, lightning protection, earthing;
- h) detection systems such as gas and/or fire detection (see also EN 60079-29-1, EN 15001-1);
- i) communication;
- j) others.

A gas measuring installation can be connected with other gas installations.

EXAMPLE 1 As part of a pressure regulating installation.

Any additional connected installation or equipment shall not adversely affect the integrity of the gas measuring installation or its measurement.

EXAMPLE 2 Connected installations can be gas pressure regulating installations, gas drying facilities, odorization injection equipment.

The gas measuring installation shall be designed such that the correct functioning is ensured for all specified pressure and temperature ranges as well as, where appropriate, impurities present in the gas.

The specified pressure and temperature range shall cover at least MOP, TOP, MIP, minimal pressure at the inlet of the installation, $T_{\min}$, $T_{\max}$ and ambient temperature.

The design shall also take into account environmental factors such as vibrations, pulsation and noise.

The design shall ensure appropriate access/egress for inspection, removal or replacement of the gas meter.

In case of an emergency, it shall be possible to shut down the installation safely.

The capacity and the correct functioning of the installation shall be based on the minimum and maximum values for:

- a) volume or mass flow rate;
- b) gas temperature;
- c) velocity of gas in the meter run;