

TECHNICAL REPORT

ANSI/ISA-TR12.13.03-2009

ANSI Technical Report prepared by ISA

**Guide for Combustible Gas Detection
as a Method of Protection**

Approved 14 December 2009

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ANSI/ISA-TR12.13.03-2009, Guide for Combustible Gas Detection as a Method of Protection

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Foreword

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The primary reason for development of this technical report is to support the existing allowance for combustible gas detectors as a method of protection as permitted within ANSI/NFPA 70, National Electrical Code (NEC), Articles 500 and 505. This document also provides guidance on the use of combustible gas detectors as a method of area classification designation, gas free work permit (hot work permit) application and supplemental protection.

Abstract

This document provides guidance on the use of combustible gas detection as a method of protection as permitted by ANSI/NFPA 70 (NEC), the use of combustible gas detection for reduction of area designation by API 500 and API 505, and to support the Hot Work Permit discussed in OSHA regulations 29 CFR 1910.119(k).

Keywords

Apparatus, combustible gas detection, fixed apparatus, combustible gas, combustible vapor, gas concentration, gas free work permit, hot work permit, portable apparatus, transportable apparatus

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Introduction

Combustible gas detection apparatus and systems should be used whenever there is the possibility of a hazard to life or property caused by the accumulation of a combustible gaseous atmosphere. Such apparatus can provide a means of reducing the hazard by detecting the presence of the combustible gas and issuing suitable audible or visual warnings and/or to initiate specific actions such as increased ventilation rates, plant shutdown, evacuation, and operation of fire suppression procedures.

Combustible gas detection apparatus and systems may be used to monitor a gas atmosphere to initiate maintenance or operation action when low levels of combustible gas are detected.

Additionally, combustible gas detection apparatus can be used to confirm that the area is suitable for engagement of work activities or to permit energizing electrical equipment in hazardous (classified) locations.

Performance requirements for combustible gas detecting apparatus are set out in ANSI/ISA-12.13.01 (IEC 61779-1 to -5 Mod) and ANSI/FM 6325/ISA-12.13.04.

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1 Scope

Combustible gas detection used for process safety management may also be used to provide protection from explosion or fires by minimizing the possibility of an accumulation of combustible gases reaching ignitable levels. Criteria are developed to establish combustible gas levels to initiate alarms, initiate increase in ventilation rates and to initiate shutdown of processes to shutoff the flow of combustible gas that has breached containment. It is the intent of this document to compile and refine techniques for the use of combustible gas sensors and controllers to monitor and control sources of combustible 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 combustible gas detection as a method of protection.

1.1 This document provides guidance on the use of a combustible gas detection system as a method of protection in Class I hazardous (classified) locations as defined within the following specific 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 combustible gas detection equipment;
- API RP 500 and API RP 505 for the use of combustible gas detection equipment to augment ventilation to ensure adequate dilution of combustible gas to prevent the possibility of ignition;
- Title 29 Code of Federal Regulations 1910.119(k) OSHA regulations to support the hot work permit.

NOTE 1 — Applicable combustible gas detection equipment performance standards include ANSI/ISA-12.13.01 and ANSI/FM 6325/ISA-12.13.04.

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

Documents other than API RP 500 and RP 505 that describe area classification techniques, but which have not included combustible gas detection as part of the process to reduce the probability of ignition are ANSI/NFPA 497 and ANSI/ISA-TR12.24.01 (IEC 60079-10 Mod). Application of combustible gas detection and control as described in this document can provide additional protection from fire and explosion over typical area classification 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.

1.2 This document provides guidance on the use of portable combustible gas detection apparatus to allow live maintenance on equipment or work with electrical powered tools within hazardous (classified) locations.

1.3 This document provides guidance on the use of combustible gas detection as a supplement in adequately ventilated spaces.

1.4 For the purpose of this document, apparatus includes

fixed apparatus;

portable apparatus; and

transportable apparatus.

1.5 This document is NOT intended to cover the following:

- a) Guidance on area classification
- b) Apparatus intended only for the detection of non-combustible toxic gases
- c) Apparatus of laboratory or scientific type intended only for analysis or measurement purposes
- d) Apparatus intended for mining applications
- e) Apparatus intended for applications in explosives processing and manufacture
- f) Apparatus intended only for process control applications
- g) Apparatus intended for the detection of a potentially combustible atmosphere resulting from dust or mist in air
- h) Apparatus intended for confined space entry.

1.6 Combustible gas hardware 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 must be controlled by the various responses of the combustible gas detection and control devices, there must also be interaction with the HVAC control system or devices.

2 References

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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.

ANSI/ISA-60079-0 (12.00.01), Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations: General Requirements

ANSI/ISA-TR12.24.01 (IEC 60079-10 Mod), Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

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/ISA-12.13.01 (IEC 61779-1 to 5 Mod), Performance Requirements for Combustible Gas Detectors

ANSI/ISA-RP12.13.02 (IEC 61779-6 Mod), Recommended Practice for the Installation, Operation, and Maintenance of Combustible Gas Detection Instruments

ANSI/FM 6325/ISA-12.13.04, Performance Requirements for Open Path Combustible Gas Detectors

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

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

ANSI/NFPA 72, National Fire Alarm Code®

API RP500, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2

API RP505, Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2

API RP14C, Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms

API RP14F, 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 RP14FZ, 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

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

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.

3 Definitions

For the purpose of this document, the definitions from ANSI/ISA-12.13.01 and ANSI/FM 6325/ISA-12.13.04 apply except where definition is necessary as part of this document.

3.1 alarm

3.1.1 low level alarm

a local and/or remote indication of a low level gas concentration

3.1.2 high level alarm

a local and/or remote indication of a high level gas concentration

3.2 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.

3.3 malfunction

a fault condition within any part of the gas detection system where the gas detection system can no longer reliably detect gas

3.4 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 Fixed installations with otherwise unsuitable equipment

The following three cases illustrate how gas detection may be used as a method 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 4.1 are followed. Adherence to these same criteria would permit equipment that is rated for ordinary 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. Combustible gas detection equipment 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 combustible gas at the location.

NOTE — API RP 500:2002, Section 6.5.1(a) and API RP 505:2002, Section 6.8.1(a) allow that the installation of combustible gas detection equipment can be the basis for designating the area as Division 2/Zone 2.

- 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 combustible gas, electrical equipment for unclassified locations may be installed. Combustible gas detection equipment 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 combustible gas within the building.

NOTE — API RP 500:2002, Section 6.5.1(a) and API RP 505:2002, Section 6.8.1(a) allow that the installation of combustible gas detection equipment can be the basis for designating the area as "unclassified".

- 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. Combustible gas detection equipment 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 combustible gas within the control panel.

Subclauses 4.1 through 4.4 provide general recommended practices for applying combustible gas detection as a method of protection of electrical equipment pertinent to requirements of ANSI/NFPA 70 (NEC).

4.1 Criteria for use

The criteria for use of combustible gas detection equipment 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 ensure only qualified persons service the installation.
- b) The combustible gas detection equipment should be Listed for compliance to ANSI/ISA-12.13.01 or ANSI/FM 6325/ISA-12.13.04. The combustible gas detectors are of a stationary type, permanently mounted and Listed for detection of the specific combustible gas to be encountered.

- (1) The portion of the gas detection equipment installed in the described cases of Clause 4 (a) – (c) is required to be rated for Class I, Division 1/Zone 1, and that portion of the 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 combustible gas detection equipment 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 gas detection system.

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 — Combustible gas detection equipment 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 ensure the sensing of combustible gas in the space protected in all areas where such gas might flow or accumulate.
- d) Sensing a combustible gas concentration of less than or equal to 20% LFL (as defined by risk assessment), or 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 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 gas concentrations are likely.

- e) Action to reduce the rate of increase in combustible gas concentration should be taken at or before the 20% LFL or 1 LFL•m.

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 combustible gas concentration of 40% LFL or 3 LFL•m (or less if defined 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 combustible gas detection system malfunction, corrective action to reduce or limit the increase in gas concentration should be initiated immediately.

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

NOTE 3 — To prevent gas migration through the conduit and/or cable system, reference ANSI/NFPA 70 “Canned Pumps, Process, or Service Connections, and ...” for additional requirements on seals.

- g) The calibration of the combustible 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 ANSI/ISA-12.13.02 for combustible 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 manned 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 combustible gas into the area. Any systems in the bypass mode must be made continuously obvious by audible or visual means to facility personnel; and the audible or visual alarm devices must 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 4.a or 4.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 autoignition temperature (in degrees Celsius) of the specific gas or vapour 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 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 combustible gas has been detected and power should not be restored until confirmation that the space is free of combustible gas.
- k) For use of redundant or duplicate components, a single diagnostic fault for the 1-out-of-2 combustible 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 4.1(j).
- l) The combustible gas detection system should be configured in a failsafe de-energized-to-trip manner to ensure notification upon failure or trouble condition.

4.2 System Architecture

A 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.

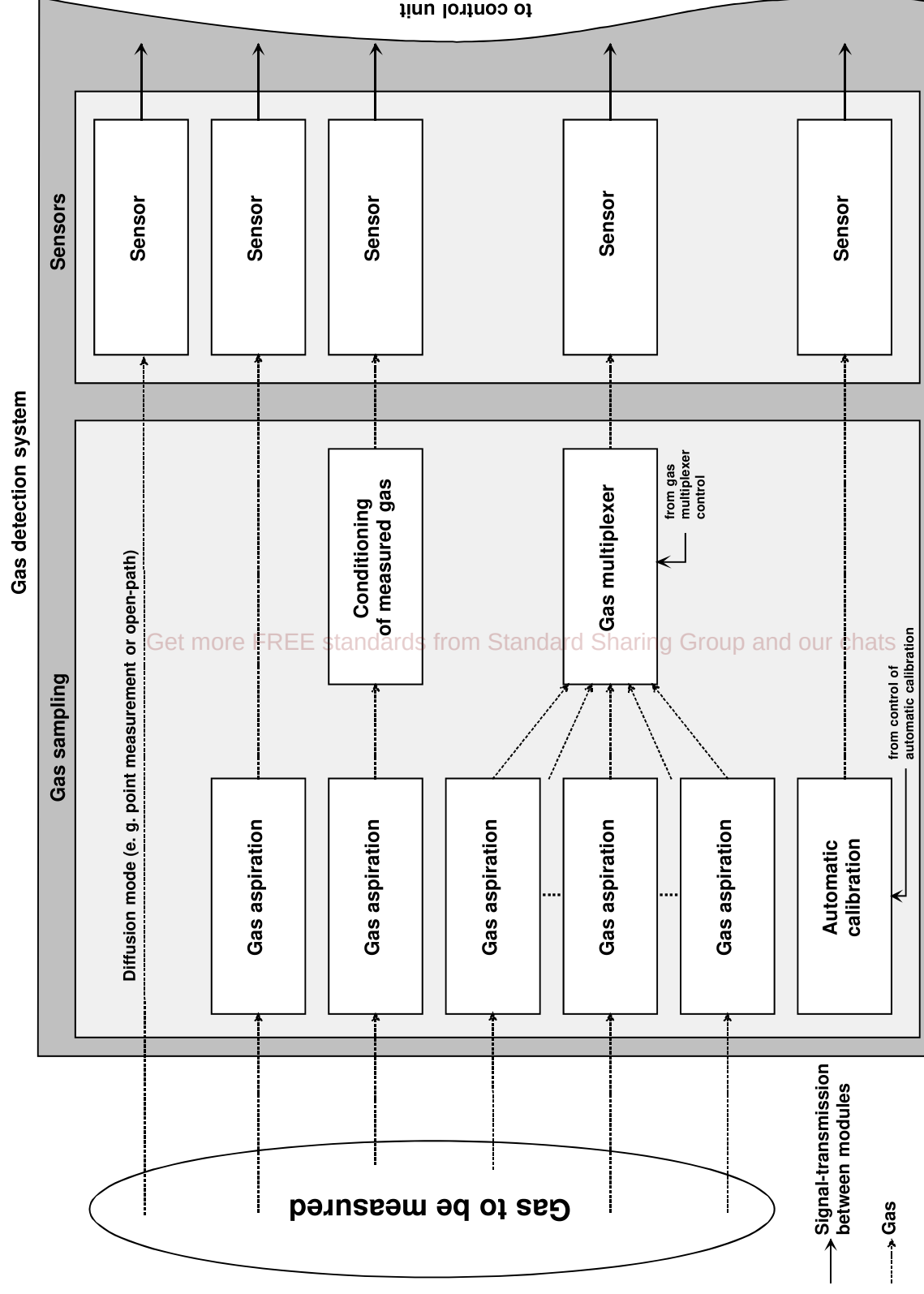


Figure 1a - Modules of a gas detection system (Gas sampling, sensors)

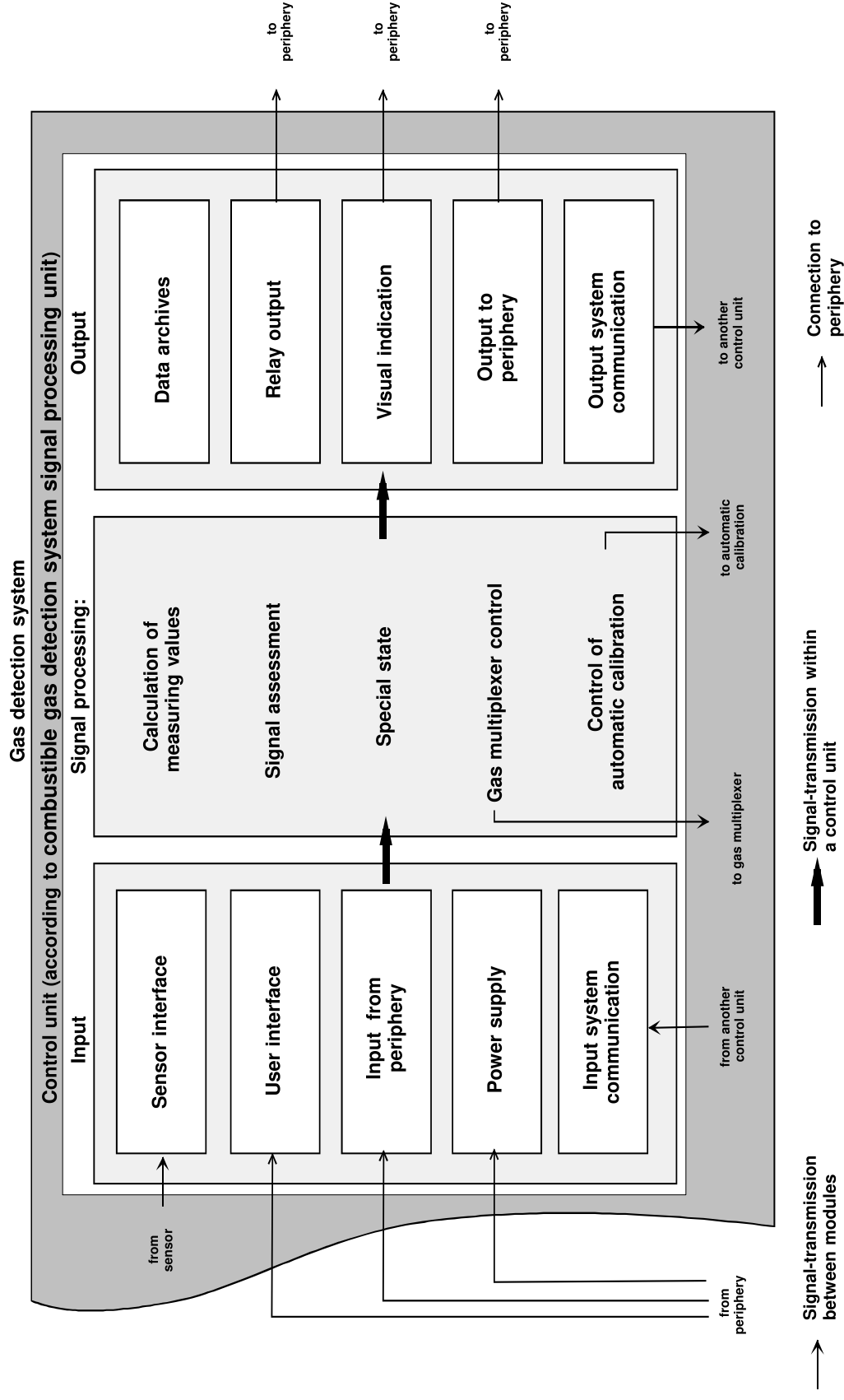


Figure 1b - Modules of a gas detection system (Control unit)

Figure 1 - Modules of a gas detection system (Extracted in part from EN 50402)

A combustible gas protection layer typically does not stop the propagation of the accident sequence. By definition, a successful combustible gas detection function prevents an already bad situation from getting worse. A successful combustible 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.

The following should be considered for risk analysis:

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

4.3 Installation

For guidance on placement of combustible gas detection sensors, reference ANSI/ISA-RP12.13.02 and ANSI/ISA-84.00.01. In addition, guidance is provided in API RP 14C, API RP 14F, and API RP 14FZ.

Location of combustible 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 combustible 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.
- 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 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.

4.4 Maintenance requirements

The combustible gas detection system should be installed, operated, and maintained in accordance with ANSI/ISA-RP12.13.02, manufacturers' instructions or recommended practices developed for specific

applications of combustible gas detectors. The combustible gas detector should be bump tested and/or calibrated according to the manufacturer's instructions, but at least quarterly, for the gas or gases that are the basis for the classification.

4.5 Documentation

The type of detection equipment, its listing, installation location(s), alarm and shutdown criteria, and calibration frequency should be documented when combustible gas detectors are used as a protection technique. The documentation should be readily available and be part of maintenance and safety procedures. A 'Management of Change' procedure should be in place to insure the documentation is updated whenever there is a change to the setup.

5 Live equipment maintenance

5.1 General

Combustible gas detection equipment used to monitor local conditions as a general indication of the presence of combustible gas at the place and time that the permitted work is being performed must be suitably marked for use in the hazardous (classified) location. The combustible gas detection equipment is to be capable of and calibrated for detection of the combustible gas likely to be present in the classified area during the time that the permitted work is being performed. The combustible gas detection equipment should be Listed for compliance to ANSI/ISA-12.13.01.

Note - The combustible gas detection equipment may be of portable, transportable or fixed point type detection.

5.2 Gas free work permit (hot work permit)

The use of combustible gas detection equipment as a method of protection must 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 must be temporarily bypassed for maintenance or trouble-shooting may be operated in a hazardous location with the method of protection bypassed while combustible gas detection apparatus is used and monitored by trained personnel. In addition, any portable electronic devices not suitable for the hazardous (classified) location may be operated while the combustible gas detection apparatus is used to monitor the atmosphere within the workplace. As a minimum, the following should be incorporated:

- a) All portable/transportable gas detection systems should be checked for functionality with a known concentration of combustible 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 combustible gas throughout the work area.
- c) Continuous monitoring should be used to confirm the continued absence of a combustible 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.

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

6 Combustible gas detection systems in adequately ventilated classified areas

The primary protection against the accumulation of 100% LFL combustible gas concentrations is by adequate ventilation, where adequate ventilation is defined as the ventilation rate (natural or artificial) that is sufficient to prevent the accumulation of significant quantities of vapor-air or gas-air mixtures in concentrations above 25% LFL. Discussion of adequate ventilation is provided in API RP 500, Section 6.3 and API RP 505, Section 6.6.

A space with ventilation rate of at least six air changes per hour can be considered as adequately ventilated with no additional considerations.

The combustible gas detection equipment is required to comply with the requirements of 4.1(b). When used in conjunction with adequate ventilation, combustible gas detection equipment provides an additional level of protection in an area.

An additional benefit is that combustible gas detection equipment can provide indication of combustible gas levels that are well below alarm levels (i.e. $5\% < \text{LEL} < 20\%$). Indication of low levels of combustible gas should be used to initiate troubleshooting and repair activities that would prevent disruptive and costly shutdown due to more severe gas leaks. The applications described in Clauses 6.1 through 6.3 provide enhancement that can provide for reduced heating cost with reduced outside air changes; elimination of lost production, reduced repair costs by identifying low level gas leaks early.

6.1 Adequately ventilated areas

Where ventilation rates are considered adequate by being at or in excess of 6 air changes per hour, it is recommended that a combustible gas system that meets the criteria of 4.1 (a) through (l) be utilized in areas classified Class I, Division 1 or 2 or Zone 1 or 2 where fire or explosion hazards exist due to flammable gases or vapors.

- a) Disconnection of electrical equipment as described in 4.1 (f) or 4.1(j) need not be considered upon detection of combustible gas unless it is coincident with loss of ventilation.
- b) Upon loss of ventilation a trouble alarm is to be transmitted to the control room or other appropriate location.

6.2 Low ventilation rates

Less than six air changes per hour may be employed and still considered adequately ventilated provided the air exchange rate has been determined by one of the following methods:

- a) Fugitive emission calculations.

Where adequate ventilation rates less than 6 air changes per hour are determined by fugitive emission calculations, it is recommended that a combustible gas system that meets the criteria of 4.1 (a) through (l) be utilized in areas classified Class I, Division 1 or 2 or Zone 1 or 2 where fire or explosion hazards exist due to flammable gases or vapors.

Most especially if the ventilation rate calculated by the procedure described in the referenced documents is less than 3 air changes per hour it is highly recommended that continuous monitoring with fixed combustible gas detectors be provided to assure less than 25% LFL is maintained.

NOTE — Reference API RP 500, Section 6.3.2.4.8 or API RP 505, Section 6.6.2.4.8 Fugitive Emission calculation methods.

b) Recirculation

Reduced outside air exchange below determined adequate ventilation rates may be used where recirculation of inside air is employed, provided all the following criteria are observed:

- 1) the area is monitored continuously with a combustible gas detection system that meets the criteria of 4.1 (b) through (l);
- 2) the combustible gas detection system is set up to automatically stop recirculation and/or provide high level alarm; and
- 3) the outside air exchange is provided at six air changes per hour or more if the measured level exceeds 20% LFL (or 1 LFL•m) level.

Disconnection of electrical equipment as described in 4.1 (f) or 4.1(l) need not be considered upon detection of combustible gas unless it is coincident with loss of ventilation.

Upon loss of ventilation a trouble alarm is to be transmitted to the control room or other appropriate location to initiate corrective action.

6.3 Unclassified locations near potential combustible gas sources

Where ventilation air, free of ignitable concentrations of flammables is required, for example, the air intake for a control room located in an unclassified location, near potential combustible gas sources, gas detection to monitor the air inlet should be installed. The following actions should be considered at or below the 20% LFL (or 1 LFL•m) level:

- 1) Shut down the air intake (close dampers and/or de-energize fan supply as appropriate)
- 2) Shut down the process (to halt the release of combustible gas and in preparation for de-energizing the electrical power system)
- 3) De-energize the power to the space and/or release the fire suppression agent as an inerting agent

NOTE 1 — Caution should be exercised when combustible gas sensors are installed inside ventilation air ducts or other turbulent flow applications. This equipment and sensors should be specifically designed, tested, and approved for low-level combustible gas detection in turbulent air applications to ensure that the actions recommended above will function when flammable gasses or vapors are present in the ventilation system.

NOTE 2 — Consideration should be given to the actions above to ensure that they do not result in a more hazardous condition. (See Appendix B.)

NOTE 3 — Where condensation of moisture or formation of frost could occur, the equipment used should be selected with considerations for prevention, or toleration of these conditions.

Installation of combustible gas detectors in or adjacent to selected electrical equipment may be considered to ensure that if combustible gas continues to accumulate within the space, proper choice for disconnection of electrical power can be made.

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Annex A — A permit for electrical work in classified locations (example)

Date: _____ Time applicable: _____ Location: _____ Permit #: _____

Specific work to be performed: _____

Risk category(s) for activity or device: (Circle one): Probable(B) Occasional(C) Remote(D) Improbable (E)

Area classification where work will be performed: (Circle one): Division 1/Zone 1, Division 2/Zone 2

The Risk category selected requires identification of minimum safeguards for the specific devices and activities.

Initial those safeguards listed below that apply.

____ 1. A Job Safety Analysis (JSA) has been conducted for the specific work to be performed per this permit.

____ 2. Appropriate action has been taken to remove the reason(s) for the Division 1 classification during the activity or device use. (Examples: increase ventilation or eliminate source)

____ 3. The person responsible for the work will remain at the work site while the work is in progress
Name: _____

____ 4. A combustible gas indicator test will be conducted before starting and as needed while the work is performed. Proper detector operation has been verified.
Name: _____

____ 5. Firefighting equipment is available in the vicinity of the work.

____ 6. Lockout Tagout (LOTO) has been employed where needed to eliminate potential electrical sources of ignition.

____ 7. Other precautions (describe): _____

It is the responsibility of the person in charge of the work to have a copy of this permit before work starts and to ensure that all prescribed precautions are followed.

GFWP submitted by

GFWP approved by

Exception(s) to above requirements / Justification: _____

Exception(s) approved by: _____

NOTE 1 — When a Gas Free Work Permit (GFWP) requires that the location be tested with combustible gas detectors, fixed units add to the safety, but they may not be used in lieu of portable combustible gas detectors.

NOTE 2 — If extension cords are used in conjunction with 120 VAC electrical tools or other devices, a Gas Free Work Permit (GFWP) is required if the tool or device connects to the extension cord in a classified location.

NOTE 3 — Connections between extension cords and devices or tools should utilize locking means to prevent accidental disconnection.

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Annex B — Examples of actions

Actions taken upon detection of combustible gas must be carefully considered to ensure that a more hazardous condition is not developed. For shutdown actions the order in which the actions occur could increase the release rate of the combustible gas, remove the diluting effect of the ventilation system or possibly introduce an ignition source in the presence of combustible gases if performed in an improper sequence. Special application examples follow:

1. Combustible gas detected at the combustion air intake of an internal combustion engine (turbine or reciprocating) will initiate shutdown of the engine.
2. When combustible gas is detected at the ventilation air intake to an unclassified Control or Electrical room, air intake must be halted to prevent further accumulation of combustible gas within the room. Air circulation may be continued with all air re-circulating through the air return after the damper for the outside air intake is closed, to further dilute any accumulation of combustible gas.
3. If there is any chance that combustible gas could be introduced directly into a Motor Control Center or other power equipment it may be prudent to introduce a purge into the equipment prior to de-energizing the equipment to eliminate ignition of combustible gas from arcs produced at opening contacts.

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