IEC 60079-29-4

Edition 1.0 2009-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Explosive atmospheres –
Part 29-4: Gas detectors – Performance requirements of open path detectors for flammable gases

Atmosphères explosives –
Partie 29-4: Détecteurs de gaz – Exigences d'aptitude à la fonction des détecteurs de gaz inflammables à chemin ouvert

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FOREWORD

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International Standard IEC 60079-29-4 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

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 this standard shall take precedence.

The text of this standard is based on the following documents:

FDIS	Report on voting
31/819/FDIS	31/841/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60079 series, under the general title: *Explosives atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

EXPLOSIVE ATMOSPHERES –

Part 29-4: Gas detectors – Performance requirements of open path detectors for flammable gases

1 Scope

This part of IEC 60079-29 specifies performance requirements of equipment for the detection and measuring of flammable gases or vapours in ambient air by measuring the spectral absorption by the gases or vapours over extended optical paths, ranging typically from one metre to a few kilometres.

Such equipment measures the integral concentration of the absorbing gas over the optical path in units such as LFL metre for flammable gases.

NOTE 1 Actual values of concentration can be deduced only where it can be established that the concentration is uniform over the optical path, for example in very short optical paths (<100 mm). In such cases, the equipment is within the scope of IEC 60079-29-1.

NOTE 2 This standard is based upon present absorption techniques using infrared radiation. Other techniques and applications may require additional test considerations (e.g. pressure test).

Equipment falling within the scope of this standard is classified by the following types:

Type 1: an optical transmitter and receiver, located at either end of a path through the atmosphere to be monitored.

Type 2: an optical transceiver (i.e. combined transmitter and receiver) and a suitable reflector, which may be a topographic feature or a retroreflector, located at either end of a path through the atmosphere to be monitored.

This standard is also applicable when an equipment manufacturer makes any claims regarding any special features of construction or superior performance that exceed the minimum requirements of this standard. All such claims shall be verified and the test procedures should be extended or supplemented, where necessary, to verify the claimed performance. The additional tests shall be agreed between the manufacturer and the test laboratory and identified and described in the test report.

This standard does not apply to any of following:

a) equipment intended to provide range resolution of gas concentration (e.g. Light direction and ranging (LIDAR));

b) equipment consisting of a passive optical receiver without a dedicated optical source;

c) equipment intended to measure the local volumetric concentration of gas (point sensors);

d) equipment intended for the detection of dusts or mists in air;

e) equipment for cross stack monitoring;

f) equipment intended for the detection of explosives; and

g) equipment intended only for the identification of individual gas or vapour components, (e.g. Fourier transform infrared spectroscopy (FTIR)).

This standard is applicable to equipment which is intended for use in hazardous or non-hazardous areas, or both. Equipment for use in hazardous areas is also required to have explosion protection (see 4.1.1).

This standard applies to portable, transportable and fixed equipment intended for commercial and industrial applications.

NOTE 3 This standard is intended to provide for the supply of equipment giving a level of performance suitable for general purpose applications. However, for specific applications a prospective purchaser or an appropriate authority may additionally require equipment to be submitted for particular tests or approval. Such tests or approval are regarded as additional to and separate from the provisions of the standards referred to above.

2 Normative references

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

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 as well as IEC 60079-29-1 and the following apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426.

3.1 Equipment

3.1.1
alarm only equipment
equipment which generates an alarm signal but does not have a meter or output giving a measure of the integral concentration

3.1.2
fixed equipment
equipment fastened to a support, or otherwise secured in a specific location

3.1.3
transportable equipment
equipment not intended to be carried by a person nor intended for fixed installation

3.1.4
portable equipment
equipment intended to be carried by a person

NOTE Typically portable equipment will be used as a spot-reading equipment.

3.2 Alarms

3.2.1
alarm set point
fixed or adjustable setting of the equipment that is intended to pre-set the value of integral concentration at which the equipment will automatically initiate an indication, alarm, or other output function

3.2.2
alarm signal
audible, visual, electronic or other signal generated by the equipment when an integral concentration of gas in excess of a preset value is detected

3.2.3
latching alarm
alarm which, once activated, requires a deliberate action to deactivate it

3.3 Signals and indications

3.3.1
fault signal
audible, visual, or other type of output which provides, directly or indirectly, a warning or indication that the equipment is defective

3.3.2
beam blocked signal
audible, visual or other type of output which provides, directly or indirectly, a warning or indication that the optical path is obscured or that the signal detected is too weak to enable the equipment to function normally

3.3.3
inhibition signal
audible, visual, or other type of output which provides, directly or indirectly, a warning or indication that normal operation has been suspended

3.3.4
indicating devices
means for displaying values or states in analogue or digital form

3.3.5
special state
state of the equipment other than those in which monitoring of gas concentration takes place

NOTE For example warm-up, calibration mode or fault condition

3.4 Gaseous atmospheres

3.4.1
ambient air
atmosphere in the area being monitored by the equipment

3.4.2
clean air
air which is free from gases or vapours (flammable, toxic or environmentally harmful gases) to which the equipment is sensitive or which influence the performance of the equipment

3.4.3
flammable atmosphere
mixture with air, under normal atmospheric conditions, of flammable materials in the form of gas, vapour or mist, in which, after ignition, combustion spreads throughout the unconsumed mixture

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

NOTE 2 Although a mixture which has a concentration above the upper explosive limit is not a flammable atmosphere, there is a risk of creating a flammable atmosphere by dilution.

NOTE 3 Normal atmospheric conditions include variations above and below reference levels of 101,3 kPa (1013 mbar) and 20 °C provided the variations have negligible effect on the explosion properties of the flammable materials.

NOTE 4 For the purposes of this standard, the terms "explosive", "combustible" and "flammable" are regarded as synonymous.

3.4.4
flammable gas
gas which, when mixed with air in certain volumetric ratios, forms a flammable atmosphere

3.4.5
integral concentration
mathematical integral of the gas concentration along the optical path.

NOTE 1 It is expressed in units of concentration multiplied by distance, e.g. LFL.metre for flammable gases or ppm.metre for toxic gases

NOTE 2 100 % LFL x 1 metre = 1 LFL.metre;

10 % LFL × 10 metre = 1 LFL.metre.

3.4.6
lower flammable limit
LFL
volume ratio of flammable gas or vapour in air below which a flammable gas atmosphere will not be formed

3.4.7
upper flammable limit
UFL
volume ratio of flammable gas or vapour in air above which an explosive gas atmosphere will not be formed

3.4.8
explosion protection
measures applied in the construction of electrical equipment to prevent ignition of a surrounding explosive gas atmosphere by the equipment

3.4.9
toxic gas
gas that may be harmful to human health and/or the performance of persons due to its physical or physico-chemical properties

3.5 Optical equipment

3.5.1
open path
distance in space which traverses the area (or part of the area) in which the atmosphere is being monitored and through which gases in the atmosphere are free to move

3.5.2
optical axis
median line of the optical path

3.5.3
optical path
path traversed by optical radiation from an optical transmitter to an optical receiver.

NOTE The radiation may traverse the open path once, twice or many times depending on the form taken by the instrument

3.5.4
optical radiation
ultra-violet, visible or infra-red regions of the electromagnetic spectrum

3.5.5
albedo
proportion of incident light scattered back from a surface

3.5.6
transmitter
assembly in which the optical transmitting element(s) are housed and which may contain associated optical and electrical components

3.5.7
transceiver
assembly in which the optical detecting element(s) and optical transmitting element(s) are housed and which may contain associated optical and electrical components

3.5.8
receiver
assembly in which the optical detecting element(s) are housed and which may contain associated optical and electrical components

3.5.9
retroreflector
individual or multiple arrangement of reflecting corners of cubes arrayed so that light is reflected back parallel to its incident path

3.5.10
gas cell
sealed enclosure (capable of being filled with test gases) and having transparent ends

3.6 Performance characteristics

3.6.1
drift
variation with time of the indication produced by the equipment under normal conditions when monitoring a fixed distribution of gas concentration in the optical path

3.6.2
time of response
t_x
time interval, with the equipment stabilised, between the time when an instantaneous variation in the integral concentration is produced in the optical path and the time when the indication reaches a stated percentage (x) of its final value

4 General requirements

4.1 Detection equipment

4.1.1 Components

All parts of the open path gas detection equipment intended for use in explosive gas atmospheres shall comply with the appropriate requirements for explosion protection.

The operation and storage temperature limits of this standard could exceed the required temperature limits of these other parts of IEC 60079 series for certain types of equipment. In this case, the examination and testing of the protection technique(s) used for the equipment shall be extended to cover the temperature range. If this extension is not possible due to requirements of the protection techniques used, then the temperature range of this standard shall be reduced to the range specified for the protection technique(s).

4.1.2 Electrical assemblies and components

Electrical assemblies and components shall comply with the appropriate construction and test requirements of 4.2 and of Clause 5 respectively.

4.1.3 Optical radiation

Optical radiation produced by the equipment shall conform to the requirements given in IEC 60825-1.

4.2 Construction

4.2.1 General

The gas detection equipment shall be so designed and manufactured as to avoid physical injury or other harm which might be caused by direct or indirect contact.

All parts of the equipment shall be suitable for its intended use. It shall be capable of withstanding, without damage or impairment of performance, the effects of vibration, dust, corrosive media and climatic conditions to be expected during operational use in environments in which the equipment is intended to be used.

Fine adjustment of the optical beam direction shall be possible and an indication shall be provided to confirm that satisfactory alignment of the optical beam has been achieved. Such equipment need not form a permanent part of the equipment.

All equipment shall be constructed to facilitate, where applicable, regular functional, service, and calibration checks.

4.2.2 Indicating devices

4.2.2.1 Indications and output signals

An indication or output signal shall be provided to show that the equipment is switched on.

The indication or output signal shall be a measure of the actual integral concentration over the open path.

NOTE The open path is independent of the number of times the optical radiation traverses it.

If the equipment enters a special state (eg. inhibition, beam blockage or a fault), a signal shall be provided. For fixed equipment, this shall include a contact or other transmittable output signal. If these conditions are separately indicated, they shall be clearly identified.

Indicating or controlling devices, where provided, need not be an integral part of the equipment.

When the equipment is intended for alarm only, the manufacturers shall provide or identify suitable points for connecting an indicating or recording device for testing the compliance of the equipment with this standard.

4.2.2.2 Individual indicator lights

When individual indicator lights are incorporated in the equipment they shall be coloured as follows:

a) alarm indicators shall be coloured RED;

b) fault, inhibition and beam blockage indicators shall be coloured YELLOW;

c) power supply indicators and normal operation indicators shall be coloured GREEN.

4.2.2.3 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

When non-latching alarm devices, output contacts, or signal outputs are provided to indicate detection of an integral gas concentration in excess of a pre-set alarm level, the fact shall be indicated clearly and prominently in the instruction manual.

The operation of any other output functions shall be clearly stated in the manual.

4.2.4 Fault signals

Equipment shall provide a fault signal if any of the following conditions (as a minimum) occur:

a) under range indication (below the zero point) between zero and -10 % full scale equivalent;

b) beam blockage;

c) low battery indication, if applicable;

d) a short-circuit or open-circuit in connections to any remote sensor, if applicable.

Such signals shall be differentiated from any alarms.

4.2.5 Adjustments

All means of adjustment shall be designed so as to discourage unauthorised interference with the equipment.

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

4.3 Software-controlled equipment

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

4.3.1 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.

4.3.2 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 equipment 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 traversing 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 equipment 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.

4.3.3 Data transmission

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

NOTE Reliability checking of the data transmission may include, but is not limited to, transmission errors, repetition, deletions, insertion, re-sequencing, corruption, delay, and masquerade.

4.3.4 Self-test routines

Computerised digital units shall incorporate self-test routines. On failure detection, the equipment 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 equipment:

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 equipment;