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Gas Detection as a Risk Mitigation Technique

There are many differences between gas detection systems used for process monitoring and those used for protecting the safety of personnel

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FIGURE 1. Gas detectors for process monitoring provide continuous measurements of gas concentrations in supply lines; they have no role in personnel safety

Some types of gas detectors keep an eye on production processes. Others, relying on a number of different technologies, can help save lives. While both functions are important in a chemical processing plant, there are significant differences between gas detection equipment for monitoring the production process versus gas detection equipment for mitigating risk and maintaining life safety (Figure 1).

TYPES OF DETECTORS

The first and simpler type of gas detector is used for process monitoring only. These detectors are integrated into a gas supply line for the sole function of continuously measuring the concentrations of gases in the supply line for process adjustments. Gas concentration monitors are subject to fewer and less stringent standards than detectors intended for alarm notification purposes. In addition, gas concentration monitors usually have simple displays and do not offer "smart" capabilities, such as built-in highway addressable remote transducer (HART) protocol. The HART protocol is the global standard for sending and receiving digital information across analog wires between smart devices in a system.

The second and significantly more sophisticated type of gas detector is used in a facility's hazardous-area safety system. These detectors are responsible for detecting leaks of combustible or toxic gases for alarm notification purposes. Because the devices are installed in high-risk areas, they have to be product certified for hazardous locations, as well as performance certified for the specific attributes and functions required. While gas concentration monitors can also be found in hazardous areas, a fact that contributes to the confusion between detector types, they cannot serve a life-safety function regardless of where they are installed.

Life-safety gas systems require not only the ability to detect risk — for instance, leaking gas — but also the ability to mitigate risk through action. Mitigation techniques range from alarm notification and ventilation actuation to equipment shutdown and evacuation notification. The guidance and recommended practices for a life-safety gas-detection system are spelled out by the International Electrotechnical Commission (IEC; Geneva, Switzerland; www.iec.ch) in the standard IEC 60079-29-2, Explosive Atmospheres — Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen.

If gas never leaks, then the potential for harm to people, equipment or processes is decreased. So even before choosing effective life-safety gas-detection systems, plant engineers can minimize incidents caused by gas leaks by designing tightly controlled processes. This is done by following good engineering practices, such as minimizing the number of flange connections where leaks could occur.

Matching capabilities with needs

Plant owners and operators first need to understand whether the area they are planning for needs gas detection for process monitoring or for risk mitigation and life safety (Figure 2). One major application area for risk mitigation is within hazardous-area classified locations, defined in Chapter 5 of the National Electrical Code (NEC), National Fire Protection Association (NFPA 70). Areas deemed Class I are those where flammable gases, flammable liquid-produced vapors or combustible liquid-produced vapors are or may be present in the air in quanti-

FIGURE 2. Hazardous areas in hydrocarbon processing plants are protected by life-safety gas detectors as part of a total risk-mitigation system.

ties sufficient to produce explosive or ignitable mixtures.

Class I Division 1 is a location where combustible materials are routinely present in ignitable concentrations, while Class I Division 2 is a location in which the same materials are handled, processed or used, but in which the materials are normally confined and can escape only in the case of accident, breakdown or failure, or in the event of abnormal operation of ventilation equipment.

A gas detector intended for risk-mitigation and life-safety functionality must be Class I Division 1 hazardous-area certified in order to ensure explosion safety even in the unlikely event of containment failure. In addition, the risk-mitigation and life-safety gas detector must be performance certified in order to ensure proper safety actions are taken to mitigate the situation.

However, a gas-monitoring detector can be Class I Division 2 hazardous-area certified to monitor a contained process if the area is classified as Class I Division 2 and no performance certification is necessary, due to its non-safety purpose. It is important to note that maintenance of these gas-monitoring devices requires physical access, which requires decommissioning an area and can in turn result in costly plant downtime. To avoid process interruptions, some facilities instead elect to use devices appropriate for Class I Division 1, choosing higher capabilities and lower lifecycle costs over lower initial cost.

Setting the safety integrity level

Another consideration for understanding gas-detection requirements is the target safety integrity level (SIL) necessary for a facility. The SIL is a statistical representation of the integrity of the safety instrumented system (SIS) when a process demand occurs. Stated another way, The SIL helps quantify functional safety, which is the part of overall safety that depends on a system or equipment operating correctly in response to its inputs. The purpose of the SIS is to reduce risk, so SIL levels can be defined in terms of the risk reduction factor (RRF). The inverse of the RRF is the probability of failure on demand (PFD).

IEC 61508, Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PES), defines the requirements for ensuring that systems are designed, implemented, operated and maintained to provide the required SIL. Four SILs are defined according to the risks involved in the system application, with SIL 4 being used to protect against the highest risks. The standard also calls for a process that can be followed by all links in the supply chain so that information about the system can be communicated using common terminology and system parameters (Figure 3).

The specific SIL characterizes the requirements that must be met in order to achieve an overall risk reduction target. A risk assessment effort yields a target SIL that becomes a requirement for the final system. The requirements of IEC 61508 standards establish necessary constraints of a product development process — including appropriate quality control, process management and verification and validation methodologies, as well as failure modes, effects and diagnostic analysis — so that one can reasonably justify that the final system attains the required SIL.

Further guidance related to SIL is provided by IEC 61511, Functional safety — Safety instrumented systems for the process industry sector. According to this standard, facilities must follow these guidelines:

1. Conduct a hazardous operation analysis and risk assessment to identify and evaluate problems that may represent risks to personnel or equipment. This evaluation will help in determining the facility's target SIL.
2. Develop auditing, verification and validation activities to improve the integrity of the safety-related functions.
3. Develop post-incident and post-accident activities for root-cause analysis and corrective actions.

In the case of SIL product testing, third-party organizations document the design of the process and test both hardware and software in order to provide a more complete evaluation of product operation. Compared to their non-SIL counterparts, products that have achieved third-party SIL certification generally offer improved diagnostics (by providing information on failure modes) and are likely to cut maintenance costs by reducing the frequency of calibration and testing.

Categories of risk

Given that the purpose of a hazardous-area gas-safety system is risk mitigation, it is appropriate to review the risks associated with combustible and toxic gases.

Combustible gases are those that can cause a fire or explosion if the gas is exposed to an ignition source, such as a spark, a hot surface, an open flame or even friction caused by

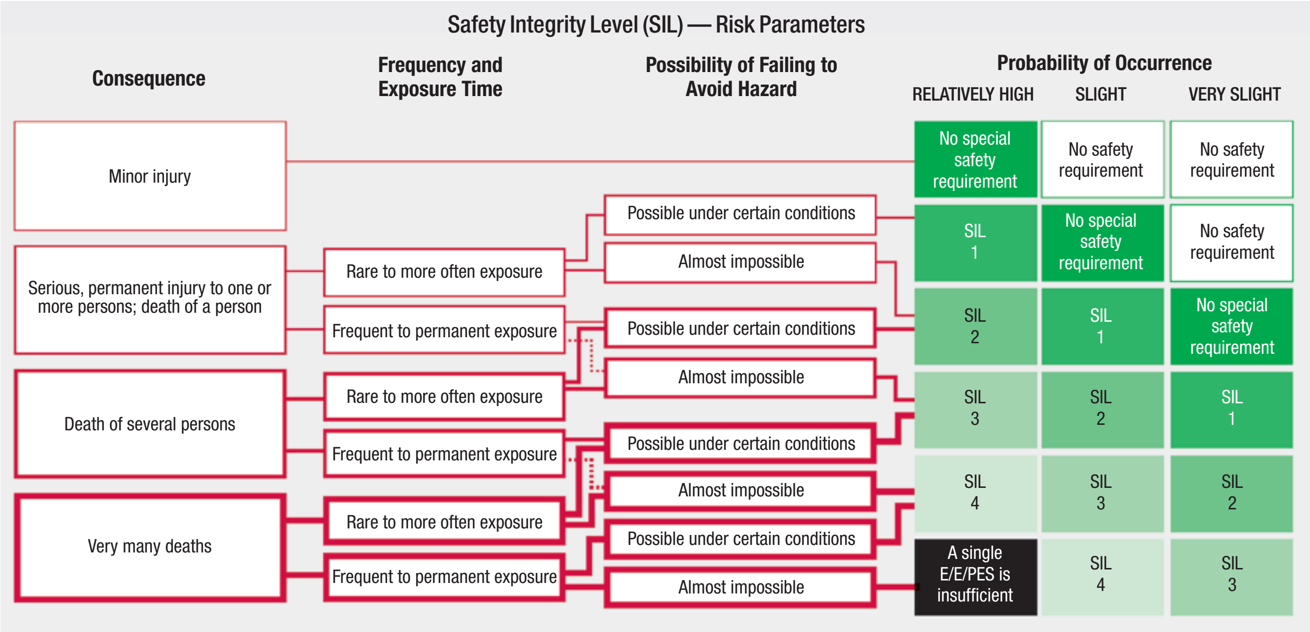

FIGURE 3. Safety integrity level (SIL) is defined as a relative level of risk-reduction provided by a safety function; a SIL (1, 2, 3 or 4) can be specified as a facility's target level of risk reduction. SIL is a measurement of performance required for a safety instrumented function (SIF), as defined in IEC 61508

gas escaping through a pipe fissure. Containment is the first safety measure in relation to combustible gases, but the detection of leaks is a second critical safety measure. Many gases are both combustible and toxic.

A toxic gas is one that can cause harm to humans, ranging from minor irritation to death. Even at low concentrations measured in parts per million (ppm), certain toxic gases can cause death by poisoning caused by exposure to carbon dioxide or by asphyxiation. Asphyxiation occurs with exposure to atmospheres containing less than the concentration of oxygen needed for human life. The addition of any gas, except oxygen, to air reduces the oxygen concentration through displacement and dilution, particularly when the added gases are nitrogen or other inert gases such as argon and helium. Breathing as little as one or two breaths of air containing too little oxygen can have immediate and lasting effects, from unconsciousness to serious injury or death.

From a risk-mitigation perspective, there is a hierarchy of risk that should be considered when designing a plant's hazardous-area gas detection system. The risk mitigation objectives in Figure 4 are ranked in priority order, based on severity of risk. The type or types of gas detection required for detecting the risk underlying each objective are also listed.

Gas detection for risk mitigation

According to IEC 60079-29 Series standards and IEC 62990 Series standards currently under development, a life-safety gas system does more than detect the presence of combustible and toxic gases. It must be able to provide alarm notification if data from the detectors hit a certain threshold. It must also have the ability to take corrective actions, such as opening a vent, closing a valve or door or shutting down equipment to mitigate risk (Figure 5).

In life-safety systems, the detectors tend to have more feature-rich displays than gas concentration monitors, as well as smart capabilities that improve digital information transfers. The detectors are connected to a controller and various other devices that can take a number of different actions in order to help bring a dangerous situation back to a safe state.

In addition to detectors, a risk-mitigation gas system includes a safety system controller (SSC), which receives and interprets input from multiple detectors and decides whether or not some action needs to be taken. In order to prevent nuisance alarms, the SSC may discount information from a single detector if it is not confirmed by data from other detectors in the same area.

In descriptions of risk-mitigation or life-safety gas systems, the term "functional safety" can cause confusion. Not interchangeable with "life safety," functional safety relates to the evaluation of risk based on an assessment of the entire safety system. If a life-safety gas system has faulty wiring, for example, the risk level in terms of functional safety is higher even if the detectors and other devices in the system are in good working order.

Standards and certifications

Before embarking on the design of a life-safety gas detection system, plant engineers should also review applicable safety standards, which can provide the backbone of a plan to help ensure continuous safe operation of plant processes. Standards address which devices and systems should be included in a life-safety plan. There are also standards that deal with detector performance, installation, calibration and maintenance — all of which are critical to effective gas detection. See the box on p. 50, Gas Detection Guidance Documents, for further details.

Hazardous-location standards. These standards are meant to ensure that a device can survive and perform adequately in a hazardous-classified environment. These standards vary depending on the region of the world. The IEC sets standards

Risk mitigation objectives: Gas detection type required				
	Risk-mitigation and life-safety gas detection		Process-monitoring gas detection	
Objectives	Combustible gas	Toxic gas		Notes
Priority #1: Explosion prevention	✓			1. Gas detectors for risk mitigation can also be used for validation of area classification (for example, less than 10 h flammable atmosphere exposure per year)
Priority #2: Personnel protection	✓	✓		1. Limits for short- and longterm exposure to toxic gas have been set by agencies, such as the U.S. Occupational Safety and Health Administration and Control of Substances Hazardous to Health in the U.K.
Priority #3: Equipment protection	✓			1. A gas-related equipment explosion will likely also pose a threat to people
Priority #4: Process protection	✓	✓	✓	1. Gas detectors for risk mitigation and life safety are needed outside of gas-carrying pipes to detect leaks that could pose a threat to personnel, equipment or facility 2. Gas detectors for process monitoring are needed to maintain production control

FIGURE 4. Risks related to toxic and combustible gases can be prioritized to help determine the appropriate type of gas detection required

followed as a basis by most countries, but in some cases, national deviations may apply. In the U.S., a major source of industry standards is the National Fire Protection Association (NFPA; Quincy, Mass.; www.nfpa.org). Since the 2010 Edition, NFPA 72 (National Fire Alarm and Signaling Code) has included gas detector criteria. NFPA 70 (National Electrical Code) also addresses the use of gas detectors as a method of protection.

Other key standards that apply to gas detection in hazardous areas include the following:

- Combustible gas; IEC 60079-29 Series; EN 60079-29 Series; UL 60079-29 Series; and CSA C22.2 No. 60079-29 Series from the Canadian Standards Association
- Toxic gas: IEC 62990 Series under development; European standard EN 45544 Series; and ANSI /ISA -92.00.01 from the American National Standards Institute (ANSI) and the Instrumentation Society of America (ISA)

Some standards set out the performance levels to which each life-safety device should be tested. Performance testing and certification verifies that a device will operate as specified by the manufacturer under worst-case standardized conditions. Some gas detector manufacturers self-certify product performance, meaning that they rely solely on their own internal tests and evaluations to attest that their products meet applicable standards. Others add to their own testing and evaluation a third-party testing organization's report, which may not be obtained through proper laboratory accreditation means. Though safety-device manufacturers know their devices and are knowledgeable in their field, properly accredited third-party test-

GAS DETECTION GUIDANCE DOCUMENTS (IEC, E.U., U.S. AND CANADA)

Combustible Gas Performance Standards

- IEC/EN 60079-29-1 Explosive Atmospheres — Part 29-1: Gas Detectors — Performance Requirements of Detectors for Flammable Gases
- CSA C22.2 No. 152: Combustible Gas Detection Instruments
- ANSI/ISA-60079-29-1 Explosive Atmospheres — Part 29-1: Gas Detectors — Performance Requirements of Detectors for Flammable gases; ANSI/UL 2075, Gas and Vapor Detectors and Sensors

Recommended Practice Standards:

- IEC/EN 60079-29-2 Explosive Atmospheres — Part 29-2: Gas Detectors — Selection, Installation, Use and Maintenance of Detectors for Flammable Gases and Oxygen
- C22.1 Appendix H: Combustible Gas Detection Instruments for Use in Class I Hazardous Locations
- ANSI/ISA-60079-29-2 Explosive Atmospheres — Part 29-2: Gas Detectors — Selection, Installation, Use and Maintenance of Detectors for Flammable Gases and Oxygen

Method of Protection Guidance Standards

- EN 1127-1 Explosive Atmospheres — Explosion Prevention and Protection — Part 1: Basic Concepts and Methodology
- C22.1 Appendix H (of the Canadian Electrical Code) Combustible Gas Detection Instruments for Use in Class I Hazardous Locations
- ANSI/ISA-TR12.13.03-2009: Guide for Combustible Gas Detection as a Method of Protection
- Other regional and local protection guidance standards

Notes

1. Though some regulatory authorities have laid out gas-detection system design and performance requirements, there are no documented rules concerning optimum detector placement or quantity. Hazardous operation analysis, however, can assist planners in this regard. So can past experience, which shows that it is helpful to identify the most likely sequence of events leading to a gas leak, as well as typical environmental conditions during leakages, when determining optimal sensor installation points.
2. The documents list above does not include all standards that may be applicable for a specific application or geographic location. ❑

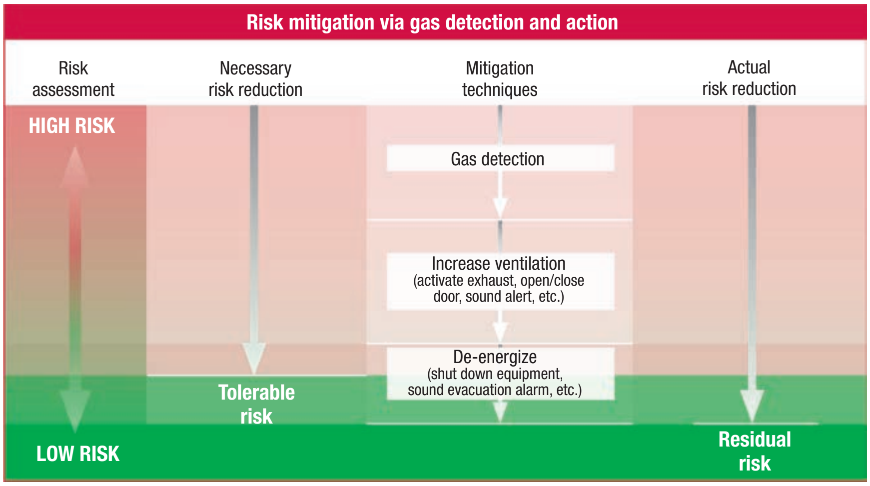

FIGURE 5. **The gas detection system can perform a sequence of mitigation actions to reduce the risk level below the tolerable risk threshold. The strength of the mitigation actions taken increases with the severity of the ignition risk. Subject to conditions, the mitigation actions may or may not sufficiently reduce risk, so this process continues in a loop, continually monitoring and mitigating risk**

ing and certification provides an independent and unbiased evaluation of the design and product performance. Furthermore, at any time, standards are being evaluated for relevant updates and potential new standards and recommendations are being developed. See the box on p. 54, Current Standards Activity, for a selection of in-development standards relevant to gas-detection technologies.

Accredited third-party testing. Experts in reliability engineering and in certification process conduct accredited third-party testing activities. A number of independent organizations now have documented safety and performance criteria for gas detectors. These include Factory Mutual (FM) and Underwriters Laboratories (UL) in the U.S., the Canadian Standards Association (CSA), Det Norske Veritas — Germanischer Lloyd (DNV GL) in Norway and Germany and UL-DEMKO in Denmark. When these organizations certify a product, it means that independent experts have determined that it is fit for duty.

Process-monitoring gas detection systems can be self-certified by the manufacturer. In most regions of the world, however, life-safety gas detectors designed for hazardous locations must be performance-certified by an accredited third-party agency to the performance standards applicable in that location.

In the U.S., confusion is caused by the fact that one major certification organization, UL, puts gas detectors into two different certification categories, “Listed” and “Classified,” rather than mandating clarity of use within the product manual. Listed means that the gas detector has been evaluated and approved for both hazardous locations and performance (for risk-mitigation and life-safety gas detectors). Classified means that the gas detector has been evaluated only for hazardous locations and that no performance evaluation has been done (for process monitor gas detectors). The bottom line is that UL Listed and FM approved gas detectors will meet the requirements of any gas detection application, while UL Classified gas detectors are suitable only for process monitoring.

In addition to detector performance in a life-safety gas system, the performance of the control architecture should be third-party certified from detection to action to validate the entire safety function relied upon. The SSC itself should also be properly rated for a hazardous classified location.

CHOOSING A DETECTOR

There are a number of different gas-detection technologies currently available. In order to choose from among them, plant personnel should consider the capabilities, advantages and disadvantages of each technology and compare these to the characteristics and requirements of the application.

The technologies discussed in this article are incorporated into what are known as fixed-detection devices, which are permanently placed in a location where gas leaks might occur. Fixed-detection devices are part of systems that protect people in a given area from harm caused by toxic and combustible gases. Besides performing their basic functions, advanced versions of fixed-detection instruments and systems offer onboard digital intelligence that allows diagnostic functions, historical data logging, digital communications and additional microprocessor-based functionality. The following sections detail the main types of fixed-detection devices offered by manufacturers of gas-detection devices.

Point gas detectors

Point-type gas detectors monitor a specific area or point in a facility.

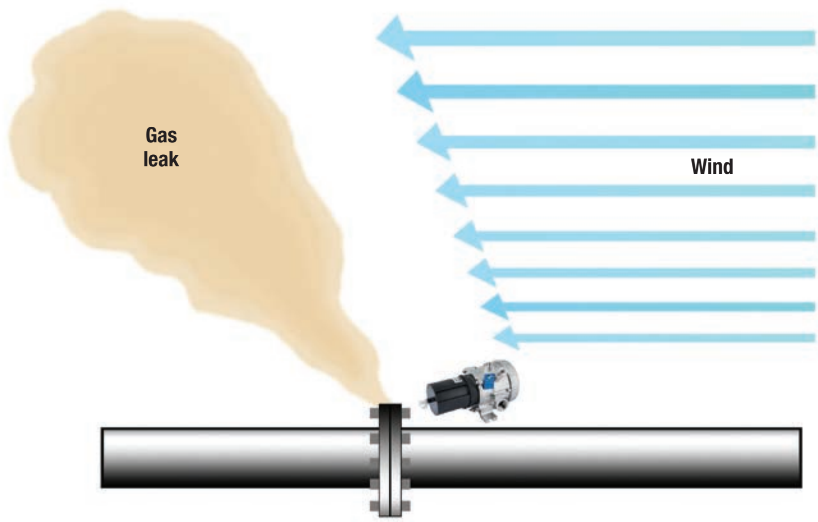

FIGURE 6. **Point gas detectors monitor a specific area or point in a facility. Because the gas leak must come into contact with a point-type detector, performance of point detectors can be limited by environmental and application factors, as shown**

These detectors are used to indicate the presence of combustible or toxic gas. The gas must come into contact with the detector for sensing to occur. Point detectors require calibration for the gas type to be detected and must be regularly inspected to ensure that they are capable of performing as expected. Point detectors that are SIL 2 capable have maintenance procedures defined in their safety manual and may, in some cases, only require an annual bump test rather than quarterly inspection. (Figure 6.)

Catalytic. The small catalytic gas sensor (CGS) is the one most frequently installed to detect combustible gas. Operation of a CGS detector is based on heat created by the catalyzed reaction between oxygen in the air and a combustible gas. A CGS detector must be in the gas cloud for detection to occur.

Of all available gas sensors, CGS offers the greatest range in detection of combustible vapors. Those detected include hydrocarbons, hydrogen and acetylene. Catalytic sensors also offer good repeatability and accuracy, as well as fast response time and low initial cost.

However, a rapid increase of high-concentration combustible gas in an environment can quickly move ambient air out of the sensor so that there is insufficient oxygen to maintain the catalyzing process. In addition, catalytic sensors fail without signaling plant personnel, so they require routine bump testing and calibration, typically every three months. Catalytic sensors are also susceptible to poisoning from a variety of substances, including silicones, halogens, acid, vapors from polyvinyl chloride (PVC) and other corrosive materials.

Infrared. IR point-gas detection is based on the principle that hydrocarbon combustible gases absorb specific wavelengths of IR light. Detectors using this technology include an IR light source and a sensor to measure light intensity at IR wavelengths. If gas is present in the optical path, the IR light intensity is reduced. This change provides the data needed to calculate gas concentration.

Like CGS detectors, IR detectors must be in the gas cloud for detection to occur. But unlike their CGS counterparts, IR sensors can only detect hydrocarbon gases, making IR detectors not suited for settings where there is danger from non-hydrocarbon gases, such as hydrogen, carbon disulfide and others.

Nevertheless, use of IR gas detectors is growing rapidly because they compare favorably to CGS detectors in other ways. For example, IR detectors are immune to contaminant poisoning, require less maintenance than catalytic sensors and are unaffected by changes in oxygen level or high gas concentrations. And unlike catalytic sensors, some IR detectors are failsafe, meaning that the instrument checks itself and reports any internal condition preventing detection.

In addition to combustible gases, point-type gas detectors are also designed to pick up leaks of toxic gases, such as hydrogen sulfide, carbon monoxide, nitrogen dioxide, ammonia, chlorine and sulfur dioxide. The detectors measure gas concentration at the point where the detector is located and give readings in parts per million (ppm). Contact with the gas is required for detection to occur.

Point toxic-gas detectors are placed where there is a potential for a toxic gas leak. Placement considerations include airflow in the area, as well as factors like the density and anticipated source of the toxic gas.

Electrochemical cells. For toxic gases, the most common fixed-detector technologies are electrochemical (EC) cells and metal-oxide semiconductor (MOS) sensors. EC sensors consist of electrodes connected via a load resistor. The electrodes are encased in a permeable membrane that diffuses detected gas across the electrodes. Once this occurs, the assembly is submerged in an electrolyte solution.

Available in a variety of different sizes and packages, EC sensors are used to detect a wide range of toxic gases in many applications. Generally considered the main choice for toxic gas detection, these sensors offer a number of advantages, including stability, repeatability, consistency, high sensitivity and low power requirements. On the downside, use of EC sensors is restricted in very hot and very cold environments. In addition, EC sensors are generally not failsafe, so in most cases they must be routinely inspected and calibrated to ensure proper operation.

Metal oxide semiconductor (MOS). There are many variations of the MOS technology, which is most frequently used if the target gas is hydrogen sulfide. MOS sensor advantages include long life, wide operating temperature range and excellent performance in low-humidity environments.

Open path or line-of-sight

Open path, or line-of-sight (LOS), gas detectors continuously monitor combustible hydrocarbon gas levels between two points at ranges of up to, or in some cases, greater than 120 meters. This detection technology uses a beam of light that travels between two modules. When a gas cloud passes through the beam, the gas concentration is measured. To ensure that the target gas passes through the beam, the modules must be strategically located and properly aligned. The modules themselves, however, need not be in the gas cloud for detection to occur (Figure 7).

As with point-type detectors, it is best practice that LOS detectors are calibrated for the gas type to be detected. Typically, open-path detectors are self-monitoring and will alert users in the case of a blocked light beam or some other trouble that adversely affects their operation.

LOS detectors should be designed to withstand harsh industrial conditions, including chemical exposure and heavy vibration. Other specific product features to look for include large-area coverage, failsafe operation, infrequent calibration requirements and low maintenance.

Disadvantages of the technology can include initial cost and the module alignment challenges that can prevent the detectors from working properly. Ideally, the design of the chosen detector will provide the largest possible field of view, which increases the modules' alignment tolerance, making installation faster and easier. In addition, LOS detectors do not provide a direct gas-concentration measurement, measured in percentage of lower flammable level (LFL); rather, the detector provides a gas-concentration measurement integrated over the entire beam length, measured in LFL-meters. Therefore, the detector cannot discern between a small, dense gas cloud and a large,

FIGURE 7. Line-of-sight gas detectors continuously monitor combustible hydrocarbon gas levels between two points at ranges of up to 120 meters. This allows a large coverage area, with the result that fewer detectors may be needed. However, a limitation of this technology is that is it unable to pinpoint the location of the leak

FIGURE 8. Acoustic gas detectors are non-contact leak detectors that recognize unique sound "fingerprints." They are ideal for locations where there is a risk of a high-pressurized gas leak

dispersed gas cloud.

Intended to supplement rather than replace point detection systems, LOS detectors often work with point detectors to provide optimal protection of chemical facilities. In situations like this, the point detectors should be installed at or near known high-risk gas leakage points or accumulation areas to provide specific information about the level of gas present in these locations. As for the LOS detectors, they should be installed at plant or process-area boundaries, where they can monitor the plant perimeter and track gas cloud movement into and out of the facility. Movement of gas clouds throughout the facility can be followed by monitoring the output signals of all the gas detectors on a workstation graphic display screen.

Acoustic

Capable of recognizing unique acoustic "fingerprints," ultrasonic gas-leak detectors sense the high-frequency sound emitted by pressurized leaking gas. In some applications, acoustic gas detection is faster than other fixed gas-detection technologies because acoustic detectors do not have to wait for gas to contact them in order to "hear" a leak. Acoustic detectors are generally unaffected by rain, fog, wind or extreme temperatures, making them suitable for harsh outdoor environments (Figure 8).

Along with these advantages, however, come some limitations. For example, acoustic detectors cannot distinguish specific gas types. Nor can they detect toxic parts-per-million concentrations or the lowest gas concentration capable of producing a flash of fire in the presence of an ignition source (LFL). Therefore, acoustic detectors are best used as a complement to other gas detection methods.

When selecting an industrial acoustic gas detector, look for a high-fidelity microphone capable of continuously checking for the distinct ultrasound emitted by pressurized gas leaks across the widest spectrum of frequencies, while ignoring nuisance ultrasonic sources in the environment that could cause false alarms. The detectors should also require minimal maintenance and be SIL 2-capable for all gas types.

Putting it all together

While gas-concentration monitors keep tabs on process gas in a chemical plant, risk-mitigation gas detection systems are on the alert for gas leaks that could pose a danger to plant personnel. These life-safety systems mitigate risks stemming from leaks of both toxic and combustible gases, help prevent explosions and harm to workers caused by leaking gas, and in turn, reduce costly downtime.

When considering the purchase of detectors and other components that make up a gas-detection system, it is natural to look for ways to reduce the cost of the system. Use caution in this regard, though, because cutting the cost of the life-safety gas system you specify could increase risks to your facility and workers. Specifying and installing the right combustible- and toxic-gas detectors — with appropriate product approvals and performance certifications — ensures that your gas detection system will mitigate risk as intended. ■

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CURRENT STANDARDS ACTIVITY

Each part of the world has industry safety standards that address its specific needs as determined by local regulatory agencies. Gas detection standards, in particular, are evolving with the goals of providing more specific guidance and greater harmonization across standards and worldwide. Below are just a few of the topics being actively addressed today:

- ***Gas detection as a method of protection.*** The UL STP 9200 committee (chaired by article author Jon Miller) is working on UL 12.13.03, which is the second edition of ANSI/ISA-12.13.03 (but transition to UL)
- ***Gas detection for classified area monitoring.*** Requirements have been recently clarified in CSA C22.1:2018 (Canadian Electrical Code), and efforts are ongoing to revise the National Electrical Code with corresponding text to harmonize the two standards
- ***Personnel protection via toxic gas detector performance standards.*** The IEC TC31 MT60079-29 and JWG45 committees (IEC committees chaired by article author Jon Miller) are developing a Toxic Gas Detection Performance standard, Toxic Gas Detection Recommended Practice standard and Oxygen Gas Detection Performance standard ❑

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