IS/IEC 60079-29-1 (2007): Explosive atmospheres, Part 29: Gas detectors, Section 1: Performance Requirements of Detectors for Flammable Gases [ETD 22: Electrical Apparatus for Explosive Atmosphere]

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भारतीय मानक

विस्फोटक वातावरण

भाग 29 गैस संसूचक

अनुभाग 1 ज्वलनशील गैसों के लिए संसूचकों की कार्यकारिता अपेक्षाएँ

Indian Standard

EXPLOSIVE ATMOSPHERES

PART 29 GAS DETECTORS

Section 1 Performance Requirements of Detectors for Flammable Gases

ICS 29.260.20

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

March 2012 **Price Group 13**

NATIONAL FOREWORD

This Indian Standard (Part 29-1) which is identical with IEC 60079-29-1 : 2007 'Explosive atmospheres — Part 29-1: Gas detectors — Performance requirements of detectors for flammable gases' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

Guidance for the selection, use and maintenance of gas detecting apparatus are set out in IEC 60079-29-2 'Explosive atmospheres — Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen'.

The Interpretation sheet is to be given at the end of the publication.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60079-0 Electrical apparatus for explosive gas atmospheres — Part 0: General requirements	IS/IEC 60079-0 : 2004 Electrical apparatus for explosive gas atmospheres: Part 0 General requirements	Identical to IEC 60079-0 : 2004
IEC 60079-20 Electrical apparatus for explosive gas atmospheres — Part 20: Data for flammable gases and vapours relating to the use of electrical apparatus	IS/IEC 60079-20 : 1996 Electrical apparatus for explosive gas atmospheres: Part 20 Data for flammable gases and vapours relating to the use of electrical apparatus	Identical to IEC 60079-20 : 1996
IEC 60079-29-2 Explosive atmospheres — Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen	IS/IEC 60079-29-2 : 2007 Explosive atmospheres: Part 29 Gas detectors, Section 2 Selection, installation, use and maintenance of detectors for flammable gases and oxygen	Identical to IEC 60079-29-2 : 2007
IEC 61000-4-1 Electromagnetic compatibility (EMC) — Part 4-1: Testing and measurement techniques — Overview of IEC 61000-4 series	IS 14700 (Part 4/Sec 1) : 2008 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 1 Overview of IEC 61000-4 series (*first revision*)	Identical to IEC 61000-4-1 : 2006

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Indian Standard

EXPLOSIVE ATMOSPHERES

PART 29 GAS DETECTORS

Section 1 Performance Requirements of Detectors for Flammable Gases

1 Scope

This part of IEC 60079-29 specifies general requirements for construction, testing and performance, and describes the test methods that apply to portable, transportable and fixed apparatus for the detection and measurement of flammable gas or vapour concentrations with air. The apparatus, or parts thereof, are intended for use in potentially explosive atmospheres (see 3.1.8) and in mines susceptible to firedamp.

This standard is also applicable when an apparatus manufacturer makes any claims regarding any special features of construction or superior performance that exceed these minimum requirements. In these cases, all such claims should be verified and the test procedures should be extended or supplemented, where necessary, to verify the performance claimed by the manufacturer. When verifying the superior performance of one criterion, other performance criteria are not required to meet the standards minimum requirements, however, these reduced claimed performance criteria (as confirmed in the manufactures Installation Manual) should also be verified. (e.g. temperature range of 0 °C to 60 °C; 0 °C to 40 °C at ±10 % accuracy and 40 °C to 60 °C at ±15 % (manufacturers claimed accuracy). The additional tests should be agreed between the manufacturer and test laboratory and identified and described in the test report.

This standard is applicable to flammable gas detection apparatus intended to provide an indication, alarm or other output function; the purpose of which is to give a warning of a potential explosion hazard and in some cases, to initiate automatic or manual protective action(s).

This standard is applicable to apparatus, including the integral sampling systems of aspirated apparatus, intended to be used for commercial, industrial and non-residential safety applications.

This standard does not apply to external sampling systems, or to apparatus of laboratory or scientific type, or to apparatus used only for process control purposes. It also does not apply to open path (line of sight) area monitors. For apparatus used for sensing the presence of multiple gases, this standard applies only to the detection of flammable gas or vapour.

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirement of IEC 60079-29-1 will take precedence.

NOTE 1 IEC 60079-29-1 is intended to provide for the supply of apparatus giving a level of safety and performance suitable for general purpose applications. However, for specific applications, a prospective purchaser (or an appropriate authority) may additionally require the apparatus to be submitted to particular tests or approval. For example, group I apparatus (i.e. apparatus to be used in mines susceptible to firedamp) may not be permitted to be used without the additional, prior approval of the relevant authority in mines under its jurisdiction. Such particular tests/approval are to be regarded as additional to and separate from the provisions of the standards referred to above and do not preclude certification to or compliance with these standards.

NOTE 2 All apparatus calibrated on specific gases or vapours can not be expected to correctly indicate on other gases or vapours.

NOTE 3 For the purposes of this standard, the terms "lower flammable limit (LFL)" and "lower explosive limit (LEL)" are deemed to be synonymous, and likewise the terms "upper flammable limit (UFL)" and "upper explosive limit (UEL)" are deemed to be synonymous. For ease of reference, the two abbreviations LFL and UFL may be used hereinafter to denote these two sets of terms. It should be recognized that particular authorities having jurisdiction may have overriding requirements that dictate the use of one of these sets of terms and not the other.

NOTE 4 For the purposes of this standard, the term “indicating up to a volume fraction of X %” includes apparatus with an upper limit of the measuring range equal to or less than X %.

2 Normative references

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

IEC 60079-0: *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-20: *Electrical apparatus for explosive gas atmospheres – Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

IEC 60079-29-2, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen*

IEC 61000-4-1: *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series.* Basic EMC publication

IEC 61000-4-3: *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test.* Basic EMC publication

IEC 61000-4-4: *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test* – Basic EMC publication

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 and the following apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in Chapter 426 of the International Electrotechnical Vocabulary (IEV) IEC 60050 (426).

3.1 Gas properties

3.1.1
ambient air
normal atmosphere surrounding the apparatus

3.1.2
clean air
air that is free of flammable gases and interfering or contaminating substances

3.1.3
explosive gas atmosphere
mixture with air, under normal atmospheric conditions, of flammable substances in the form of gas or vapour, in which, after ignition, self-sustaining flame propagation

NOTE 1 This definition specifically excludes dusts and fibres in suspension in air. Mists are not covered by this standard.

NOTE 2 Although a mixture that has a concentration above the upper flammable limit (see 3.1.9) is not an explosive atmosphere, in certain cases for area classification purposes, it is advisable to consider it as an explosive gas atmosphere.

NOTE 3 Normal atmospheric conditions include variations above and below the reference levels of 101,3 kPa and 20 °C provided the variations have a negligible effect on the explosive properties of the flammable materials.

3.1.4
firedamp
flammable gas, consisting mainly of methane, found naturally in mines

3.1.5
flammable gas
gas or vapour which, when mixed with air in a certain proportion, will form an explosive atmosphere

NOTE For the purposes of this standard, the term "flammable gas" includes flammable vapours.

3.1.6
lower flammable limit
LFL
volume fraction of flammable gas or vapour in air below, which an explosive gas atmosphere does not form, expressed as a percentage (see IEC 60079-20)

NOTE This is also known as lower explosive limit (LEL).

3.1.7
poisons (for sensors)
substances, which lead to temporary or permanent loss of sensitivity of the sensors

3.1.8
potentially explosive atmosphere
atmosphere that could become explosive (the danger is a potential one)

NOTE This would include an atmosphere with gas concentration currently above UFL, where dilution with air would render it explosive.

3.1.9
upper flammable limit
UFL
volume fraction of flammable gas or vapour in air above, which an explosive gas atmosphere does not form, expressed as a percentage (see IEC 60079-20)

NOTE This is also known as upper explosive limit (UEL).

3.1.10
volume fraction (v/v)
quotient of the volume of a specified component and the sum of the volumes of all components of a gas mixture before mixing, all volumes referring to the pressure and the temperature of the gas mixture

NOTE The volume fraction and volume concentration take the same value if, at the same state conditions, the sum of the component volumes before mixing and the volume of the mixture are equal. However, because the mixing of two or more gases at the same state conditions is usually accompanied by a slight contraction or, less frequently, a slight expansion, this is not generally the case.

3.1.11
zero gas
gas recommended by the manufacturer, which is free of flammable gases, and interfering and contaminating substances, the purpose of which is calibration/adjustment of the apparatus zero

3.2 Types of instruments

3.2.1
alarm-only apparatus
apparatus having an alarm but not having a meter or other indicating device

3.2.2
aspirated apparatus
apparatus that samples the gas by drawing it to the gas sensor – for example, by means of a hand-operated or electric pump

3.2.3
continuous duty apparatus
apparatus that is powered for long periods of time, but may have either continuous or intermittent sensing

3.2.4
diffusion apparatus
apparatus in which the transfer of gas from the atmosphere to the gas sensor takes place by random molecular movement, i.e. under conditions in which there is no aspirated flow

3.2.5
fixed apparatus
apparatus that is intended to have all parts permanently installed

3.2.6
group I apparatus
apparatus for mines susceptible to firedamp

3.2.7
group II apparatus
apparatus for places with a potentially explosive atmosphere, other than mines susceptible to firedamp

3.2.8
portable apparatus
spot-reading or continuous duty apparatus that has been designed to be readily carried from place to place and to be used while it is being carried. A portable apparatus is battery powered and includes, but is not limited to

a) a hand-held apparatus, typically less than 1 kg, which requires use of only one hand to operate,
b) personal monitors, similar in size and mass to the hand-held apparatus, that are continuously operating (but not necessarily continuously sensing) while they are attached to the user, and

c) larger apparatus that can be operated by the user while it is carried either by hand, by a shoulder strap or carrying harness and which may or may not have a hand directed probe.

3.2.9
spot-reading apparatus
apparatus intended to be used for short, intermittent or irregular periods of time as required (typically 5 min or less)

3.2.10
transportable apparatus
apparatus not intended to be portable but which can be readily moved from one place to another

3.2.11
stand-alone gas detection apparatus
fixed gas detection apparatus that provide a conditioned electronic signal or output indication to a generally accepted industry standard (such as 4-20 mA or 3-15 psi), intended to be utilized with stand-alone control units or signal processing data acquisition, central monitoring and similar systems, which typically process information from various locations and sources including, but not limited to gas detection apparatus

3.2.12
stand-alone control unit
fixed gas detection control units intended to provide meter indication, alarm functions, output contacts and/or alarm signal outputs when utilized with stand-alone gas detection apparatus

3.3 Sensors

3.3.1
remote sensor
sensor that is not integral to the main body of the apparatus

3.3.2
sensor
assembly in which the sensing element is housed and that may also contain associated circuit components

3.4 Supply of gas to instrument

3.4.1
sample line
a means by which the gas being sampled is conveyed to the sensor including accessories, e.g. filter, water trap

3.4.2
sampling probe
separate sample line, which is attached to the apparatus as required, that may or may not be supplied with the apparatus. It is usually short (e.g. in the order of 1 m) and rigid (although it may be telescopic), but it may be connected by a flexible tube to the apparatus

3.5 Signals and alarms

3.5.1
alarm set point
fixed or adjustable setting of the apparatus that is intended to preset the level of concentration at which the apparatus will automatically initiate an indication, alarm or other output function

3.5.2
fault signal
audible, visible or other type of output, different from the alarm signal, permitting, directly or indirectly, a warning or indication that the apparatus is not working satisfactorily

3.5.3
latching alarm
alarm that, once activated, requires deliberate action to be deactivated

3.5.4
special state
all states of the apparatus other than those in which monitoring of gas concentration takes place, for example warm-up, calibration mode or fault condition

3.6 Times

3.6.1
drift
variation in the apparatus indication with time at any fixed gas volume fraction (including clean air) under constant ambient conditions

3.6.2
final indication
indication given by the apparatus after stabilisation

3.6.3
minimum time of operation (spot-reading apparatus)
time interval between the initiation of a measurement procedure and the time when the apparatus indication reaches a stated percentage of the final indication

3.6.4
stabilisation
state when three successive readings of an apparatus, taken at 2 min intervals, indicates no changes greater than ±1 % of the measuring range

3.6.5
time of response *t*(*x*) (not applicable to spot-reading apparatus)
time interval, with the apparatus in a warmed-up condition, between the time when an instantaneous change between clean air and the standard test gas, or vice versa, is produced at the apparatus inlet, and the time when the response reaches a stated percentage (x) of the stabilised signal on the standard test gas

3.6.6
warm-up time (not applicable to spot-reading apparatus)
time interval, with the apparatus in a stated atmosphere, between the time when the apparatus is switched on and the time when the indication reaches and remains within the stated tolerances (see Figures 1 and 2)

3.7 Miscellaneous

3.7.1
nominal supply voltage
voltage that is given by manufacturers as the recommended operating voltage of their gas detection apparatus

3.7.2
special tool
tool required to gain access to, or to adjust, controls. The design of the tool is intended to discourage unauthorised interference with the apparatus

3.7.3
type of protection
measures applied in the construction of electrical equipment to prevent ignition of the surrounding explosive atmosphere by such apparatus (see 4.1.2)

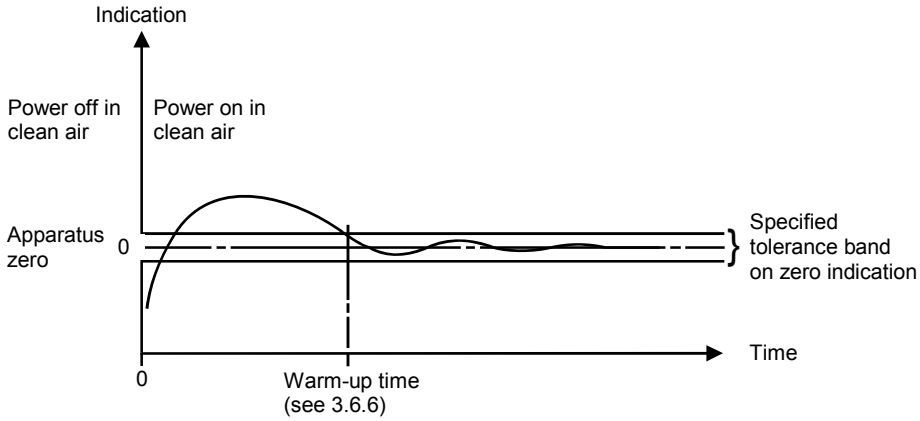


Figure 1 – Warm-up time in clean air (typical)

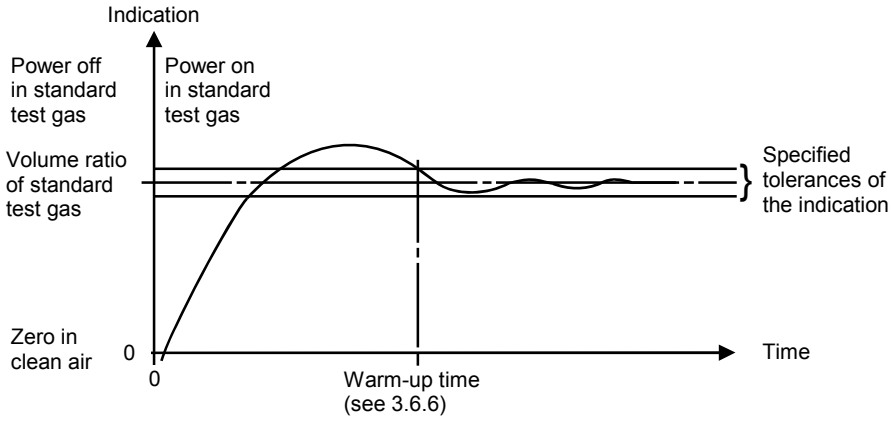


Figure 2 – Warm-up time in standard test gas (typical)

4 General requirements

4.1 Introduction

4.1.1 The apparatus shall comply with the requirements of this standard and Annex A criteria.

Where an apparatus manufacturer makes any claims regarding any special features of construction or superior performance that exceed these minimum requirements, all such claims shall be verified and the test procedures shall be extended or supplemented, where necessary, to verify the claimed performance.

4.1.2 Electrical assemblies and components shall comply with the construction and test requirements of 4.2 and Clause 5, where applicable. In addition, parts of the flammable gas detection apparatus intended for use in hazardous areas shall employ materials, and comply with the construction and explosion protection as specified in the other relevant parts of IEC 60079 series.

The operation and storage temperature limits of this standard could exceed the required temperature limits of these other parts of IEC 60079 for certain types of equipment. Therefore, the certification of the protection technique(s) used for the apparatus shall cover this extended temperature range. Conversely, where the certification is required outside the normal temperature limits appropriate to the protection technique(s) used, the test temperature exceeding the required ranges within this standard shall be changed appropriately.

4.1.3 For group I apparatus any electrical circuits to be installed in the same area as the sensor, including those within the sensor, shall be intrinsically safe ("ia"); the sensing elements shall be intrinsically safe, or their enclosures shall comply with the safety requirements specified in 4.1.2.

4.2 Construction

4.2.1 General

Gas detection apparatus or parts thereof (e.g. remote sensors) specifically intended for use in the presence of corrosive vapours or gases, or which may produce corrosive by-products as a result of the detection process (e.g. catalytic oxidation or other chemical process) shall be constructed of materials known to be resistant to corrosion by such substances.

All apparatus shall be constructed to facilitate regular accuracy checks.

All materials and components used in the construction of the apparatus shall be used within the manufacturer's ratings or limitations, unless otherwise specified by appropriate safety standards.

NOTE Apparatus using absorption principles where the gas is sampled by diffusion would typically be expected to have an optical chamber length of up to 30 cm. However, for special applications a longer fixed optical chamber length may be employed for point detection purposes.

4.2.2 Indicating devices

4.2.2.1 General

An indication shall be provided to show that the apparatus is energized.

NOTE For fixed apparatus the indication may be shown at the control unit.

4.2.2.2 Resolution

For alarm-only apparatus or apparatus where the resolution of the read-out device is inadequate to demonstrate compliance with this standard, the manufacturer shall identify suitable points for connecting indicating or recording devices for the purpose of testing the compliance of the apparatus with this standard. The indication on the readout device shall not contradict the results obtained by additional indicating or recording devices.

4.2.2.3 Measurement range

Any under-range or over-range measurements shall be clearly indicated as such.

4.2.2.4 Selectable range

If the apparatus has more than one measuring range, the range selected shall be clearly identified.

4.2.2.5 Indicating light

If only one indicating light is provided for signalling alarms, faults and other indications, it shall be coloured red. If separate indicating lights are used or if a multi-coloured indicating light is provided, the colours shall be used in the following order of priority ((a) being highest priority):

a) alarms indicating the presence of a gas concentration beyond an alarm set point shall be coloured RED;

b) equipment fault indicators shall be coloured YELLOW;

c) power supply indicators shall be coloured GREEN.

4.2.2.6 Indicator light marking

In addition to the colour requirements, the indicator lights shall be adequately labelled to show their functions.

4.2.3 Alarm or output functions

4.2.3.1 General

Alarm devices shall not be adjustable to operate outside the measuring range.

4.2.3.2 Continuous duty apparatus

If alarm devices, output contacts or alarm signal outputs are provided as part of fixed or continuous duty portable apparatus and are intended to operate when a potentially hazardous gas concentration is detected, they shall be of a latching type requiring a deliberate manual action to reset. If two or more alarm set points are provided, the lower may be non-latching – based on user preference. Alarms shall remain in operation while the alarm condition is still present. An additional audible alarm may be silenced.

NOTE The latching device may reside in software.

If it is possible to de-activate alarm devices, output contacts or alarm signal outputs, e.g. for calibration purposes, this deactivation shall be indicated by a signal. For fixed apparatus, this shall include a contact or other transmittable output signal. Alternatively, the output signal or contacts are not required if the alarms are automatically re-enabled within 15 min.

4.2.3.3 Group I portable apparatus indicating up to 5 % v/v

Alarm devices shall not be adjustable above 3 % v/v. An additional over-range alarm, which indicates when full scale has been exceeded, may be provided.

4.2.3.4 Group II portable apparatus indicating up to 100 % LFL

Alarm devices shall not be adjustable above 60 % LFL. An additional over-range alarm, which indicates when full scale has been exceeded, may be provided.

NOTE For other group II apparatus, it is recommended that alarm devices should be set to operate at a gas volume fraction not higher than 60 % LFL.

4.2.4 Fault signals

Fixed and transportable apparatus shall provide a fault signal in the event of failure of power to the apparatus.

A short-circuit or open-circuit in connections to any remote sensor shall be indicated by a fault signal.

Automatically aspirated apparatus shall be provided:

a) in the case of fixed and transportable apparatus, with an integral flow-indicating device that produces a fault signal in the event of flow failure,

b) in the case of portable apparatus, with a means of verifying the air flow.

4.2.5 Adjustments

All adjustment devices shall be designed so as to discourage unauthorized or inadvertent interference with the apparatus. Examples would include procedural devices, in the case of a keyboard instrument, or mechanical devices such as a cover requiring the use of a tool.

Fixed explosion-protected apparatus housed in explosion-protected enclosures shall be designed so that, if any facilities for adjustment are necessary for routine recalibration and for resetting or like functions, these facilities shall be externally accessible. The means for making adjustments shall not degrade the explosion protection of the apparatus.

The adjustments of the zero and signal amplification shall be so designed that adjustment of one will not affect the other.

4.2.6 Battery-powered apparatus

Apparatus powered with integral batteries shall be provided with an indication of low battery condition, and the nature and purpose of this indication shall be explained in the manual (see 4.4 j)).

4.2.7 Stand-alone gas detection apparatus for use with separate control units

A specification shall be supplied with the apparatus that describes the relationship the gas concentration (detected by the apparatus) has with the corresponding output signal or indication (transfer function). Such specification shall be detailed to the extent that the accuracy of this transfer function can be verified. As a minimum, the manufacturer shall provide data showing the relationship between the output signal and the gas concentrations corresponding to 0, 10 %, 25 %, 50 %, 75 % and 100 % of full-scale output indication. Full-scale output and status signals (e.g. fault, inhibit) shall also be specified by the manufacturer.

Where necessary, equipment shall be provided by the manufacturer to interpret the output signal or indication, which will enable the accuracy of the transfer function to be verified.

4.2.8 Separate control units for use with stand-alone gas detection apparatus

A specification shall be supplied with the apparatus that describes the relationship the input signal has with the calculated gas concentration (transfer function). Such specification shall be detailed to the extent that the accuracy of this transfer function can be verified. As a minimum, the manufacturer shall provide data showing the relationship between the input signal and the gas concentrations corresponding to 0, 10 %, 25 %, 50 %, 75 % and 100 % of full-scale output indication. Required inputs for full-scale indication and status signals (e.g. fault, inhibit) shall also be specified by the manufacturer.

Where necessary, equipment shall be provided by the manufacturer to provide the input signals, which will enable the accuracy of the transfer function to be verified.

4.2.9 Software-controlled apparatus

In the design of software-controlled apparatus, the risks arising from faults in the programme shall be taken into account.

4.2.9.1 Conversion errors

The relationship between corresponding analogue and digital values shall be unambiguous. The output range shall be capable of coping with the full range of input values within the instrument specification. A clear indication shall result if the conversion range has been exceeded.

The design shall take into account the maximum possible analogue-to-digital, computational and digital-to-analogue converter errors. The combined effect of digitisation errors shall not be greater than the smallest deviation of indication required by this standard.

4.2.9.2 Special state indication

If a special state is entered by an apparatus this shall be indicated by a signal. For fixed apparatus, this shall include a contact or other transmittable output signal.

4.2.9.3 Software

Software components shall comply with the following:

a) It shall be possible for the user to identify the installed software version, for example by marking on the installed memory component, in (if accessible) or on the apparatus or by showing it on the display during power up or on user command.

b) It shall not be possible for the user to modify the program code.

c) Parameter settings shall be checked for validity. Invalid inputs shall be rejected. An access barrier shall be provided against parameter changing by unauthorised persons, e.g. it may be integrated by an authorisation code in the software or may be realised by a mechanical lock. Parameter settings shall be preserved after removal of power, and while passing a special state. All user changeable parameters and their valid ranges shall be listed in the manual.

d) Software shall have a structured design to facilitate testing and maintenance. If used, program modules shall have a clearly defined interface to other modules.

e) Software documentation shall be included in the technical file of the product. It shall include:

   1) the apparatus to which the software belongs;

2) unambiguous identification of program version;
3) functional description;
4) software structure (e.g. flow chart, Nassi-Schneidermann diagram);
5) any software modification provided with the date of change and new identification data.

4.2.9.4 Data transmission

Digital data transmission between spatially separated components of apparatus shall be reliable. Delays resulting from transmission errors shall not extend the response time t_{90} or time to alarm for alarm only apparatus by more than a third. If they do, the apparatus shall pass over to a defined special state. The defined special state shall be documented in the instruction manual.

4.2.9.5 Self-test routines

Computerised digital units shall incorporate self-test routines. On failure detection, the apparatus shall pass over to a defined special state. The defined special state shall be documented in the instruction manual.

The following minimum tests shall be performed by the apparatus:

a) power supply of digital units shall be monitored within time intervals of maximum ten times response time *t*(90) or time to alarm for alarm only apparatus
b) all available visible and audible output functions shall be tested. The test shall be carried out automatically after starting operation or on user request. The result may need to be verified by the user
c) monitoring equipment with its own time base (e.g. watchdog) shall work independently and separately from the parts of the digital unit, which perform the data processing;
d) program and parameter memory shall be monitored by procedures, which allow the detection of a single bit error
e) volatile memory shall be monitored by procedures that test the readability and writeability of the memory cells.

The tests except for test b) shall be done automatically and be repeated cyclically equal to or less than 24 h and after switching on.

4.2.9.6 Functional concept

The manufacturer shall provide documentation for functional concept analysis and evaluation using the following list:

– measuring sequence (including all possible variations),
– possible special states,
– parameters and their tolerable adjustment range,
– – representation of measuring values and indications,
– generation of alarms and signals,
– extent and realisation of test routines,
– extent and realisation of remote data transmission.

4.3 Labelling and marking

The apparatus shall comply with the marking requirements of IEC 60079-0

NOTE Electrical equipment, which does not fully comply with the relevant parts of IEC 60079-0 but where equivalent safety is claimed, should be marked with the symbol “s”.

In addition, the apparatus shall also be marked:

a) “IEC 60079-29-1” (to represent conformance with this performance standard);

b) year of construction (may be encoded within the serial number);

4.4 Instruction manual

Each apparatus shall be provided with an instruction manual that includes the following information:

a) complete instructions, drawings and diagrams for safe and proper operation, installation and servicing of the apparatus,

b) operating instructions and adjustment procedures,

c) recommendations for initial checking and calibration of the apparatus on a routine basis, including instructions for the use of the field calibration kit, if provided (see also 5.4.26).

   For portable apparatus, these shall include the requirement and method for performing a functional check with gas before each day of use;

   NOTE- Users are referred to IEC 60079-29-2.

d) details of operational limitations including, where applicable, the following:

   1) gases for which the apparatus is suitable and the relative sensitivities to these gases,

   2) information that describes the sensitivities to other gases to which the apparatus is responsive,

   3) response times *t*(90) for the standard test gas(es), and information that describes how response times could vary for other gases,

   4) temperature limits,

   5) humidity ranges,

   6) pressure limits,

   7) supply voltage limits,

   8) maximum power consumption,

   9) relevant characteristics and construction details of required interconnecting cables,

   10) battery data,

   11) sample flow rate,

   12) warm-up time,

   13) stabilization time,

e) details of storage life and limitations for the apparatus, replacement parts and accessories, including, where applicable, the following:

   1) temperature,

   2) humidity,

   3) pressure,

   4) time,

f) bases used for converting test and calibration gas concentrations from % LFL to % volume fraction;

g) information on the adverse effects of poisons and interfering gases or substances and oxygen-enriched or deficient atmospheres on the proper performance (and, in the case of oxygen-enriched atmospheres, on electrical safety) of the apparatus;

h) for aspirated apparatus, indication of the minimum and maximum flow rates and pressure; also, tubing type, maximum length and size for proper operation;

i) for aspirated apparatus, instructions for ensuring that the sample lines are intact and that proper flow is established (see 4.2.4);

j) statements of the nature and significance of all alarms and fault signals, the duration of such alarms and signals (if time-limited or non-latching), and any provisions that may be made for silencing or resetting such alarms and signals, as applicable;

k) details of any method for the determination of the possible sources of a malfunction and any corrective procedures (i.e. trouble-shooting procedures);

l) a statement that alarm devices, outputs or contacts are of the non-latching types, where applicable (see 4.2.3.2);

m) for battery-operated apparatus, installation and maintenance instructions for the batteries;

n) a recommended replacement parts list;

o) where optional accessories (e.g. collecting cones, weather-protecting devices) are supplied, the manufacturer shall list such accessories and state their effects on the instrument characteristics (including response time and sensitivity), and provide means for their identification (e.g. part numbers included in manual);

p) details of certification and marking, and any special conditions of service;

q) where the special nature of the apparatus (such as non-linear responses) requires additional instructions or special information that are alternative to, or in addition to, the requirements of 4.3 and 4.4 a) to p), the instructions or information shall be provided.

5 Test methods

5.1 Introduction

The test methods and procedures described in 5.2 to 5.4 are intended as a basis for establishing whether the apparatus conforms with the supplementary requirements for performance given in Annex A.

5.2 General requirements for tests

Where it is necessary to apply LFL and UFL values for the purposes of this standard, they shall be taken from IEC 60079-20.

5.2.1 Samples and sequence of tests

5.2.1.1 General

For the purpose of type testing, the tests shall be carried out on one apparatus. Another apparatus may be used for tests according to 5.4.4.2 to 5.4.4.5, 5.4.18 and 5.4.24.

For IR-sensors using optical filters, the test 5.4.3.3 shall be conducted with two apparatus where the centre wavelength of the optical filters shall be at the minimum and maximum limits of the specification. One of these units may be used subsequently for 5.4.4.2 to 5.4.4.5, 5.4.18 and 5.4.24.

5.2.1.2 Sequence

The apparatus shall be subjected to all of the tests applicable to that type of apparatus, as described in 5.4.

Test 5.4.2 shall be conducted prior to all other tests. The manufacturer may request a particular order of the other tests. However, the tests 5.4.4.2 to 5.4.4.5, 5.4.18, and 5.4.24 shall always be conducted in this sequence.

5.2.1.3 Stand alone gas detection apparatus

Stand alone gas detection apparatus shall be tested to the requirements of 5.4.2 through 5.4.13, 5.4.15, 5.4.16, 5.4.18, 5.4.20 through 5.4.27 (if applicable) using the parameters of the transfer function.

5.2.1.4 Stand alone control units

Stand alone control units shall be tested to the requirements of 5.4.2, 5.4.3, 5.4.6, 5.4.7, 5.4.13, 5.4.15, 5.4.16, 5.4.18, 5.4.20, 5.4.21, 5.4.25 and 5.4.27 using the parameters of the transfer function pertinent to the specific type of gas detector.

5.2.1.5 Sample

Tests shall also be carried out, where applicable, to ensure that the apparatus satisfies the construction requirements of 4.2. The requirements for these tests are generally self-evident, except that for short-circuit requirements in 4.2.4, ballast resistors shall be substituted for each wire connecting the instrument to any remote sensor. The values of these resistors shall be those declared, in the instruction manual (see 4.4 d)), to be the maximum lead resistances allowing satisfactory compliance with the standard. The device used for the short circuit shall be of negligible resistance and shall be applied to convenient points in the circuit, at the sensor ends of the ballast resistors.

5.2.1.6 Sample with selectable range

For apparatus having more than one selectable range or scale for the same or different gases or vapours, each range shall be tested. For the second and subsequent ranges the necessary amount of testing shall be agreed upon between the manufacturer and the test laboratory.

5.2.2 Preparation of apparatus before testing

The apparatus shall be prepared and mounted as near to typical service as possible, in accordance with the instruction manual, including all necessary interconnections, initial adjustments and initial calibrations. Adjustments may be made, where appropriate, at the beginning of each test.

In particular, the following points shall be noted:

a) Apparatus having remote sensors

   For the purpose of the tests in 5.4, where reference is made to exposure of the sensor to the test conditions, the entire remote sensor (including any or all normally attached protective mechanical parts) shall be exposed.

   For apparatus having connection facilities for more than one remote sensor, only one remote sensor needs to be subjected to the tests. The replacement of all but one sensor by "dummy" impedances yielding the worst case load conditions for the test in question shall be permitted. The worst case load conditions shall be determined by the testing laboratory within the limits specified in the instruction manual (see 4.4 d)).

For apparatus having remote sensor(s), all tests shall be performed with resistances connected in the detector circuit to simulate the maximum line resistance specified by the manufacturer, except where minimum line resistance offers a more stringent test in the judgement of the test laboratory.

b) Apparatus having self-contained sensors

The entire apparatus shall be exposed to the test conditions without removal of any normally attached parts, including any sampling probe for tests 5.4.11, 5.4.15, 5.4.16 and 5.4.17.

c) Alarm-only apparatus

For alarm-only apparatus, readings shall be taken using an external meter connected to the test points described in 4.2.2.2.

In all cases, optional parts shall be either attached or removed according to which condition will give the most unfavourable result (at the discretion of the testing laboratory) for the test being conducted.

5.2.3 Mask for calibration and tests

When a mask is used for calibration or for the injection of test gas into the sensor, the design and operation of the mask used by the testing laboratory – in particular the pressure and velocity inside the mask – shall not inadmissibly influence the response of the apparatus or the results obtained.

NOTE It is recommended that the testing laboratory should consult with the manufacturer in determining the design of the calibration mask. The manufacturer may provide a suitable calibration mask together with details of suggested pressure or flow for application of calibration gases with the apparatus.

5.3 Normal conditions for test

5.3.1 General

The test conditions specified in 5.3.2 to 5.3.12 shall be used for all tests, unless otherwise stated.

5.3.2 Test gas(es)

The flammable gas(es) to be used in a mixture with clean air for initial and all subsequent tests shall be selected in accordance with a) to c) with decreasing priority below.

a) The specific gas for apparatus intended for sensing a single flammable gas only.

b) Methane for apparatus intended for sensing methane or firedamp, or intended for general purpose flammable gas detection that includes the detection of methane.

c) A gas from the range of flammable gases for which the apparatus is deemed to be suitable by the manufacturer. The choice of this gas should be made by agreement between the manufacturer and the test laboratory.

NOTE 1 It is recommended to test apparatus with catalytic combustion sensors intended for general purpose gas detection including methane with test gases methane and propane in order to get representative results (e.g. concerning sensitivity, response times and drift).

NOTE 2 It is recommended to test apparatus with IR-sensors intended for general purpose gas detection of hydrocarbons including methane with test gases methane and propane in order to get representative results (e.g. concerning sensitivity).

For all the other gases for which the apparatus is claimed to be suitable, the calibration curves and response times shall be supplied by the manufacturer and a representative sample verified by the testing laboratory. The volume fraction of the component within the test gas(es) shall be known to a relative expanded uncertainty of ±2 % of the nominal value.

NOTE 3 For the purpose of this standard, where it is appropriate to use zero gas rather than clean air, references to clean air may be regarded as references to zero gas.

NOTE 4 The gas mixture may be prepared by any suitable method, for example in accordance with the methods outlined in ISO 6142 or ISO 6145, or by commercially produced certified gas mixtures.

5.3.3 Standard test gas

The volume fractions of the standard test gases shall be as follows:

a) for group I apparatus indicating up to a volume fraction of 5 % methane: equivalent range of either a volume fraction of (1,5 ± 0,15) % or a volume fraction of (2,0 ± 0,2) %, as agreed between the manufacturer and the testing laboratory;
b) for other group I and all group II apparatus: 45 % to 55 % of the measuring range, not within the explosive range wherever possible. If this concentration is within the explosive range, the flammable gas shall be mixed with nitrogen if the measuring function of the apparatus is not affected by oxygen deficiency. Otherwise the concentration of the standard test gas shall be taken outside the explosive range as near as possible to the values stated above;

The volume fractions shall be known to a relative expanded uncertainty of ±2 %.

5.3.4 Flow rate for test gases

When the apparatus is exposed to the test gases, including air, the flow rate of the gas shall be in accordance with the manufacturer's instructions.

NOTE For apparatus that samples by diffusion, either a calibration mask in accordance with 5.2.3 or a test chamber may be used (see also Annex B).

5.3.5 Voltage

a) Mains-powered and fixed DC powered apparatus shall be operated within 2 % of the manufacturer's recommended supply voltage and frequency.
b) Battery-powered apparatus shall, for short-term tests, be equipped with new or fully charged batteries at the commencement of each series of tests. For long-term testing, it is permissible to energize the unit from a stabilized power supply.

5.3.6 Temperature

The ambient air and test gas shall be held at a temperature constant to ±2 K within the range of 15 °C to 25 °C, throughout the duration of each test, unless otherwise specified for the particular test.

5.3.7 Pressure

The tests shall be performed at pressures between 86 kPa and 108 kPa with a maximum variation of ±1 kPa throughout the duration of each short-term test, unless otherwise specified for the particular test. For long-term tests, the influence of pressure changes shall be taken into account, using the results of the pressure test (5.4.8).

5.3.8 Humidity

The ambient air and test gas shall be held at a relative humidity (RH), controlled to within ±10 % RH, over the range 20 % to 80 % throughout each test unless otherwise specified for the particular test.

For short applications of test gases, the use of dry gases is permitted. The properties of the measuring principle of the sensor shall be taken into account.

5.3.9 Stabilization time

In each instance where the apparatus is subjected to a different test condition, the apparatus shall be allowed to stabilize under these new conditions before measurements are taken.

5.3.10 Orientation

The apparatus shall be tested in the orientation recommended by the manufacturer.

5.3.11 Communications options

For apparatus having serial or parallel communications options used during normal gas detection operation, tests in 5.4.3, 5.4.7 and 5.4.16 shall be performed with all communication ports connected. The maximum transaction rate, cabling characteristics and activity level specified by the instrument's manufacturer shall be employed.

5.3.12 Gas detection apparatus as part of systems

For gas detection apparatus, which are part of systems, tests in 5.4.3, 5.4.7, 5.4.16 and 5.4.20 shall be performed with the maximum system communications transaction rate and activity level. This shall correspond to the largest and most complex system configuration permitted by the manufacturer.

5.4 Test methods

5.4.1 General

The following tests shall be performed in accordance with 5.3, unless otherwise stated. All tests shall be performed. At the end of each test, indications shall be taken in both clean air and the standard test gas, unless otherwise stated. The values of the indications used for verification of compliance with the performance requirements of Annex A shall be the final indications (see 3.6.2) of both the clean air and standard test gas readings, unless otherwise stated.

5.4.2 Unpowered storage

All parts of the apparatus shall be exposed sequentially to the following conditions in clean air only:

a) a temperature of (–25 ± 3) °C for 24 h;

b) ambient temperature for at least 24 h;

c) a temperature of (60 ± 2) °C for 24 h;

d) ambient temperature for at least 24 h.

At each temperature, the humidity of the clean air shall be so that condensation does not occur.

The above temperatures may be varied only after an agreement has been reached between the manufacturer and testing laboratory (see also 4.1.2). Where temperatures other than those listed above are used, they shall be listed in the certification documents.

5.4.3 Calibration and adjustment

5.4.3.1 Initial preparation of the apparatus

The apparatus shall be calibrated and adjustments shall be carried out, if needed, to obtain correct indications in accordance with the manufacturer's instruction manual.

5.4.3.2 Calibration curve

The apparatus shall be exposed to the gas selected in accordance with 5.3.2, at four volume fractions evenly distributed over the measuring range, starting with the lowest and finishing with the highest of the selected volume fractions. This operation shall be carried out three times consecutively.

5.4.3.3 Response to different gases

For group II apparatus, the accuracies of the response curves or correction charts provided in the manufacturer's manual shall be checked by measuring the response for the representative gases according to 5.3.2, at a minimum of three different volume fractions spread evenly over the measuring range to verify response characteristics.

The ratio between the indication of the apparatus (before correction using the manufacturer's response curve or correction charts) and the gas volume fraction obtained for each of the three gas volume fractions of each gas tested shall not be less than 0,4 and shall not exceed 2,0.

5.4.4 Stability (continuous duty apparatus only)

NOTE For these tests, battery-powered apparatus should be powered from internal batteries wherever possible, otherwise an external power supply may be used.

5.4.4.1 Short-term stability

The apparatus shall be exposed to six applications of the standard test gas for 3 min followed by exposure to clean air for a period of 7 min. Indications shall be taken at the end of each exposure to air and the standard test gas.

5.4.4.2 Long-term stability (fixed and transportable apparatus – Group I only)

The apparatus shall be operated in clean air continuously for a period of four weeks and shall be exposed to the standard test gas for an 8 h period at weekly intervals over the four-week period. Indications shall be taken prior to the application of, after stabilization and prior to removal of the standard test gas.

Following this period, the following test shall be performed.

The apparatus shall be run in a methane-air mixture with a volume fraction of 1,0 % (v/v) ± 0,05 % (v/v) for 5 days, indications being taken daily in clean air and the standard test gas.

5.4.4.3 Long-term stability (portable apparatus – Group I only)

The apparatus shall be operated in clean air continuously for a period of 8 h per working day over a total of 20 working days. The apparatus shall be exposed to the standard test gas for 1 h during each operating period. Indications shall be taken prior to the application of, after stabilization, and prior to removal of the standard test gas.

Following this period, the following test shall be performed.

The apparatus shall be operated in a methane-air mixture with a volume fraction of 1,0 % (v/v) ± 0,05 % (v/v) for 8 h, taking indications in clean air and the standard test gas at the end of this period. The apparatus shall then be switched off and exposed to clean air for 16 h. This cycle shall be repeated a further 4 times.

5.4.4.4 Long-term stability (fixed and transportable apparatus – Group II only)

The apparatus shall be operated continuously in clean air for a period of two months. At the end of the first week, the apparatus shall be exposed to the standard test gas for an 8 h period. Indications shall be taken prior to the application of test gas, after stabilization of the reading and prior to the removal of test gas.

At the end of each subsequent week, the apparatus shall be exposed to the standard test gas until the reading has stabilized. Indications shall be taken prior to both the application and the removal of the test gas.

5.4.4.5 Long-term stability (portable apparatus – Group II only)

The apparatus shall be operated in clean air continuously for a period of 8 h per working day over a total of 20 working days. The apparatus shall be exposed to the standard test gas until stabilized, once during each operating period. Indications shall be taken prior to the application of, after stabilization and prior to removal of the standard test gas.

5.4.5 Stability (spot-reading apparatus only)

The apparatus shall be exposed to clean air for 1 min followed by the standard test gas for 1 min. The operation shall be repeated 200 times. The final indication will be taken in clean air and the standard test gas, after stabilization at the end of the test.

NOTE For these tests, battery-powered apparatus should be powered from internal batteries wherever possible, otherwise an external power supply may be used.

5.4.6 Alarm set point(s)

5.4.6.1 General

When the apparatus is provided with either

a) externally adjustable means of setting either one or more alarm set points, or

b) internally pre-set alarm point(s) the activation of such alarms by gas at the appropriate set point values shall be verified by using test gases as described in 5.4.6.2 and 5.4.6.3. In all cases, the test gas shall be applied until either activation of the alarm(s) or twice the respective $t(90)$, whichever is less.

For apparatus with several alarm set points, these tests shall be carried out for each alarm set point.

5.4.6.2 Increasing concentration

For apparatus of type a) set the alarm set point at 10 % relative below the concentration of the standard test gas. If the alarm set point cannot be set at this concentration the alarm shall be set as near as possible to that concentration. In this case and for apparatus of type b), the test gas shall have a volume fraction of 10 % relative above the concentration of the alarm set point. Expose the apparatus to clean air and then to the standard test gas or the specified test gas.

5.4.6.3 Decreasing concentration

For apparatus of type a) set the alarm set point at 5 % of the measuring range. If the alarm set point cannot be set at this concentration the alarm shall be set as near as possible to that concentration. In this case and for apparatus of type b), the test gas shall have a volume fraction of the alarm set point minus 5 % of the measuring range. Expose the apparatus to standard test gas and then to clean air or the specified test gas.

5.4.7 Temperature

This test shall be performed in a temperature chamber having the capability of holding the sensor or apparatus at the specified temperature within ±2 °C. When the apparatus (or the portion under test) has reached the temperature specified in Annex A, as appropriate, the sensor shall be exposed sequentially to air and the standard test gas, which shall be at the same temperature as the atmosphere in the test chamber. The dew point of the air or standard test gas shall be below the lowest temperature of the test chamber and kept constant during the test.

5.4.8 Pressure

The effects of pressure variation shall be observed by placing the sensor or apparatus (including the aspirator for aspirated apparatus) in a test chamber that permits the pressure of clean air and of the standard test gas to be varied.

The pressure shall be maintained at the specified levels for 5 min, before a reading is accepted or a test is made. Readings shall be taken with clean air and standard test gas.

5.4.9 Humidity

The test shall be done with three different humidities evenly distributed over the range specified in Annex A. The apparatus shall be allowed to stabilize at 40 °C. After stabilization it shall be adjusted according to the instructions of the manufacturer. For each humidity, the apparatus shall be exposed for 15 min to clean air and then to the standard test gas at the same humidity. The relative humidity levels shall be known to within ±3 % RH.

The concentration of the test gas shall be held constant, or due allowance of changes in its concentration by dilution in water shall be made.

5.4.10 Air velocity

5.4.10.1 General

The effects of air speed over a range of 0 m/s to 6 m/s on apparatus with sensors that operate by diffusion shall be determined using the test conditions given in 5.4.10.2.

5.4.10.2 Test conditions

The separate sensors of apparatus with remote sensors and, when practicable, the entire apparatus if the sensors are integral shall be tested in a flow chamber.

NOTE The flow chamber should be suitable for the application of clean air and the standard test gas.

For apparatus having integral sensors, which are too large to be tested in a flow chamber, other flow apparatus for carrying out the test shall be permitted.

Irrespective of whether a flow chamber or other flow apparatus is used, orient the sensor in relation to the direction of the air flow as follows:

1) sensor oriented directly towards direction of flow,
2) sensor oriented away from the direction of flow,
3) sensor oriented at right angles to the direction of flow.

Measurements shall be made under static conditions, at 3 m/s and at 6 m/s.

NOTE Directions of flow which are not likely to occur in practice, due to the design of the apparatus, or which are expressly prohibited within the manufacturer's instruction manual may not be tested.

5.4.11 Flow rate for aspirated apparatus

The apparatus shall be tested by varying the flow rate

1) from 130 % of the nominal flow rate or, if this is not possible, from the nominal flow rate,
2) to the flow rate at which the failure alarm is set, or to 50 % of the nominal flow rate if no failure alarm is provided.

5.4.12 Orientation

5.4.12.1 Portable apparatus

During tests with clean air and standard test gas, rotate the sensor, or the whole apparatus if relevant, through 360° in steps of 90° around each of its three mutually perpendicular axes (one axis at a time). Record the indication in each position.

5.4.12.2 Fixed and transportable apparatus

Test the sensor, or the apparatus having an integral sensor, with clean air and standard test gas within the orientation limits stated in the manufacturer's instructions, but in no case less than a deviation of ±15° from the nominal orientation.

5.4.13 Vibration

5.4.13.1 Test equipment

The vibration test machine shall consist of a vibrating table capable of producing a vibration of variable frequency and variable constant displacement (peak-to-peak), with the test apparatus mounted in place, as required by the following test procedures.

5.4.13.2 Procedures

The apparatus shall be energized and mounted on the vibration test machine and vibrated successively in each of three planes respectively parallel to each of the three major axes of the apparatus.

The alarm set point shall be set to 20 % of full-scale range.

Before, and at the conclusion of the test, the apparatus shall be exposed to clean air followed by the standard test gas.

The apparatus shall be mounted on the vibration table in the same manner as intended for service use including any resilient mounts, carrier or holding devices that are provided as standard parts of the apparatus.

The apparatus shall be vibrated over the frequency range specified at the excursion or constant acceleration peak specified, for a period of 1 h in each of the three mutually perpendicular planes. The rate of change of frequency shall not exceed 10 Hz/min.

5.4.13.2.1 Procedure 1

For portable and transportable apparatus, remote sensors, and controllers where the sensor is integral with or directly attached to the controller, the vibration shall be as follows:

10 Hz to 30 Hz, 1,0 mm total excursion,

31 Hz to 150 Hz, 19,6 m/s^2 acceleration peak.

5.4.13.2.2 Procedure 2

For control units intended to be installed remotely from the sensor, the vibration shall be as follows:

10 Hz to 30 Hz, 1,0 mm total excursion,

31 Hz to 100 Hz, 19,6 m/s^2 acceleration peak.

5.4.14 Drop test for portable and transportable apparatus

This test is applicable to portable apparatus and transportable apparatus. If the manufacturer recommends that the instrument be used in its carrying case, the test shall be carried out with the case only.

NOTE If components of fixed apparatus can be used like portable or transportable apparatus according to the instruction manual, these components should be considered to be portable or transportable for this test.

Before, and at the conclusion of the test, the apparatus shall be exposed to clean air followed by the standard test gas.

Portable apparatus shall be released, while operating, from a height of 1 m above a concrete surface and allowed to free fall.

Transportable apparatus with a mass less than 5 kg shall be released, while not operating, from a height of 0,3 m above a concrete surface and allowed to free fall.

Other transportable apparatus shall be released, while not operating, from a height of 0,1 m above a concrete surface and allowed to free fall.

The test required above shall be performed three separate times, the portable apparatus being released each time with a different side (surface) facing down at the time of release and the transportable apparatus to be in an orientation for normal transport.

The apparatus shall be considered to have failed this test if there is a loss of function (e.g. alarm, pump function, controls, display) after the test.

5.4.15 Warm-up time

The alarm set point shall be set to 20 % of the measuring range.

The apparatus shall be switched off and left for 24 h in clean air. After the 24 h period, the apparatus shall be switched on in clean air and the warm-up time measured.

Group I apparatus, except spot-reading apparatus, shall be switched off for a further 24 h in clean air. After this period, the apparatus shall be exposed for 5 min to the standard test gas, then switched on in the presence of the test gas and the warm-up time measured.

5.4.16 Time of response (not applicable to spot-reading apparatus)

The apparatus shall be switched on in clean air and, after an interval corresponding to at least two times the warm-up time, as determined in accordance with 5.4.15, without switching off, the apparatus or the sensor(s) shall be subjected to step changes from clean air to the standard test gas and from standard test gas to clean air. These changes shall be introduced by means of suitable equipment (see Annex B).

The times of response $t(50)$ and $t(90)$ for increasing concentration, and $t(50)$ and $t(10)$ for decreasing concentration shall be measured.

The times of response shall apply to the apparatus in the as supplied condition and without optional accessories, e.g. collecting cones, weather protection, attached to the sensor for special purposes.

For an optional sampling probe, an extra test is required to measure the additional delay. This shall be less than 3 s/m of the total length of the probe plus tubing or any greater value, which is stated in the instruction manual.

5.4.17 Minimum time to operate (spot-reading apparatus)

The standard test gas shall be applied to the apparatus simultaneously with the initiation of the measurement procedure.

Clean air shall than be applied to the apparatus simultaneously with the initiation of the measurement procedure.

5.4.18 High gas concentration operation above the measuring range

This subclause applies to all apparatus with an upper limit of the measuring range less than 100 % (v/v) gas.

The entire apparatus, or the remote sensors of fixed or transportable apparatus, shall be subjected to the test given in 5.4.18.1 or 5.4.18.2 using a test apparatus that simulates a step change between gas concentrations such as those described in Annex B.

All gas concentrations above full scale shall be indicated by a full scale meter indication and, where fitted, an alarm. If the indication is digital, a clear indication shall be given that the upper limit of the measuring range has been exceeded.

5.4.18.1 Spot-reading apparatus

The apparatus shall be subjected to 50 cycles, each cycle being an exposure of a volume fraction of 100 % (v/v) gas for the minimum time of operation, followed by exposure to clean air for the minimum time of operation. Following the final cycle, five operations in clean air shall be made, each operation equivalent to the minimum time of operation, and the apparatus shall then be subjected to the standard test gas.

5.4.18.2 Apparatus other than spot-reading apparatus

The apparatus, or remote sensor, shall be subjected to a step change from clean air to a volume fraction of 100 % gas that shall be maintained for 3 min. The sensor shall then be subjected to clean air for 20 min, followed by the standard test gas.

5.4.19 Battery capacity

5.4.19.1 Battery-powered portable continuous duty apparatus

5.4.19.1.1 Battery discharge

With a battery fully charged at the beginning of the test, the apparatus shall be operated in clean air for a total period of

a) 8 h, if fitted with a user-operable on/off switch,

b) 10 h, if not so fitted, or

c) any longer time as specified by the manufacturer.

At the end of the specified period, the apparatus is exposed to the standard test gas.

5.4.19.1.2 Low battery duration

The apparatus shall then continue to operate until an indication that the low battery condition has been reached. The apparatus shall continue to operate for an additional 10 min.

5.4.19.2 Battery-powered portable spot-reading apparatus

5.4.19.2.1 Battery discharge

With the battery fully charged at the beginning of the test, the apparatus shall be operated in clean air 200 times.

The duration of each operation shall be equal to the minimum time of operation; 1 min shall elapse after each operation.

At the end of the 200 operations, the apparatus shall be exposed to the test gas.

5.4.19.2.2 Low battery discharge

The cycle of operations shall then be continued until an indication that the low battery condition has been reached. The apparatus shall be operated for an additional 10 times.

5.4.20 Power supply variations

The apparatus shall be set up under normal conditions (see 5.3), at nominal supply voltage and, where appropriate, rated frequency. For apparatus with remote sensors, the test shall be performed with both maximum and minimum resistance of the interconnecting cable. The apparatus shall then be subjected to the following tests.

The apparatus calibration shall be checked at both 115 % and 80 % of nominal supply voltage.

Where the manufacturer of the apparatus specifies a supply range other than those specified above, the apparatus shall be tested at the upper and lower limits of the supply voltage specified by the manufacturer.

It shall be verified at the minimum supply voltage that all output functions are working properly even at the maximum load conditions.

NOTE 1 This includes testing of analogue outputs at the maximum load and maximum current.

NOTE 2 This includes testing that relays are able to energize at the minimum supply voltage.

5.4.21 Power supply interruptions, voltage transients and step changes of voltage

5.4.21.1 General

The apparatus shall be set up under normal conditions, in accordance with 5.3, and then shall be subjected to the tests specified in 5.4.21.2 to 5.4.21.4 in clean air only.

The alarm set point shall be set to 20 % of the measuring range.

5.4.21.2 Short interruption of power supply

The power supply shall be interrupted for 10 ms, repeated 10 times at random time intervals having a mean value of 10 s.

5.4.21.3 Voltage transients

The apparatus shall be tested according to IEC 61000-4-4, test severity 2. The test procedure for type tests performed in laboratories shall be used. The test duration shall be 1 min for each line or terminal to be tested.

5.4.21.4 Step changes of voltage without interruption

For a.c. and external d.c. powered apparatus, the power voltage shall be increased by 10 %, maintained at this value until the apparatus is stabilized, and then reduced to 15 % below nominal voltage. Each step change shall take place within 10 ms.

5.4.22 Addition of sampling probe

When it is intended to add a sampling probe, the apparatus shall first be calibrated using clean air and the standard test gas without the sampling probe. The sampling probe shall then be added, and clean air and standard test gas applied again.

5.4.23 Dust (for apparatus where the air is sampled by natural diffusion only)

The effect of dust shall be simulated by uniformly reducing the gas inlet area of the apparatus by 50 % before subjecting it to clean air or the standard test gas.

5.4.24 Poisons and other gases

5.4.24.1 Poisons (applicable only to group I apparatus with catalytic or semiconductor sensors)

The apparatus shall be exposed to a volume fraction of 1 % methane in air mixture containing a volume fraction of 10×10^{-6} of hexamethyldisiloxane and shall perform 40 min continuous operation for continuous duty apparatus, or 100 tests for spot-reading apparatus.

Certain materials that may be present in industrial atmospheres can lead to "poisoning" or other undesirable effects which may result in a change of sensitivity of a gas sensor.

NOTE As improved tolerances to these materials are frequently claimed by manufacturers, evidence of the testing procedure used to substantiate these claims and test results may be open to validation or verification by agreement between a purchaser, a manufacturer, and a testing laboratory. Possible "poisoning" agents and their effects on sensor performance are discussed in IEC 60079-29-2.

5.4.24.2 Other gases

The apparatus shall be tested separately with the following gas mixtures:

a) group I apparatus indicating up to a volume fraction of 5 % methane in air:
   1) a methane volume fraction of the standard test gas + a volume fraction of 13 % oxygen in nitrogen,
   2) a methane volume fraction of the standard test gas + a volume fraction of 5 % carbon dioxide in air,
   3) a methane volume fraction of the standard test gas + a volume fraction of 0,075 % ethane in air,
b) group I apparatus indicating up to a volume fraction of 100 % methane:
   1) a volume fraction of 50 % methane + a volume fraction of 6,5 % oxygen in nitrogen,
   2) a volume fraction of 50 % methane + a volume fraction of 5 % carbon dioxide in nitrogen,
   3) a volume fraction of 50 % methane + a volume fraction of 2,5 % ethane in nitrogen.

The gas mixtures may be prepared by any suitable method. The tolerances on the volume fraction of each component shall be within ±10 % of its nominal concentration.

The volume fraction of each component shall be known to a relative expanded uncertainty of ±2 % of the stated value.

5.4.25 Electromagnetic immunity

The apparatus, including the sensor and interconnecting wiring, shall be subjected to a test method used in conducting EMC radiated immunity tests according to IEC 61000-4-1 and IEC 61000-4-3.

The test requirements shall be carried out with severity level 2; test field strength 3 V/m.

NOTE More severe electromagnetic immunity test parameters may be required for specific applications or for local regulations.

The alarm set point shall be set to 20 % of measuring range.

The test shall be carried out in clean air.

In the case of field systems with remote sensing where the control unit is intended for general purpose rack mounting or its equivalent, such a control unit shall be submitted to these tests in an enclosure supplied by the manufacturer.

The instruction manual shall inform the user that such apparatus is to be used with the same enclosure to avoid adverse electromagnetic effects.

NOTE Electromagnetic emission requirements may be required by other standards.

5.4.26 Field calibration kit

If a field calibration kit is provided with the apparatus, carry out the following test:

a) calibrate the apparatus in accordance with 5.4.3.1 using the test conditions given in 5.3 and using the test equipment for the tests described in 5.4,

b) use the field calibration kit in a manner corresponding to the manufacturer's instructions for checking the apparatus response.

5.4.27 Software verification

The function of the software-controlled apparatus shall be evaluated and tested according to 4.2.9.

Annex A
(normative)

Performance requirements

Table A.1 – Performance requirements

Sub-clause	Test	Group I apparatus limits (whichever value is greater)		Group II apparatus limits (whichever value is greater)	
		Volume fraction up to 5 % methane in air indication	Volume fraction up to 100 % methane in air indication	Volume fraction up to 100 % lower flammable limit indication	Volume fraction up to 100 % gas indication
5.4.2	Unpowered storage	None	None	None	None
5.4.3.2	Calibration curve	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.3.3	Response to other gases	Not applicable	Not applicable	±7 % measuring range or ±15 % of indication	±7 % measuring range or ±15 % of indication
5.4.4 (a)	Stability, short term	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±3 % measuring range or ±10 % of indication	±3 % measuring range or ±10 % of indication
5.4.4 (b)	Stability, long term (fixed/transportable)	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±7 % measuring range or ±20 % of indication	±7 % measuring range or ±20 % of indication
5.4.4 (c)	Stability, long term (portable)	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.5	Stability (spot-reading apparatus only)	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±3 % measuring range or ±10 % of indication
5.4.6	Alarm set point(s)	Check alarm/manual reset operation	Check alarm/manual reset operation	Check alarm/manual reset operation	Check alarm/manual reset operation
5.4.7 (a)	Temperature (portable/transportable)	±0,2 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % measuring range or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % measuring range or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)

Table A.1 *(continued)*

Sub-clause	Test	Group I apparatus limits (whichever value is greater)		Group II apparatus limits (whichever value is greater)	
		Volume fraction up to 5 % methane in air indication	**Volume fraction up to 100 % methane in air indication**	**Volume fraction up to 100 % lower flammable limit indication**	**Volume fraction up to 100 % gas indication**
5.4.7 (b)	Temperature (fixed with remote sensor)	±0,2 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	Sensor: ±10 % measuring range or ±20 % of indication from 20 °C (test: –25 °C, 20 °C, 55 °C) Control unit: ±3 % measuring range or ±10 % of indication from 20 °C (test: 5 °C, 20 °C, 55 °C)	Sensor: ±10 % measuring range or ±20 % of indication from 20 °C (test: –25 °C, 20 °C, 55 °C) Control unit: ±3 % measuring range or ±10 % of indication from 20 °C (test: 5 °C, 20 °C, 55 °C)
5.4.7(c)	Temperature (fixed with sensor)	±0,2 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % methane or ±10 % of indication from 20 °C (test: –10 °C, 20 °C, 40 °C)	±5 % measuring range or ±15 % of indication from 20 °C (test: –10 °C, 20 °C, 55 °C)	±5 % measuring range or ±15 % of indication from 20 °C (test: –10 °C, 20 °C, 55 °C)
5.4.8	Pressure	±0,2 % methane or ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)	±5 % methane or ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)	±5 % measuring range or ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)	±5 % measuring range or ±30 % of indication from 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)
5.4.9	Humidity	±0,2 % methane or ±15 % of indication from the indication at adjustment at 40 °C (test: 20 %RH, 50 %RH, 90 %RH)	±5 % methane or ±15 % of indication from the indication at adjustment at 40 °C (test: 20 %RH, 50 %RH, 90 %RH)	±10 % measuring range or ±30 % of indication from the indication at adjustment at 40 °C (test: 20 %RH, 50 %RH, 90 %RH)	±10 % measuring range or ±30 % of indication from the indication at adjustment at 40 °C (test: 20 %RH, 50 %RH, 90 %RH)
5.4.10	Air velocity	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.11	Flow rate	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.12	Orientation	±0,1 % methane or ±5 % of indication	Portable: ±5 % methane or ±10 % of indication Fixed/transportable: ±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication

Table A.1 *(continued)*

Sub-clause	Test	Group I apparatus limits (whichever value is greater)		Group II apparatus limits (whichever value is greater)	
		Volume fraction up to 5 % methane in air indication	**Volume fraction up to 100 % methane in air indication**	**Volume fraction up to 100 % lower flammable limit indication**	**Volume fraction up to 100 % gas indication**
5.4.13	Vibration	±0,1 % methane or ±5 % of indication, and no loss of function, no fault signal, no damage resulting in a hazard and no false alarms	±3 % methane or ±5 % of indication, and no loss of function, no fault signal, no damage resulting in a hazard and no false alarms	±5 % measuring range or ±10 % of indication, and no loss of function, no fault signal, no damage resulting in a hazard and no false alarms	±5 % measuring range or ±10 % of indication, and no loss of function, no fault signal, no damage resulting in a hazard and no false alarms
5.4.14	Drop test	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.15	Warm-up time	Fixed/transportable: ±0,1 % methane within 5 min, and no false alarm Continuous duty portable: ±0,1 % methane within 2 min, and no false alarm	Fixed/transportable: ±3 % methane within 5 min, and no false alarm Continuous duty portable: ±3 % methane within 2 min, and no false alarm	Fixed/transportable: ±5 % measuring range within manual spec., and no false alarm Continuous duty portable: ±5 % measuring range within 2 min, and no false alarm	Fixed/transportable: ±5 % measuring range within manual spec., and no false alarm Continuous duty portable: ±5 % measuring range within 2 min, and no false alarm
5.4.16	Time of response (increasing concentration)	*t*(50) in less than 10 s *t*(90) in less than 30 s	*t*(50) in less than 10 s *t*(90) in less than 30 s	*t*(50) in less than 20 s *t*(90) in less than 60 s	*t*(50) in less than 20 s *t*(90) in less than 60 s
5.4.16	Time of response (decreasing concentration)	*t*(50) in less than 30 s *t*(10) in less than 90 s	*t*(50) in less than 10 s *t*(10) in less than 30 s	Not applicable	*t*(50) in less than 20 s *t*(10) in less than 60 s
5.4.17	Minimum time to operate	Indication at 90 % final value in less than 30 s in either gas	Indication at 90 % final value in less than 30 s in either gas	Indication at 90 % final value in less than 30 s in either gas	Indication at 90 % final value in less than 30 s in either gas
5.4.18	High gas concentration operation above the measuring range	±0,2 % methane or +20 % / –10 % of indication	±5 % methane or ±10 % of indication	±7 % measuring range or +20 % / –10 % of indication	±7 % measuring range or ±15 % of indication

Table A.1 *(continued)*

Sub-clause	Test	Group I apparatus limits (whichever value is greater)		Group II apparatus limits (whichever value is greater)	
		Volume fraction up to 5 % methane in air indication	**Volume fraction up to 100 % methane in air indication**	**Volume fraction up to 100 % lower flammable limit indication**	**Volume fraction up to 100 % gas indication**
5.4.19	Battery capacity	Portable continuous duty: ±0,1 % methane or ±5 % of indication (test: 8 h or 10 h, respectively) ±0,2 % methane or ±10 % of indication (test: 10 min after “low battery” condition) Spot-reading apparatus: ±0,1 % methane or ±5 % of indication (test: 200 operations) ±0,2 % methane or ±10 % of indication (test: 10 operations after “low battery” condition)	Portable continuous duty: ±3 % methane or ±5 % of indication (test: 8 h or 10 h, respectively) ±6 % methane or ±10 % of indication (test: 10 min after “low battery” condition) Spot-reading apparatus: ±3 % methane or ±5 % of indication (test: 200 operations) ±6 % methane or ±10 % of indication (test: 10 operations after “low battery” condition)	Portable continuous duty: ±5 % measuring range or ±10 % of indication (test: 8 h or 10 h, respectively) ±7 % measuring range or ±15 % of indication (test: 10 min after “low battery” condition) Spot-reading apparatus: ±5 % measuring range or ±10 % of indication (test: 200 operations) ±7 % measuring range or ±15 % of indication (test: 10 operations after “low battery” condition)	Portable continuous duty: ±3 % measuring range or ±10 % of indication (test: 8 h or 10 h, respectively) ±6 % measuring range or ±20 % of indication (test: 10 min after “low battery” condition) Spot-reading apparatus: ±3 % measuring range or ±10 % of indication (test: 200 operations) ±6 % measuring range or ±20 % of indication (test: 10 operations after “low battery” condition)
5.4.20	Power supply variation	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±3 % measuring range or ±10 % of indication
5.4.21	Power supply interruptions, voltage transients and step changes of voltage	No spurious alarms	No spurious alarms	No spurious alarms	No spurious alarms
5.4.22	Addition of sampling probe	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication
5.4.23	Dust	±0,1 % methane or ±5 % of indication, t(90) increase less than 10 s	±5 % methane or ±10 % of indication, t(90) increase less than 10 s	Not applicable	Not applicable
5.4.24.1	Poisons	±0,2 % methane or ±10 % of indication	±3 % methane or ±10 % of indication	Not applicable	Not applicable

Table A.1 *(continued)*

Sub-clause	Test	Group I apparatus limits (whichever value is greater)		Group II apparatus limits (whichever value is greater)	
		Volume fraction up to 5 % methane in air indication	**Volume fraction up to 100 % methane in air indication**	**Volume fraction up to 100 % lower flammable limit indication**	**Volume fraction up to 100 % gas indication**
5.4.24.2	Other gases	±10 % of the actual methane volume fraction applied.	±10 % of the actual methane volume fraction applied.	Not applicable	Not applicable
5.4.25	Electromagnetic immunity	Variation less than ±0,1 % methane and no spurious alarms	Variation less than ±3 % methane and no spurious alarms	Variation less than ±5 % measuring range and no spurious alarms	Variation less than ±3 % measuring range and no spurious alarms
5.4.26	Field calibration kit	±0,1 % methane or ±5 % of indication	±3 % methane or ±5 % of indication	±5 % measuring range or ±10 % of indication	±5 % measuring range or ±10 % of indication

Annex B
(informative)

Determination of time of response

B.1 Aspirated apparatus (see also Figure B.1)

The apparatus is attached to the equipment, for example as shown schematically in Figure B.1.

If the on/off operation is independent of the aspirator control, the apparatus is switched on and stabilized.

The two-way valve is adjusted to connect the apparatus to the clean air reservoir. Aspiration is performed until the apparatus is stabilized. The apparatus "zero" control is adjusted as necessary. Aspiration is stopped.

The two-way valve is adjusted to connect the apparatus to the test gas and aspiration is commenced. The *t*(50) and *t*(90) times of response are taken as the time intervals between the start of aspiration and the time when the apparatus reaches 50 % or 90 %, respectively, of the final indication.

A correction should be made to the time of response to allow for the aspiration of the dead volume between A and B in figure B.1.

B.2 Apparatus that samples by diffusion

B.2.1 Calibration mask method

Clean air is supplied to the apparatus, at the manufacturer's recommended linear flow rate but not exceeding 1 m/s, via the mask (see 5.2.3 and 5.3.4) until the apparatus is stabilized. The apparatus zero is adjusted as necessary. The test gas is then applied via a two-way valve. The *t*(50) and *t*(90) times response are taken as the time intervals between the time of application of the test gas and the time when the apparatus reaches 50 % or 90 %, respectively, of the final indication.

If the size of the mask is such that the time required to purge it with gas (with the apparatus in position) exceeds 25 % of the time of response of the apparatus, this test method is not acceptable and an alternative method is to be used.

It is essential to correct the time response to allow for the dead volume between the two-way tap and the entry port of the mask.

B.2.2 Applicator method (see also Figures B.2 to B.4)

The apparatus is switched on and stabilized.

The clean air supply is applied to the apparatus via an applicator, for example as shown in Figure B.2. The applicator is held in position until the apparatus is stabilized. The apparatus "zero" is adjusted as necessary.

The test gas is applied to the apparatus via a second, identical applicator in a *t*(50) and *t*(90) change over movement, for example as illustrated in Figure B.3. The *t*(50) and *t*(90) times of response are taken as the time interval between the time of application of the test gas applicator and the time when the apparatus reaches 50 % or 90 %, respectively, of the final indication.

NOTE 1 The base of the applicator is in contact with the apparatus and completely surrounds the sensor inlet. The area of the base is at least twice the area of the sensor inlet.

NOTE 2 The linear flow of clean air/test gas at the base of the applicators is 50 mm/s ± 5 mm/s.

NOTE 3 The gaps at the base of the applicator are sufficient to prevent an overpressure within the applicator of more than 50 Pa (which corresponds to approximately a 5 mm head of water) with the applicator flush against the apparatus or sensor as shown by Figure B.3.

NOTE 4 The distance between the shoulder of the applicator and the sensor inlet is typically 10 diameters of the applicator, for example as shown in Figure B.4.

NOTE 5 It is envisioned that a range of applicators, based on the above parameters, will be required to test the full range of apparatus or sensors.

B.2.3 Test chamber method

B.2.3.1 Test chamber

The construction of the chamber may encompass a wide variety in design from sophisticated permanent installations to a simple specially constructed enclosure that, in the opinion of the testing laboratory, is capable of introducing the gases or the sensors in a rapid and reproducible manner.

An example of a test chamber is illustrated in Figure B.5.

B.2.3.2 Procedure

Test chambers may be used in either of two ways:

a) the chamber is first filled with the standard test gas and the sensor is then plunged inside rapidly, or

b) the apparatus is put inside the chamber with the inlet of the sensor covered; the chamber is then filled with the standard test gas, and the sensor inlet is rapidly uncovered.

B.3 Step change response (see also Figure B.6)

The apparatus used for this test is shown schematically in figure B.6 and operates as follows:

a) the lower vessel (1) is filled with water;

b) the toy balloon (2) is filled with a 100 % LFL gas/air mixture until it fills the lower end of the tube (3);

c) the gas/air mixture is forced into the lower vessel until the balloon is forced up the tube as far as it will go;

d) the balloon is fully inflated to seal the lower part of the tube;

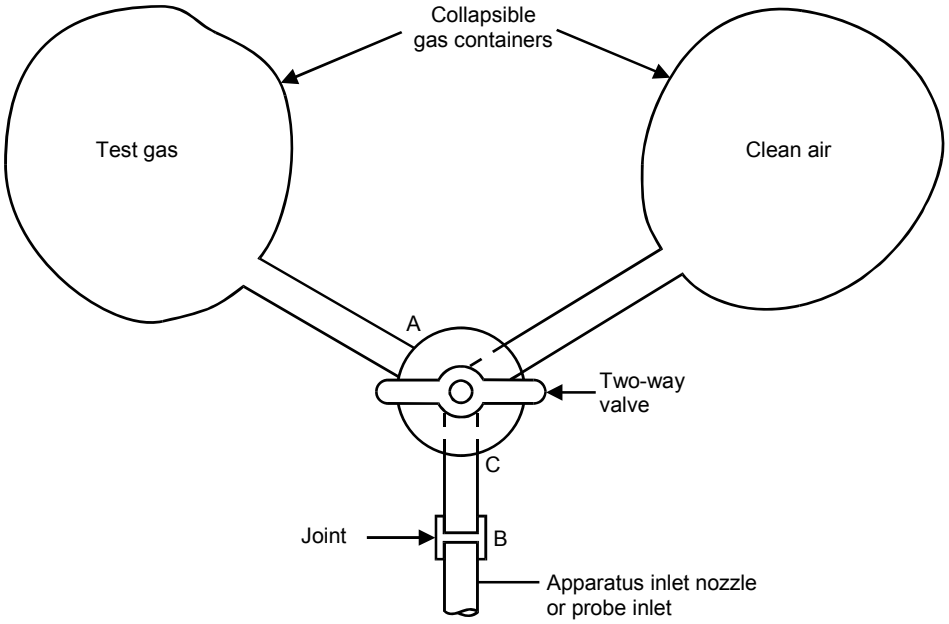
e) the gas/air mixture is pumped into the lower vessel displacing the water into the upper vessel (4);

f) the sensor (5) is positioned in the tube about 5 cm above the upper end of the balloon and the output of the instrument is connected to a recorder;

g) the balloon is broken by inserting a pin into the tube at point (6). This results in an immediate release of the gas/air mixture from the balloon and from the 0,1 m^3 of volume in the lower vessel which is at approximately 7 kPa pressure. This immediately purges the tube and as the water returns to the lower vessel (which takes about 20 s) the tube is provided with a continuous flow of "fresh" mixture travelling at a speed of approximately 20 m/s. The duration of the flow can be extended to 30 s (the maximum test time), if necessary, by placing a restriction in the hose (7) between the two vessels. A recorder, connected to the instrument output, will provide timing lines at 1 s intervals and this can be used to determine the time required to reach the 50 % LFL and 90 % LFL readings. As an alternative, the toy balloon in the 75 mm diameter tube may be replaced by a 75 mm (type size) ball valve. This simplifies the procedure considerably and the same results have been obtained by the rapid opening of the ball valve as by the bursting of the toy balloon.

B.4 Flooding (see also Figure B.6)

This test is performed in the same manner as the step change response test in Clause B.3, except that the test gas is used for filling the balloon and the lower vessel, instead of a gas/air mixture.



NOTE 1 The volume of each gas reservoir is greater (by at least a factor of 10) than the volume of gas swept out during a time of response determination.

NOTE 2 The bore of all tubing and connections is greater than the bore of the apparatus inlet nozzle or probe inlet.

NOTE 3 The volume between the valve and the apparatus inlet (between B and C) is kept to a minimum consistent with a good connection to the apparatus.

Figure B.1 – Schematic example of equipment for use with aspirated apparatus
(see also Clause B.1)

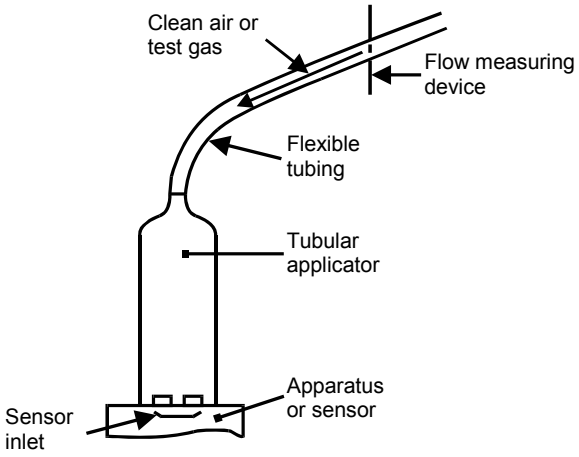


Figure B.2 – Schematic example of equipment during application of clean air or test gas
(see also B.2.2)

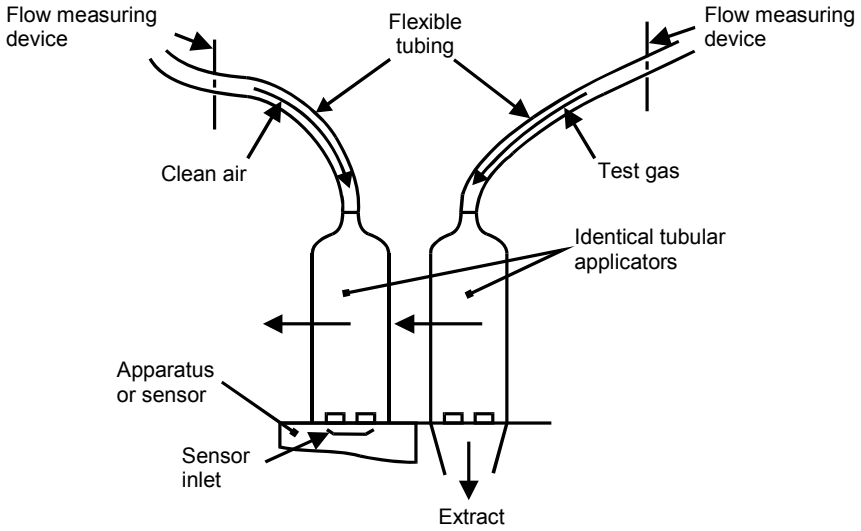


Figure B.3 – Schematic example of equipment showing change-over from clean air to test gas to begin the time of response measurement (arrows indicate movement of applicators)
(see also B.2.2)

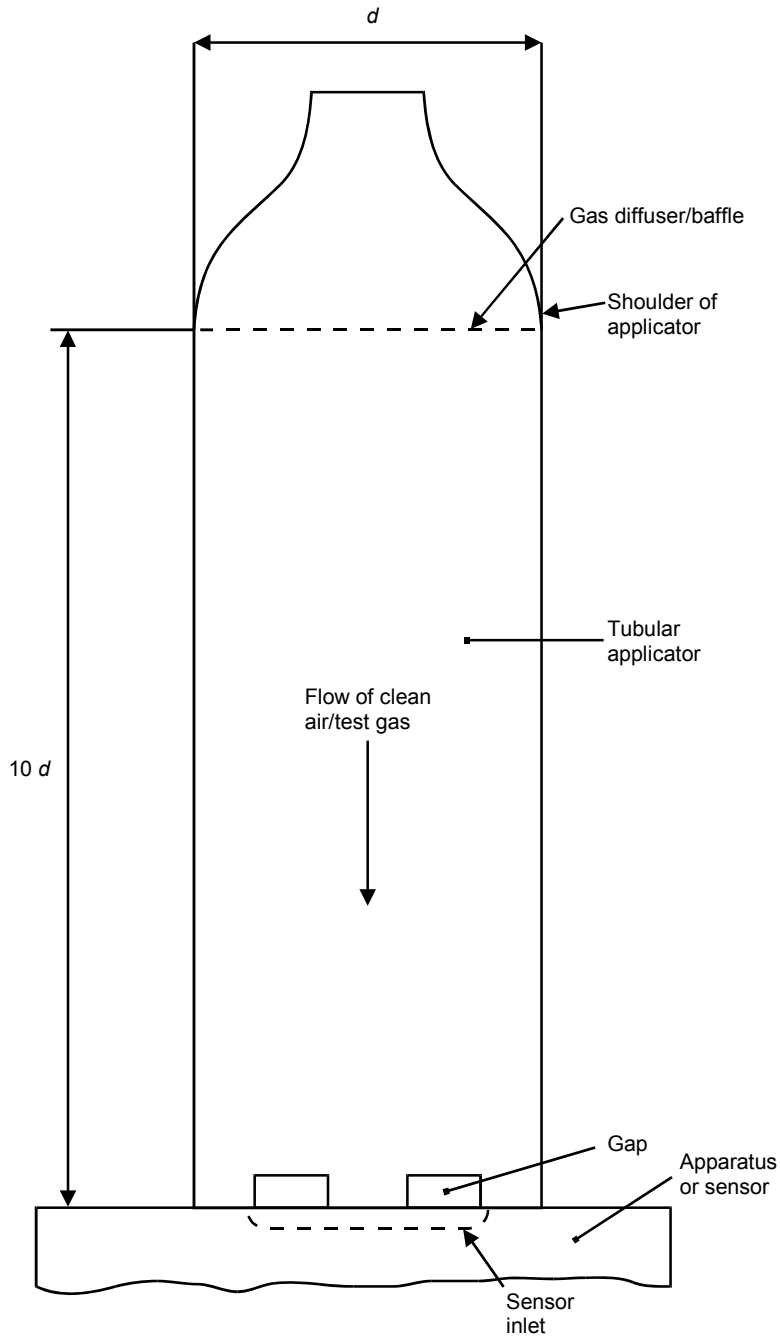


Figure B.4 – Schematic example of applicator and sensor inlet during application of test gas or clean air
(see also B.2.2)

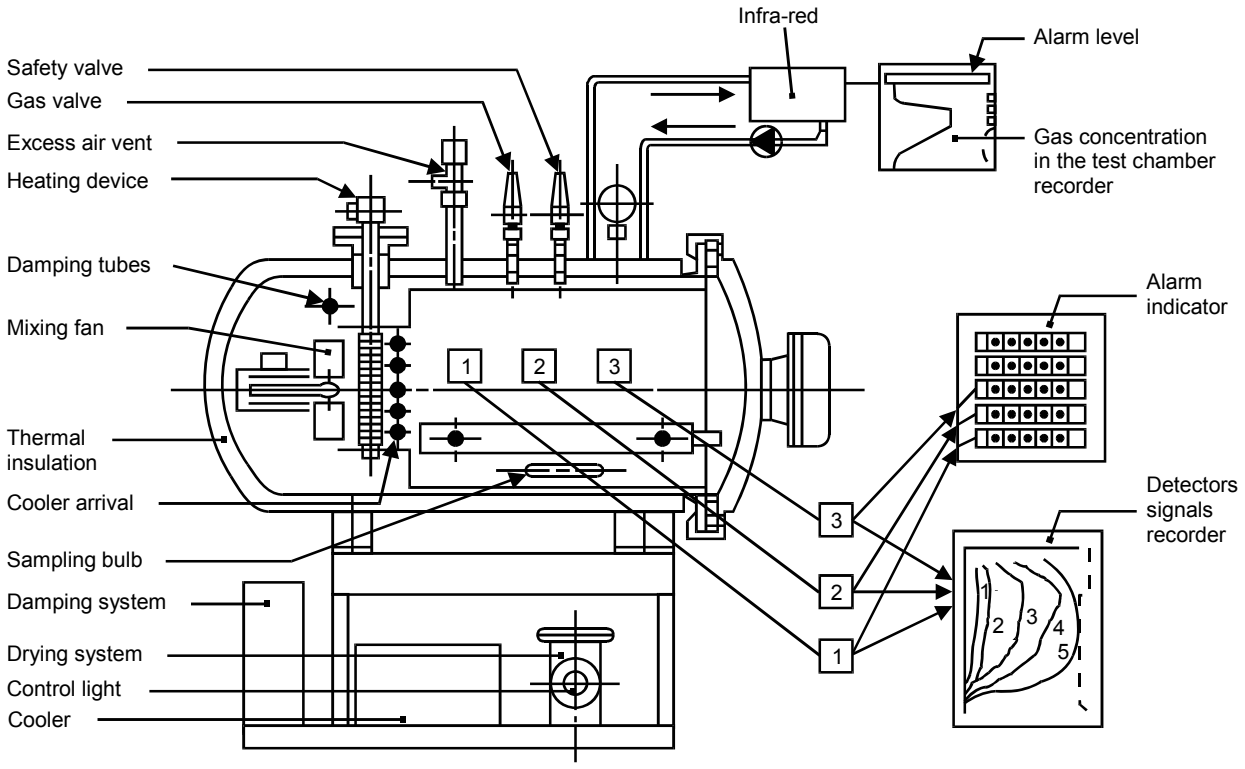
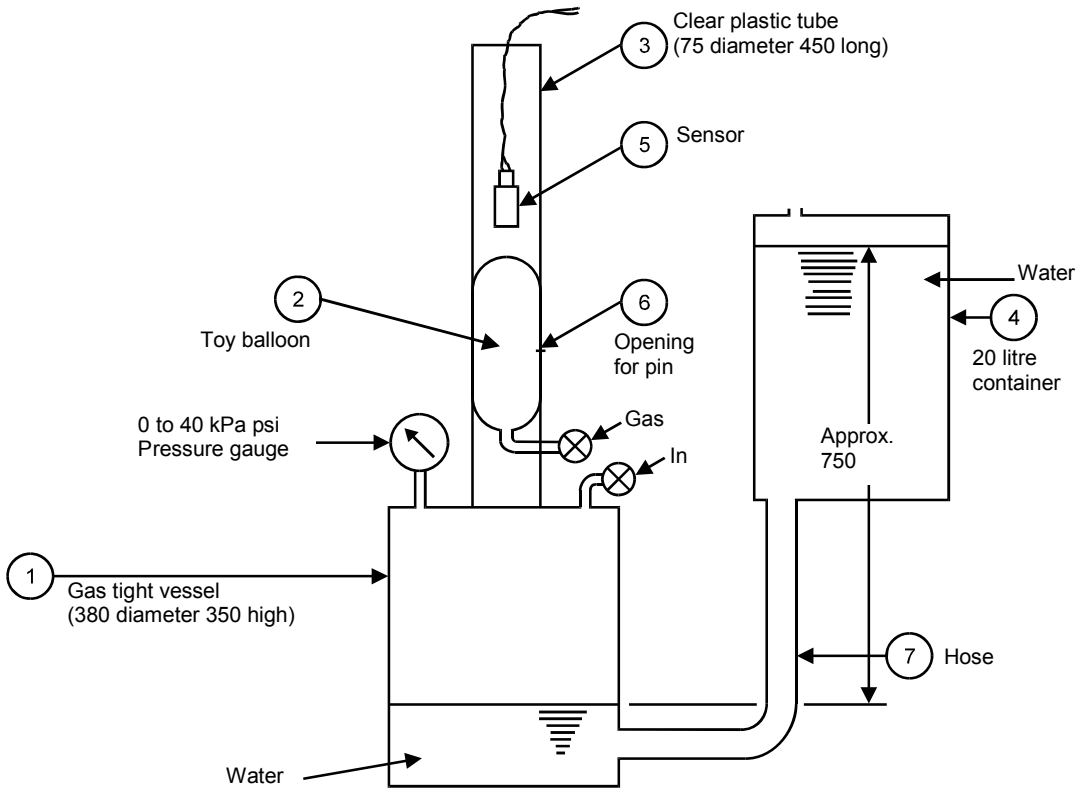


Figure B.5 – Example of automated test chamber
(see also B.2.3.1)



Dimensions in millimetres

Figure B.6 – Apparatus for step change and flooding tests

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IEC 60079-5: *Explosive atmospheres – Part 5: Equipment protection by powder filling "q"*

IEC 60079-6: *Explosive atmospheres – Part 6: Equipment protection by oil immersion "o"*

IEC 60079-7: *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60079-10: *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-11: *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

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ISO 6145-2: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 2: Volumetric pumps*

ISO 6145-4: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 4: Continuous injection method*

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ISO 6145-6: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 6: Critical orifices*

ISO 6145-7: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 7: Thermal mass-flow controllers*

ISO 6145-9: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 9: Saturation method*

ISO 6145-10: *Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods – Part 10: Permeation method*

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
31/809/ISH	31/817/RVD

Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

_____

There has been a request for formal interpretation of the drop test fail criterion in the performance standard IEC 60079-29-1 (2007), Subclause 5.4.14.

The fail criterion is:

“The apparatus shall be considered to have failed this test if there is a loss of function (e.g. alarm, pump function, controls, display) after the test”.

Question:

Is the interpretation of this text, that the loss of function, even in a short period during the interruption and until restart of the equipment will fail the test? Or is a permanent loss of function needed to fail the equipment, e.g. a broken display or a pump, which cannot restart?

Bouncing of a battery spring in the moment of impact can cause the drop out of power in battery supplied equipment, and make it shut down. Is this considered as sufficient to fail the test? Or would it be sufficient safe situation for the user if the equipment could restart and show the correct measurement?

Interpretation:

Any loss of function after the test including any change of state is considered a failure since there is continued dependency on the life safety device even under adverse affects such as an accidental drop of the device during use. Automatic or manual re-starting is not acceptable.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61000-4-3 Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test	IS 14700 (Part 4/Sec 3) : 2008 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 3 Radiated, radio-frequency, electromagnetic field immunity test (*first revision*)	Identical to IEC 61000-4-3 : 2006
IEC 61000-4-4 Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test	IS 14700 (Part 4/Sec 4) : 2008 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 4 Electrical fast transient/burst immunity test	Identical to IEC 61000-4-4 : 1995

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Review of Indian Standards

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This Indian Standard has been developed from Doc No.: ETD 22 (6103).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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