IEC 60079-29-3

Edition 1.0 2014-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Explosive atmospheres –
Part 29-3: Gas detectors – Guidance on functional safety of fixed gas detection systems

Atmosphères explosives –
Partie 29-3: Détecteurs de gaz – Recommandations relatives à la sécurité fonctionnelle des systèmes fixes de détection de gaz

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EXPLOSIVE ATMOSPHERES –

Part 29-3: Gas detectors – Guidance on functional safety of fixed gas detection systems

FOREWORD

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International Standard IEC 60079-29-3 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This part of IEC 60079-29 is to be used in conjunction with the following standards:

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

– IEC 60079-29-4, *Explosive atmospheres – Part 29-4: Gas detectors – Performance requirements of open path detectors for flammable gases*

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

FDIS	Report on voting
31/1105A/FDIS	31/1117/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: *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

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INTRODUCTION

Fixed gas detection systems have been used for many years to perform safety instrumented functions. Like any instrumented system, a fixed gas detection system commonly comprises of a single or multiple gas detector input(s), a control unit and a single or multiple final element(s) or output(s). Additional peripheral equipment may be incorporated into a fixed gas detection system e.g. a gas sampling system or a gas conditioning system. If a fixed gas detection system, including any relevant peripheral equipment is to be effectively used for safety instrumented functions, it is essential that the total system achieves certain minimum standards and performance levels.

It is important to understand that the number of sensing points and their appropriate location, their redundancy, the management of regular maintenance, specifically response checking or calibration, and other gas detection specific features (such as design of gas sampling systems) are all likely to have a far greater effect on the integrity of the overall Safety Instrumented System (SIS) than the required Safety Integrity Level (SIL) or SIL-capability of any of the individual functional units. This, however, does not exclude the requirement for each Safety Instrumented Function (SIF) to have a stand-alone functional integrity.

This international standard addresses the minimum standards and performance levels of a fixed gas detection system which is based on the use of electrical, electronic or programmable electronic systems (E/E/PES) for any application where there is either a risk reduction target stated or if the gas detection system is used as an additional safe guarding system.

This international standard does not apply to portable gas detectors or fixed gas detection systems when there is no risk reduction target stated. However, this standard could be used as a best practice document for such devices or systems.

The expression ‘gas detection system’ within this international standard is generic and applies to standalone fixed gas detectors, which might have their own internal alarm trip levels and switching outputs up to complex standalone fixed gas detection systems (Annex A – Typical Applications).

This international standard takes into consideration the possible complexity of the supply chain which a gas detection manufacturer, seller or system integrator might encounter which includes, but is not limited to:

- the use of standalone gas detectors which are integrated into an overall safety system by a gas detection equipment manufacturer, seller or system integrator (or equivalent)
- the design and use of fixed gas detection sub-systems, including any associated and/or peripheral gas detection equipment which are integrated into an overall safety system by a gas detection equipment manufacturer, seller or system integrator (or equivalent)
- the design and use of a complete fixed gas detection system, including associated and/or peripheral gas detection equipment which is the overall safety system

NOTE 1 IEC 61508 Parts 1, 2 and 3 cover the design of the stand-alone gas detector, control unit or final element. Guidance on the design of peripheral equipment is included within this international standard.

Before this international standard can be applied, it is important to understand and categorise the application of the fixed gas detection system. The three main applications are:

- as a prevention system – the total system or an individual instrumented control loop has a safety function and safety integrity clearly defined.
- as a mitigation system – the total system or an individual instrumented control loop has a safety function and safety integrity clearly defined.
- as an additional safe guarding system – this covers those fixed gas detection systems or individual instrumented control loops which operate in parallel (secondary) to an

instrumented safety system, where the demand on the fixed gas detection system or individual instrumented control loop is only when the primary instrumented safety system fails or another layer of protection fails.

Under no circumstances should the use of an additional safeguarding gas detection system contribute to the Hardware Fault Tolerance (HFT) declaration for the instrumented safety system.

A fixed gas detection system, as shown in Figure 1, may operate several times per year subject to the application, therefore this international standard accepts that the demand rate associated with 'on demand' (low demand) should be specified in the safety requirements (e.g. a reference could be "> 1/yr but <10/yr").

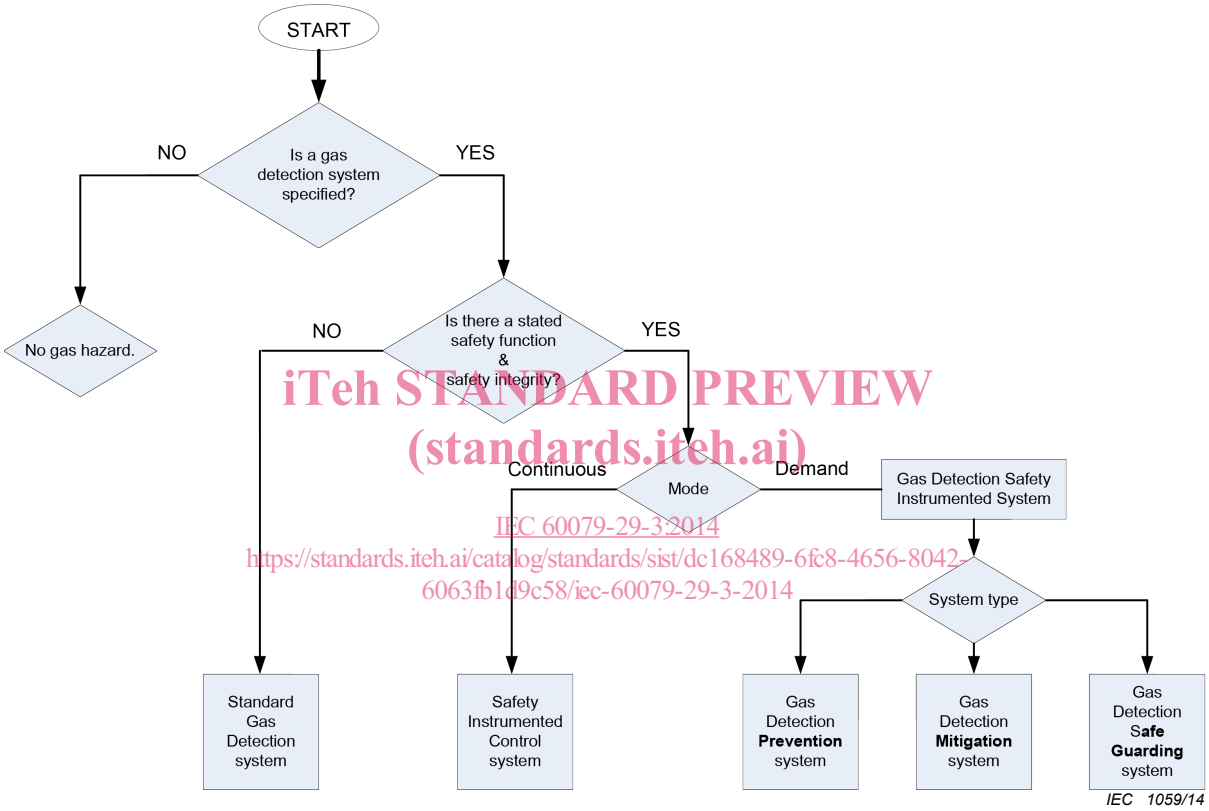

Figure 1 – Gas Detection System Architecture

To assist with the possible complexity and unique requirements associated with fixed gas detection systems, a fixed gas detection system may be broken down into functional units. Each functional unit can vary in complexity; a functional unit may be a simple gas detector or a combination of components which form peripheral equipment. Each functional unit is independently assessed against this international standard and/or IEC 61508 during the initial design phase of the functional unit, thus allowing safety data to be contributed to a functional unit.

NOTE 2 Basic elements of a sub-system/system (e.g. a gas detector, logic controller/solver, etc.) are designed as a product in compliance with IEC 61508 Parts 1, 2 and 3.

Each functional unit is then assembled in line with this international standard to deliver a complete fixed gas detection system. It is not necessary to re-assess individual functional units when they are used in a different configuration – it is only necessary to evaluate the combination of functional units.

This international standard is based on the safety lifecycle model detailed in IEC 61508, but adds additional and supportive information to assist with particular phases of this typical safety lifecycle.

This international standard specifies those requirements under 'Functional Safety Management' which all persons or companies who are involved in the supply chain of a fixed gas detection system should comply with.

NOTE 3 Functional Safety Management applies to all stages of the safety lifecycle irrespective of the product, subsystem, system supply or service being supplied.

For this document, the SIL capability excludes consideration of gas detection coverage or the transport of gas or vapour to the measuring point – IEC 60079-29-2 is pertinent to these two subjects.

Table 1 gives a broad suggestion as to the most relevant clauses to the typical tasks to be performed.

Table 1 – Typical Job Descriptions and Most Relevant Clauses

Applies to	Definitions	Conformance to this International standard	Gas detection unique features	Functional safety management	General requirements	Gas detection unique requirements	Alternative control units (logic solvers)	Factory acceptance testing	Installation and commissioning	System validation (SAT)	Operation and maintenance	System modification	System de-commissioning	Documentation
Clause	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Consultant		+++		+++										
Contractor		+++		+++										
Vendor		+++		+++										
System Integrator		+++		+++										
Manufacturer		+++		+++										
NOTE Each category above will have personnel in several of the categories below.														
General management	+	+	+		+	+	+	+	+	+	++	++	+	+
Design engineering / management	+++	+	+++		+++	+++	+++	+	+	+	++	+++	++	++
System engineer / management	+++	+	+++		+++	+++	+++	+++	++	++	+	+++	++	++
Installation engineering / management	++	+	++		+	++	+	+	+++	++	+	++	++	++
Commissioning engineer / management	++	+	++		++	++	+	+	+++	++	+	++	++	++
Service engineer / management	++	+	++		++	++	+	+	++	++	+++	+++	+++	++
Quality engineer / management	++	+	+++		+++	+++	+	+++	++	+++	+	++	+	+++
Training officers	+++	+	+++		+++	+++	++	+	+	+	+++	+	+	++
Operation & maintenance	+	+	++		+	++	+	++	+	+++	+++	+++	+++	+++
"+++" Most appropriate "++" Advisable "+" Useful The end-user, regulator and certification authorities need to be familiar with the entire family of IEC 61508 standards. NOTE See Annex B for guidance on the life cycle of gas detection.														

EXPLOSIVE ATMOSPHERES –

Part 29-3: Gas detectors – Guidance on functional safety of fixed gas detection systems

1 Scope

This International standard gives guidance for the design and implementation of a fixed gas detection system, including associated and/or peripheral gas detection equipment, for the detection of flammable gases/vapours and Oxygen when used in a safety-related application in accordance with IEC 61508 and IEC 61511. This International standard also applies to the detection of toxic gases.

Other parts of this international standard and pertinent local, national and international standards separately specify the performance requirements of a gas detector and a gas detection control unit (logic solver). These standards are commonly known as Metrological Performance Standards and are concerned with the accuracy of the measured value, the overall system performance, but not the device or system integrity with respect to the safety function. This international standard applies to the integrity of the safety function.

NOTE In certain jurisdictions it can be a requirement for a Certification Body to certify the performance of equipment for the measurement of flammable gases, vapours, toxic gases and/or Oxygen used in life safety applications.

This international standard sets out safety-related considerations of fixed gas detection systems, including associated and/or peripheral gas detection equipment in terms of the framework and philosophy of IEC 61508, and introduces the particular requirements demanded by a fixed gas detection system as shown in Figure 2.

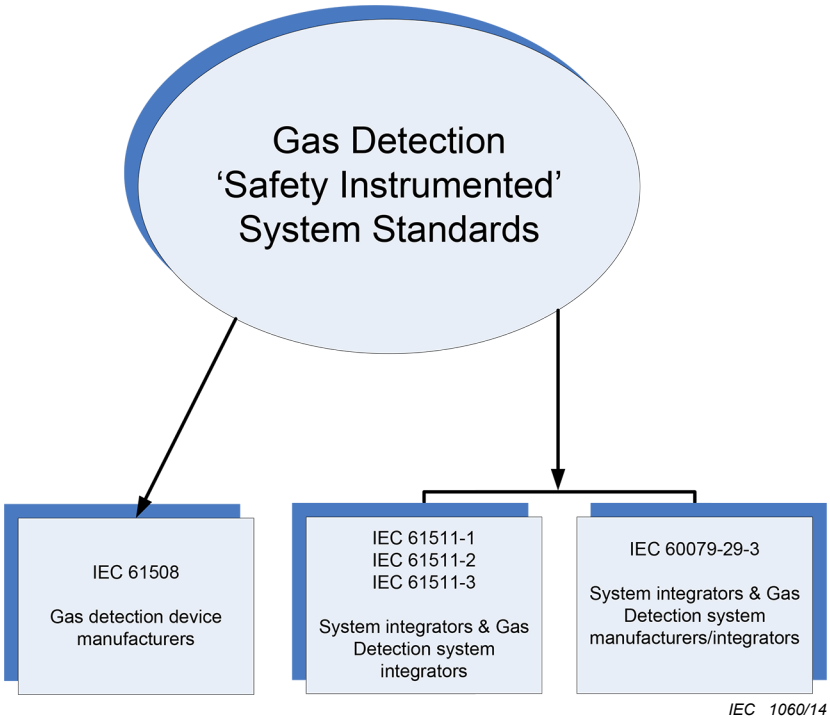

Figure 2 – Related Safety Instrumented System Standards

This international standard does not consider the Safety Integrity Level SIL 4. SIL 4 is assumed to be unrealistic to be achieved for gas detection systems.

NOTE 3 It is rare for any risk study to determine a Safety Integrity higher than SIL 2 for a fixed gas detection system.

This international standard is applicable for fixed gas detection systems, which might consist of the following hardware functional units

- Gas sensor/transmitter
- Gas detection control unit (logic solver)
- Gas sampling (single and multiplexed streams)
- Gas conditioning
- Automatic gas calibration and adjustment
- Output module (if not part of the control unit)

2 Normative references

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

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

IEC 60079-29-2:2007, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen*

IEC 60079-29-4, *Explosive atmospheres – Part 29-4: Gas detectors – Performance requirements of open path detectors for flammable gases*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

3 Terms and definitions

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

3.1
additional safe guarding system
fixed gas detection system or individual instrumented control loops which operate in parallel (secondary) to an instrumented safety system, where the demand on the fixed gas detection system or individual instrumented control loop is only when the primary instrumented safety system fails or another layer of protection fails

3.2
associated gas detection equipment
equipment additional to the gas detection equipment covered by IEC 60079-29-1 or IEC 60079-29-4 which is part of the overall fixed gas detection system and is essential with respect to the safety function

Note 1 to entry: Examples of associated gas detection equipment are gas sampling or gas multiplexing.

3.3
dangerous failure
failure which has the potential to put the safety-related system in a hazardous or fail-to-function state

Note 1 to entry: Whether or not the potential is realised can depend on the channel architecture of the system; in systems with redundant/multiple channels to improve safety, a dangerous hardware failure is less likely to lead to the overall dangerous or fail-to-function state.

Note 2 to entry: An example of a dangerous failure is the loss of a sensing head.

3.4
fail safe mode
mode of output signal where the normal operation is the energised mode.

Note 1 to entry: In the case of loss of power supply the output will be de-energised and the signal is active.

3.5
fault signal
audible, visible or other type of output, different from the alarm signal, permitting, directly or indirectly, a warning or indication that the equipment is not working satisfactorily

3.6
functional unit
entity of hardware or software, or both, capable of accomplishing a specified purpose which may consist of several elements

3.7
hardware module
entity of hardware capable of accomplishing a specified purpose e.g. a transmitter or control unit

3.8
measuring point
location of a gas detector

3.9
peripheral equipment
equipment which is part of the overall fixed gas detection system but is usually non-essential with respect to the safety function

Note 1 to entry: Data storage is an example independent from the safety function.

3.10
proof test
periodic test performed to detect hidden failures in a safety-related system so that, if necessary, the system can be restored to an “as new” condition or as close as practical to this condition

3.11
safe failure
failure which does not have the potential to put the safety-related system in a hazardous or fail-to-function state

Note 1 to entry: An example of a safe failure is a fault in an EMC filtering circuit which has no influence in normal operation but may cause a spurious alarm when EMC disturbances are present.

3.12
safe state
state of the equipment under control (EUC) when safety is achieved

Note 1 to entry: In going from a potentially hazardous condition to the final safe state, the EUC may have to go through a number of intermediate safe states. For some situations, a safe state exists only so long as the EUC is continuously controlled. Such continuous control can be for a short or an indefinite period of time.

3.13
sample line
dedicated pipe or tube which connects a sample point to a gas detector within a point to point or multi-stream sampling system

3.14
sample point
end of a sample line where the sampled gas is taken from

Note 1 to entry: A sample point (hardware) normally comprises a physical housing containing a particle filter or equivalent.

3.15
SIL-capability
characteristic of functional units that comply with the requirements of IEC 61508-2 and IEC 61508-3 suitable for use in functions which are allocated a SIL 1, 2 or 3 respectively

3.16
special state
state of the equipment other than that in which monitoring of gas concentration takes place, for example warm-up, calibration mode or fault condition

4 Requirements

4.1 General

It should be ensured that each of the requirements outlined in Clauses 5 through 16 has been satisfied to the defined criteria and therefore the clause objective(s) have been met.

4.2 Demand rate

A fixed gas detection system may operate several times per year subject to the application, therefore this international standard accepts that the demand rate associated with ‘on demand’ (low demand) should be specified in the safety requirements (e.g. a reference could be “> 1/yr but <10/yr”).

Proof test intervals for low demand mode are determined with the assumption that the demand rate is maximum 1 per year.

If the specified demand rate is higher than 1 per year by factor “X” the proof test interval shall be reduced by the factor “X”.

5 Gas detection unique features

5.1 Objective

The objective of Clause 5 is to identify unique features which apply to fixed gas detection systems with respect to other sensing elements, instrumented control systems and actuators.