# UL 121303

## STANDARD FOR SAFETY

## Guide for Use of Detectors for Flammable Gases

UL Standard for Safety for Guide for Use of Detectors for Flammable Gases, UL 121303

First Edition, Dated September 9, 2020

***Summary of Topics***

***This reaffirmation of ANSI/UL 121303 dated January 17, 2025 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.***

***This First Edition of UL 121303 is an adoption of ISA 12.13.03, Guide for Use of Detectors for Flammable Gases.***

***As noted in the Commitment for Amendments statement located on the back side of the title page, ULSE and FM are committed to updating this harmonized standard jointly.***

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated October 25, 2024.

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FM Approvals
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**FM Approvals LLC**
**FM 121303**
**First Edition**

**ULSE Inc.**
**UL 121303**
**First Edition**

# Guide for Use of Detectors for Flammable Gases

September 9, 2020

(Title Page Reprinted: January 17, 2025)



Approved American National Standard
ANSI

**ANSI/UL 121303-2020 (R2025)**

**Commitment for Amendments**

This standard is issued jointly by the FM Approvals LLC and ULSE Inc (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to FM Approvals or ULSE at any time. Revisions to this standard will be made only after processing according to the standards development procedures of FM Approvals and ULSE. FM Approvals and ULSE will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.



The most recent designation of ANSI/FM 121303 as a as an American National Standard (ANSI) occurred on January 17, 2025.

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This ANSI/UL Standard for Safety consists of the First Edition including revisions through January 17, 2025.

The most recent designation of ANSI/UL 121303 as a Reaffirmed American National Standard (ANS) occurred on January 17, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com..

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# Preface

This is the harmonized FM and ULSE standard for Guide for Use of Detectors for Flammable Gases. It is the first edition of FM 121303 and the first edition of UL 121303.

This harmonized standard is based on ISA 12.13.03, Guide for Use of Combustible Gas Detection Equipment.

This harmonized standard was prepared by FM Approvals LLC (FM) and ULSE.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

### Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

### Level of Harmonization

This standard is published as an equivalent standard for FM and ULSE.

An equivalent standard is a standard that is substantially the same in technical content. Presentation is word for word except for editorial changes.

While the technical content is the same in each organization's version, the format and presentation may differ.

### Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

The following people served as members of TC 9200 and participated in the review of this standard:

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## 1 Scope

1.1 The intent of this document is to provide recommendation for use of detectors for flammable gases, which includes fixed, portable and transportable equipment types, to provide protection from explosion or fires by minimizing the possibility of an accumulation of flammable gases reaching ignitable levels and initiating mitigative actions based upon defined gas concentration limits. There are three independent applications for use of gas detection equipment within hazardous locations: personnel and property protection, classified area surveillance, and supplemental protection for the use of otherwise unsuitable equipment.

1.2 Detectors for flammable gases for personnel and property protection provides ability to work in hazardous (classified) locations, alert user to unsafe conditions, and take mitigative actions as appropriate. It is the intent of this document to compile and provide techniques for proper use of this equipment to achieve personnel and property protection.

1.3 Area monitoring gas detection equipment provides surveillance of a hazardous (classified) location to demonstrate that levels of flammable gases are below the accepted levels of ignitable concentrations. When exposure limits are exceeded, alarm and notification are initiated to prompt evacuation of personnel from the affected location. Also, when exposure limits are exceeded and ventilation techniques are not effective, then repair of equipment is warranted, or a shutdown action will be required. This prevents further loss of containment for the affected process and that the electrical equipment not suitable for use in the flammable atmosphere be de-energized. It is the intent of this document to compile and provide techniques for the use of detectors for flammable gases to monitor and control sources of flammable gas release as a means of process safety management.

1.4 In addition, supplemental area protection is provided by use of gas detection equipment to allow the use of otherwise unsuitable electrical equipment within hazardous (classified) locations. Criteria are developed to establish flammable gas levels to initiate alarms, initiate increase in ventilation rates and to initiate shutdown of processes to shut off the flow of flammable gas that has breached containment and to de-energize all unsuitable electrical equipment. It is the intent of this document to compile and provide techniques for the use of flammable gas equipment to monitor and control sources of flammable gas release into the atmosphere within designated spaces. It is also the intent that these products and techniques be adapted by industries and used with processes that have historically not employed flammable gas detection.

1.5 Detectors for flammable gases as described in this document may be applied as stand-alone sensor/controllers or may be incorporated with or into another system such as, Basic Process and Control System (BPCS), Safety Instrumented System (SIS) or Fire and Gas System that may be employed in an industrial facility. When ventilation rates are to be controlled by the various responses of the flammable gas detection and control devices, there may also be interaction with the HVAC control system or devices.

NOTE 1: Applicable Detectors for flammable gases performance standards include FM 60079-29-1/UL 60079-29-1 and FM 60079-29-4/UL 60079-29-4.

1.6 For the purpose of this document flammable gases include flammable gases and vapors.

1.7 This document provides guidance on personnel and property protection by the use of detectors for flammable gases as defined within the following specified documents.

- ANSI/NFPA 72 for all installations.

- Title 29 Code of Federal Regulations 1910.119(k) OSHA regulations to support the hot work permit.

1.8 This document provides guidance on the use of a flammable gas detection system as a means of protection in industrial establishments with restricted public access and where the conditions of maintenance and supervision allow only qualified persons service the installation as defined within the following specified documents:

- ANSI/NFPA 70 (NEC) where for specific applications, electrical equipment that would not otherwise be permitted in the hazardous (classified) location may be used in conjunction with detectors for flammable gases;

- API RP 500 and API RP 505 for the determination of ventilation required to provide adequate dilution of the detected flammable gas to prevent the possibility of ignition;

- API RP 14F and API RP 14FZ also provide guidance on the use of gas detection as a protection technique.

Documents other than API RP 500 and RP 505 that describe area classification techniques are ANSI/NFPA 497 and ANSI/ISA 60079-10-1. Application of flammable gas detection and control as described in this document can provide additional protection from fire and explosion over typical electrical protection techniques by risk reduction methods. Industries that use these and other area classification documents can benefit by application of the techniques and criteria presented in this document.

NOTE 2: Where mandatory text is provided in this Technical Report, the basis of the mandatory text is derived directly from referenced standards.

1.9 This document provides guidance on the use of flammable gas detection as a supplement to other explosion protection in adequately ventilated spaces.

1.10 This document provides guidance on the use of detectors for flammable gases for monitoring classified areas for low LFL level of flammable gas to initiate maintenance actions to locate and repair leaks in addition to providing alarm to notify personnel for evacuation.

## 2 Referenced Publications

2.1 Any undated reference to a code or standard appearing in the requirements of this standard is referring to the latest edition of that code or standard.

2.2 The following publications are referenced in this standard:

ANSI/ISA 60079-10-1, Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

ANSI/ISA-84.00.01 (IEC 61511-1 Mod), Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, Definitions, System, Hardware and Software Requirements

ISA-TR84.00.07, Guidance on the Evaluation of Fire, Combustible Gas and Toxic Gas System Effectiveness

ANSI/NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

ANSI/NFPA 70, National Electrical Code® (NEC®)

ANSI/NFPA 72, National Fire Alarm Code®

API RP 500, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2

API RP 505, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2

API RP 14C, Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms

API RP 14F, Recommended Practice for Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1 and Division 2 Locations

API RP 14FZ, Recommended Practice for Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations

EN 50402, Electrical apparatus for the detection and measurement of combustible or toxic gases or vapours or oxygen. Requirements on the functional safety of fixed gas detection systems.

FM 60079-29-1, Explosive Atmospheres – Part 29-1: Gas Detectors – Performance Requirements of Detectors for Flammable Gases

FM 60079-29-2, Explosive Atmospheres – Part 29-2: Gas Detectors – Selection, Installation, Use and Maintenance of Detectors for Flammable Gases and Oxygen

FM 60079-29-4, Explosive Atmospheres – Part 29-4: Gas Detectors – Performance Requirements of Open Path Detectors for Flammable Gases

Title 29, Code of Federal Regulations (29 CFR), Occupational Safety and Health Administration, Department of Labor, Process Safety Management of Highly Hazardous Chemicals

Title 49, Code of Federal Regulations (49 CFR), Department of Transportation, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

UL 60079-0, Explosive Atmospheres – Part 0: Equipment - General Requirements

UL 60079-29-1, Explosive Atmospheres – Part 29-1: Gas Detectors – Performance Requirements of Detectors for Flammable Gases

UL 60079-29-2, Explosive Atmospheres – Part 29-2: Gas Detectors – Selection, Installation, Use and Maintenance of Detectors for Flammable Gases and Oxygen

UL 60079-29-4, Explosive Atmospheres – Part 29-4: Gas Detectors – Performance Requirements of Open Path Detectors for Flammable Gases

## 3 Glossary

3.1 For the purpose of this Standard, the following definitions apply.

3.2 ALARM:

a) LOW LEVEL ALARM – a local and/or remote indication of a low level gas concentration.

b) HIGH LEVEL ALARM – a local and/or remote indication of a high level gas concentration.

3.3 DETECTORS FOR FLAMMABLE GASES – equipment for the detection and measurement of flammable gas or vapour concentrations with air.

NOTE: “Historically, this equipment was known as “combustible gas detectors”. It should be recognized that some authorities having jurisdiction may still use the prior term in regulatory requirements.

3.4 BUMP TEST – application of test gas or other means of obtaining a response from the sensor to check its function. This may include the generation of an alarm. This check is performed without adjustments of sensitivity.

NOTE: This is also known as a “response check” or “functional check”.

3.5 LISTED – equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of Listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.6 MALFUNCTION – fault condition within any part of the flammable gas detection system where the flammable gas detection system can no longer reliably detect flammable gas.

3.7 OPEN PATH INFRARED SENOR (LINE-OF-SIGHT) – sensor capable of detecting flammable gas at any location along an open path traversed by an infrared beam.

3.8 SINGLE POINT SENSOR – sensor capable of detecting flammable gas at a single point location.

3.9 FIXED EQUIPMENT – equipment fastened to a support, or otherwise secured in a specific location, when energized.

3.10 PORTABLE EQUIPMENT – equipment intended to be carried by a person during its operation:

NOTE 1: a hand-held equipment, typically less than 1 kg, which requires use of only one hand to operate;

NOTE 2: personal monitors, similar in size and mass to the hand-held equipment, that are continuously operating (but not necessarily continuously sensing) while they are attached to the user; and

NOTE 3: larger equipment that can be operated by the user while it is carried either by hand, by a shoulder strap or by a carrying harness; which may or may not have a hand directed probe.

3.11 TRANSPORTABLE EQUIPMENT – equipment not intended to be portable, but which can be readily moved from one place to another.

3.12 SYSTEM – sensors, logic solvers, and final control elements for the purpose of taking the process to a safe state when predetermined conditions are violated.

## 4 Personnel and property protection

### 4.1 General

4.1.1 Detectors for flammable gases used to monitor local conditions as a general indication of the presence of flammable gas while a person is in a hazardous (classified) location is to be suitably marked for the hazardous (classified) location. The detectors for flammable gases is to be capable of and calibrated for detection of the flammable gas likely to be present in the hazardous (classified) location. The detectors for flammable gases should be Listed for compliance to FM 60079-29-1/UL 60079-29-1. For understanding of explosion protection requirements refer to UL 60079-0.

NOTE: The detectors for flammable gases may be of portable, transportable or fixed point type detection.

### 4.2 Personnel flammable gas hazard monitoring

4.2.1 The flammable gas detection equipment should be verified as suitable for use in the intended hazardous (classified) location. The detectors for flammable gases should be verified to be capable of and calibrated per manufacturer's instructions for detection of the flammable gas likely to be present. A bump test should be applied for verification of proper alarm operation and flammable gas response. Read and understand the manufacturer's instructions prior to use of the flammable gas detection equipment.

4.2.2 Obtain permit by local authority having jurisdiction if required for the intended purpose. Personnel should be adequately trained for use of the detectors for flammable gases. The flammable gas detection equipment should be verified suitable for the specific personnel, and the personnel should understand the necessary actions in the event of alarm and/or trouble indication of the flammable gas detection equipment.

NOTE: Typically it is necessary to monitor flammable gas, oxygen, and carbon monoxide for confined space entry.

### 4.3 Live equipment maintenance

4.3.1 The use of detectors for flammable gases as a method to enhance protection may be applied in accordance with the documented management work process (known as the Gas Free Work Permit (GFWP) or hot work permit) as described in OSHA 29 CFR 1910.119 (k)or as permitted by other appropriate regulation. Electrical equipment that uses an acceptable method of protection that may be temporarily bypassed for maintenance or trouble-shooting may be operated in a hazardous location with the method of protection bypassed while temporary (transportable/portable) detectors for flammable gases is used and monitored by trained personnel. In addition, any portable electronic devices (such as test equipment) not suitable for the hazardous (classified) location may be operated while the detectors for flammable gases is used to monitor the atmosphere within the workplace. As a minimum, the following should be incorporated:

a) All portable/transportable flammable gas detection systems should be checked for functionality with a known concentration of flammable gas just prior to use in conjunction with a gas free permit to certify that a work location is gas free before the introduction of sources of ignition into that work area.

b) Initial measurements should be taken to confirm the absence of an ignitable concentration of any flammable gas throughout the work area.

c) Continuous monitoring should be used to confirm the continued absence of a flammable gas.

d) Monitoring equipment should be used and monitored by properly trained personnel.

e) Contingency plans for emergencies should be in place and supervisors and personnel should be trained for proper response.

4.3.2 Annex A provides an example of a gas free work permit process that incorporates these requirements and restrictions. Portable detectors for flammable gases cannot be used to provide any means of protection other than under a managed work process or hot work permit situation.

### 4.4 Fixed detectors for flammable gas

4.4.1 The flammable gas detection equipment should be verified as suitable for use in the intended hazardous (classified) location. The detectors for flammable gases should be verified to be capable of and calibrated per manufacturer's instructions for detection of the flammable gas likely to be present.

Personnel should be adequately trained for use of the detectors for flammable gases. Read and understand the manufacturer's instructions prior to the system design and selection of equipment and prior to use of the flammable gas detection equipment after the system is commissioned.

4.4.2 The flammable gas detection equipment should be used per the following conditions:

a) equipment, in the area being protected, can be switched off at any time, without warning, without causing any hazards. Essential services such as lighting, instruments required for the safe operation of the process, and the detectors for flammable gases itself is to be verified that it is approved for the hazardous location classification defined for the area;

b) an audible and visible alarm is actuated when the flammable gas concentration reaches 20% of the LFL; and

c) the equipment being protected is automatically disconnected from the electrical supply when the flammable gas concentration reaches 40% of the LFL.

4.4.3 If the location is such that the gas concentration can be reduced by forced ventilation, the 20% LFL level alarm contact may also be used to switch on fans or other such devices to reduce the possibility of a shutdown. However, the alarms are not to be capable of being automatically reset.

## 5 Provision for otherwise unsuitable equipment within hazardous locations – Fixed gas detection equipment

### 5.1 General

5.1.1 The following three cases illustrate how flammable gas detection equipment may be used as a means of protection enabling the use of electrical equipment in hazardous areas where that equipment might not otherwise be allowed. Where a space is classified as Class I, Division 1/Zone 1, equipment that is rated for Class I, Division 2/Zone 2 applications would be permitted to be used within that space, provided the criteria stated in Clause 5.2 are followed. Adherence to these same criteria would permit equipment that is rated for unclassified locations to be installed in a location classified Class I, Division 2/Zone 2.

a) Inadequate Ventilation. In a Class I, Division 1/Zone 1 location that is so classified due to inadequate ventilation, electrical equipment suitable for Class I, Division 2/Zone 2 locations may be installed. Detectors for flammable gases listed for Class I, Division 1/Zone 1, for the appropriate material Group and for the detection of the specific flammable gas or vapor to be encountered, is necessary to monitor for flammable gas at the location.

b) Interior of a Building. In a building located in, or with an opening into, a Class I, Division 2/Zone 2 location where the interior does not contain a source of flammable gas, electrical equipment for unclassified locations may be installed. Detectors for flammable gases listed for Class I, Division 1/Zone 1, for the appropriate material Group and for the detection of the specific gas or vapor to be encountered, is necessary to monitor for flammable gas within the building.

c) Interior of a Control Panel. In the interior of a control panel containing instrumentation utilizing or measuring combustible liquids or gases, electrical equipment suitable for Class I, Division 2/Zone 2 locations may be installed. Detectors for flammable gases listed for Class I, Division 1/Zone 1, for the appropriate material Group and for the detection of the specific flammable gas or vapor to be encountered, is necessary to monitor for flammable gas within the control panel.

NOTE: Each facility will have its own unique characteristics which will influence the number of sensors, type of sensors and location of sensors to achieve adequate coverage. Each user will have their own risk assessment criteria which will also influence the placement of sensors.

Subclauses 5.2 – 5.5 provide general recommended practices for applying flammable gas detection as a means of protection of electrical equipment pertinent to requirements of ANSI/NFPA 70 (NEC).

## 5.2 Criteria for use

5.2.1 The criteria for use of detectors for flammable gases as a method of protection include all of the following:

a) The area to be protected:

– is an industrial establishment;

– has restricted public access; and

– is governed by conditions of maintenance and supervision that allow only qualified persons service the installation.

b) The detectors for flammable gases should be Nationally Recognized Testing Laboratory (NRTL) Listed for compliance to FM 60079-29-1/UL 60079-29-1 or FM 60079-29-4/UL 60079-29-4. The flammable gas detectors are of a stationary type, permanently mounted and Listed for detection of the specific flammable gas to be encountered.

1) The portion of the flammable gas detection equipment installed in the described cases of Clause 5.2 (a) – (c) is required to be rated for Class I, Division 1/Zone 1, and that portion of the flammable gas detection equipment outside the described cases is required to be rated for the location in which it is installed.

2) The power circuit for the detectors for flammable gases is required to be independent from any power circuit for the equipment within the space in order to permit continued gas detection monitoring by the flammable gas detection system.

3) Open path (line of sight) flammable gas detectors should not be used without fixed point flammable gas detection since they do not provide sufficient information on the % LFL gas concentration at a specific location along the sight path, which is necessary to effect remedial action. Open path detectors provide an average measurement over the complete sight path. While the open path flammable gas detector may provide the detection before a point source detector, they cannot be considered as the basis for protection of equipment.

NOTE 1: Reference ANSI/ISA-84.00.01 for information regarding safety instrumented system requirements and ANSI/NFPA 72 for information regarding fire alarm code requirements.

NOTE 2: Detectors for flammable gases identified as “Classified as gas or vapor detection enclosures” or “Classified as gas or vapor detection equipment” does not meet the requirement in (b) above and should not be used in the applications reviewed in this guide.

c) An adequate number of sensors is installed and appropriately placed to provide high probability of the sensing of flammable gas in the space protected in all areas where such gas might flow or accumulate.

d) Sensing a flammable gas concentration of less than or equal to 20% LFL (as defined by risk assessment), (or for supplemental open path flammable gas detectors the level less than or equal to 1 LFL·m), should activate a low level alarm (audible or visual, or both, as most appropriate for the location).

NOTE 1: Reference ANSI/NFPA 72 for audible and visual alarm device details.

NOTE 2: The 20% LFL has been historically acceptable to account for flammable gas detection equipment accuracy considerations for compliance with 49CFR 192.736.

NOTE 3: OSHA 1910.146 Permit required confined entry spaces defines a hazardous atmosphere with “flammable gas, vapour, or mist in excess of 10 percent of its lower flammable limit (LFL)”.

NOTE 4: ISO 21798 Gas Turbine Applications-Safety, Clause 5.19.4, specifies an alarm level of 10% LFL within ventilated turbine enclosures. Lower LFL alarm levels are recommended where dilution of flammable gas concentrations are likely.

e) Action to reduce the rate of increase in flammable gas concentration should be taken at or before the 20% LFL (or for supplemental open path flammable gas detectors before the 1 LFL·m. the level)

NOTE: The 20% LFL has been historically acceptable to account for gas detection equipment accuracy considerations for compliance with 49CFR 192.736.

f) Detection of a flammable gas concentration of 40% LFL or for supplemental open path flammable gas detectors 2 LFL·m (or less if determined by risk assessment) should activate a high level alarm (audible or visual, or both, as most appropriate for the area) and initiate automatic disconnection of power from otherwise inappropriate electrical devices in the area. Disconnection of the devices should consider the following:

1) In a Division 2 (Zone 2) hazardous (classified) location, the power disconnecting device(s) should be suitable for Class I, Division 1 or Zone 1 as appropriate if located inside the building (or similar area). A power disconnecting device listed for Division 2 may also be used within a Division 2 location.

2) If the disconnecting device(s) is located outside the building (or similar area), it should be suitable for the area in which it is located. Redundant or duplicate components (such as sensors) may be installed to avoid disconnecting electrical power when single component malfunctions are indicated.

3) When automatic shutdown could introduce additional or increased hazard, this method of protection should not be used.

NOTE 1: In the case of sensing 40% LFL or a flammable gas detection system malfunction, corrective action to reduce or limit the increase in flammable gas concentration should be initiated immediately.

NOTE 2: Reference ANSI/NFPA 72 for audible and visual alarm device details.

NOTE 3: To prevent flammable gas migration through the conduit and/or cable system, reference ANSI/NFPA 70 501.17 Process Sealing and 505.26 Process Sealing for additional requirements on seals.

g) The calibration of the flammable gas detection system should be checked and/or adjusted as necessary in accordance with the manufacturer’s recommendations, but at least once every three months. Checks and adjustments should verify the entire system such as test filters or by actual exposure of the sensor to a known mixture (nominal 50% LFL is recommended) of diluents and methane or other gas anticipated, in accordance with the manufacturer’s recommendations, but at least once every three months.

NOTE: Reference FM 60079-29-2/UL 60079-29-2 for flammable gas detection calibration details.

h) User-provided systems that bypass the disconnecting or other “corrective action” devices to allow calibration and maintenance are permitted, provided the bypass system is utilized only during calibration or maintenance operations, and only while the area is continuously monitored by personnel who are qualified to take corrective action should there be a malfunction in process, storage, transfer, or similar equipment that potentially might release flammable gas into the area. Any systems in the bypass mode that are to be made continuously obvious by audible or visual means to facility personnel; and the audible or visual alarm devices are to remain active while the bypass action is in effect.

NOTE: Reference ANSI/NFPA 72 for audible and visual alarm device details.

i) When electrical equipment is installed in a location in accordance with the requirements of 6.2(a) or 6.2(b), the protected location should contain no electrically heated parts or components that normally operate at a temperature equal to or above 80% of the auto-ignition temperature (in degrees Celsius) of the specific flammable gas or vapor involved unless the part or component is Listed for Class I, Division 2, (Group and Temperature Class as appropriate) hazardous (classified) locations.

NOTE: The maximum surface temperature of some parts may not occur until after power is removed, so the removal of power may not remove all sources of thermal ignition.

j) A malfunction of the flammable gas detection system should activate an alarm (trouble, audible and/or visual) as most appropriate for the area and initiate automatic disconnection of power from all electrical devices in the area that are not suitable for the classification of the area. Redundant or duplicate components (such as sensors) may be installed to avoid process shutdown or disconnecting electrical power when single component malfunctions are indicated. When automatic shutdown could introduce additional or increased hazard, this method of protection should not be used. A malfunction indication for this application should be treated as if it were indication that flammable gas has been detected and power should not be restored until confirmation that the space is free of flammable gas.

k) For use of redundant or duplicate components, a single diagnostic fault for the 1-out-of-2 flammable gas detector configuration should activate an alarm (audible or visual, or both, as most appropriate for the location). A second diagnostic fault condition should provide the same action described in 5.2(j).

l) The flammable gas detection system should be configured in a failsafe de-energized–to-trip manner to provide notification upon failure or trouble condition.

### 5.3 System Architecture

5.3.1 A flammable gas detection system includes a group of functional modules designed to monitor, detect and report a hazard. The hardware design consisting of individual components may be arranged in different ways. Depending on actual devices selected, components of a functional module may belong to different hardware components.

Figure 1 (includes Figure 1a and 1b) illustrates the modules of a gas detection system and their relations to each other. These figures are an example of a typical system and are for reference only. The actual system may contain more or less components than those indicated depending on the actual application.

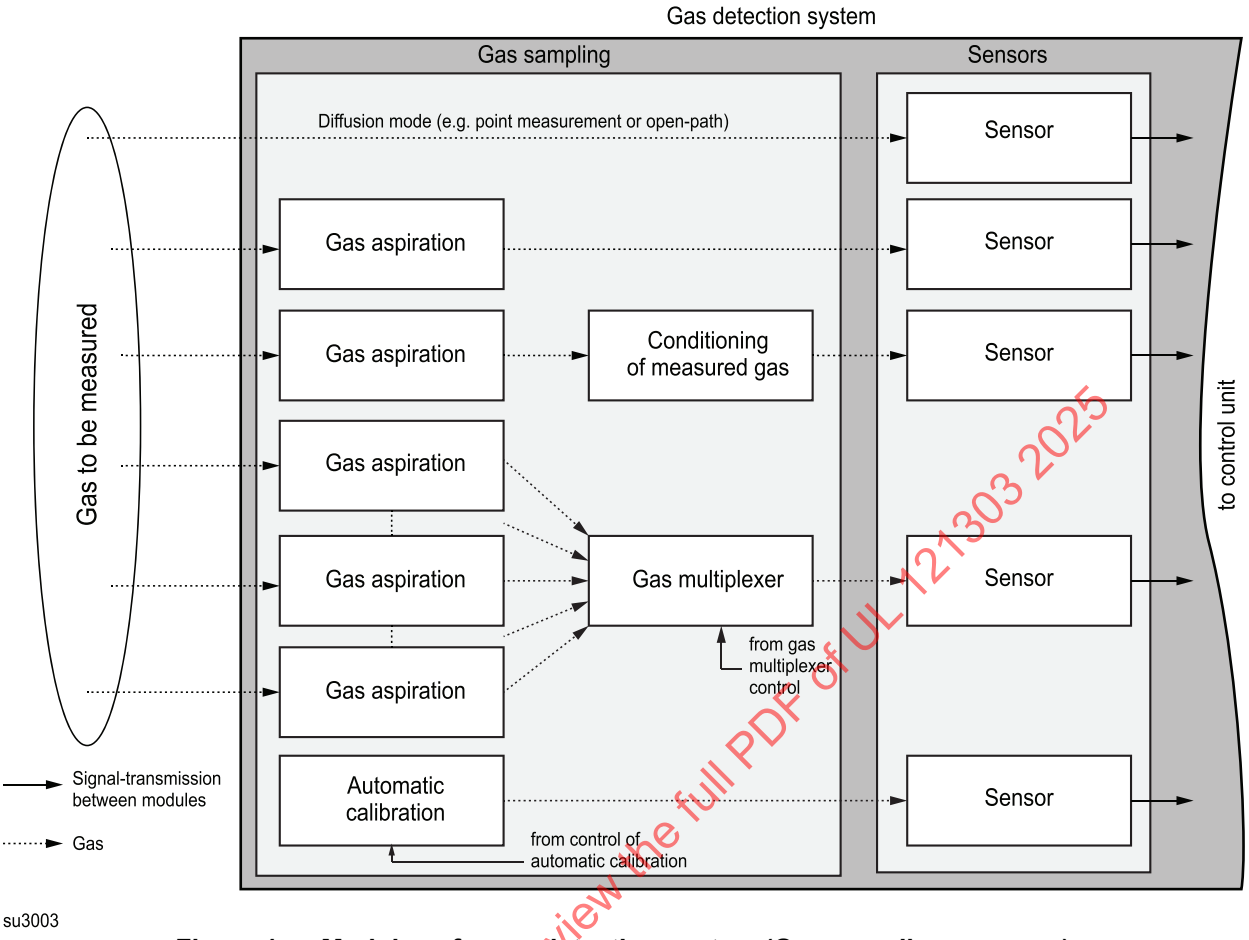


**Figure 1a – Modules of a gas detection system (Gas sampling, sensors)**

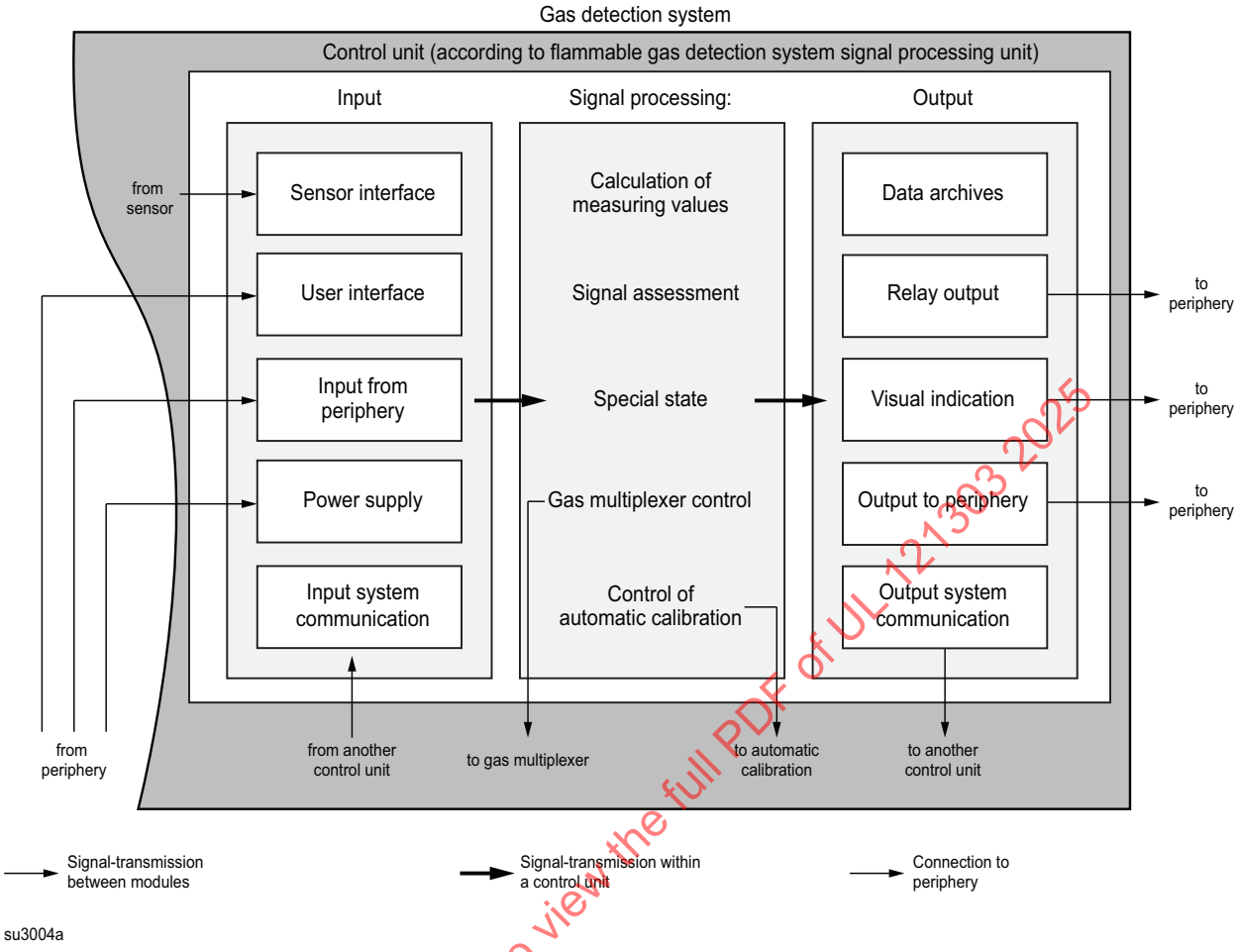


**Figure 1b – Modules of a flammable gas detection system (Control unit)**

**Figure 1**

**Modules of a gas detection system (Extracted in part from EN 50402)**

5.3.2 A flammable gas protection layer typically does not stop the propagation of the accident sequence. By definition, a successful flammable gas detection function prevents an already bad situation from getting worse. A successful flammable gas detection function prevents a failure in the process containment from escalating to a 100% LFL, fire or explosion. Mitigation effectiveness is high when a potential hazard is detected and action is taken early prior to escalation. A detection of a hazard while it is in its early stages should initiate process shutdown action to reduce or eliminate the hazard.

5.3.3 The following should be considered for risk analysis:

- Hazardous Scenario
- Detection Coverage
- Flammable Gas System Availability
- Mitigation Effectiveness

## 5.4 Installation

5.4.1 For guidance on placement of flammable gas detection sensors, reference FM 60079-29- 2/UL 60079-29-2 and ISA-TR84.00.07. In addition, guidance is provided in API RP 14C, API RP 14F, and API RP 14FZ.

5.4.2 Location of flammable gas detection sensors depends on the properties of the gas expected to be released. Considerations of sensor placement are listed in items (a) through (g).

a) For methane or other lighter than air gases, install sensors above potential sources of release.

b) For heavier than air gas, install sensor at a level about 1 ft above the floor.

c) Evaluate the ventilation system and install sensors to intercept the gas migration along a path between potential sources and air exhaust outlet.

NOTE 1: Response time, air velocity compatibility and maintenance access should be basic considerations for sensor selection.

NOTE 2: An increased test interval schedule may be necessary for flammable gas sensors applied in ventilation systems.

d) Locate sensors at exhaust air outlets.

e) Where the air handling system re-circulates a portion of room air, place at least one sensor at the return air inlet. Verify from the documentation that the type of detector selected for this application will function as expected in turbulent air flow applications.

f) Modeling of the potential liquid and/or gas release characteristics and ventilation pattern and rates may be a tool for determination of sensor placement.

g) Detector coverage assessment:

A coverage assessment seeks to determine the degree of coverage of a monitored area, with potential for a flammable gas hazard. The goal is to determine the fraction of geometric area within a monitored area in which a release would be detected. The factors of a coverage assessment include the sensor(s) placement in the monitored area, obstacles that prevent/inhibit detection, and the defined voting arrangement for the safety action.