

# **ULTRASONIC GAS LEAK DETECTION**

Benefits of complementary technologies  
within the gasses detection safety layer.

# INTRODUCTION

The purpose of this white paper is to provide an overview of flammable gas detection and the use of a layered safety model. Moreover, it elaborates on the reasons for deploying a mix of different types of flammable gas detectors within this industry layer. While this document focusses on the risks posed by flammable gas, ultrasonic gas leak detectors are similarly useful in supporting the safety case in applications where pressurised toxic gas is being used.

## THE DANGERS OF FLAMMABLE GASSES

Industrial processes increasingly involve the manufacture and use of highly dangerous substances, particularly flammable, toxic gasses. Inevitably, occasional escapes of gas occur, which create a potential hazard to the industrial plant, its employees and people living nearby. Worldwide incidents involving asphyxiation, explosions and loss of life are a constant reminder of this problem. Flammable gasses bring the risk of fire and explosion. These are a threat to life, property and the environment.

The igniting substance is usually (but not always) a hydrocarbon compound. In this white paper we take into consideration the threat posed by common hydrocarbon flammable gasses which are used for fuel, power generation, heating and cooking on industrial, commercial and residential premises. These are sourced from the oil and gas upstream and downstream supply chain, both onshore and offshore. That supply chain consists of exploration, production, processing and distribution (via pipeline or transportation vessels).

# THE LAYERED SAFETY APPROACH

In most industries, one of the key components of any safety plan for reducing risks to personnel and plant is the use of early-warning devices such as gas detectors. These devices help to allow adequate time to take remedial or protective measures. They can also be part of a total integrated monitoring and safety system for an industrial plant.

This is usually described as a layered safety approach. As per the Honeywell Process Solutions white paper 'An Integrated Approach to Safety: Defense in Depth', an integrated approach to plant safety helps improve business performance and ensure peace of mind. This methodology includes independent yet interrelated layers of protection to deter, prevent, detect and mitigate potential threats. The concept of

layers of protection is widely recognised by the process industry and the term is clearly defined in industry safety standards such as IEC 61508 and IEC 61511. Some layers of protection are preventive (e.g., emergency shutdown), while others mitigate the impact of an incident (e.g., fire and gas protective systems or plant emergency response systems). Other layers of protection can mitigate against incidents in the first place (e.g., plant and physical asset protection, constraint and boundary management, operator training and asset management); while others can provide detection and alerting as well as associated guidance (e.g., operator alarms, early event detection and integrated operator procedures).

Layers can either be automated, such as emergency shutdown (ESD) equipment, or require human intervention, such as operator responses to process alarms.

Some layers offer quantifiable risk-reduction benefits but require identification of potential risks at the onset. Others are less tangible and offer less obvious benefits.

## FIGURE 1 – INTEGRATED LAYERS OF PROTECTION

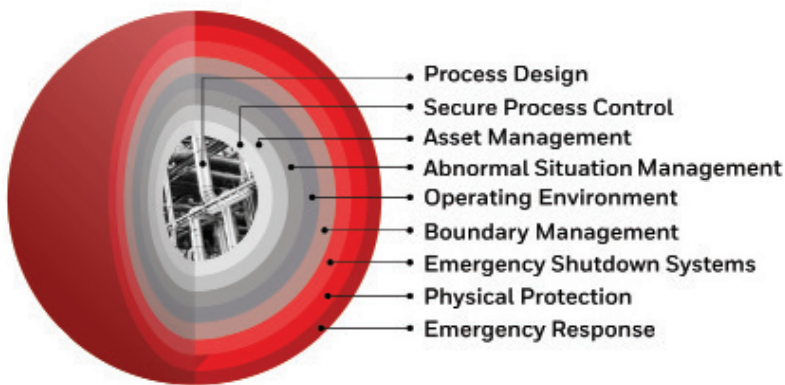


Diagram courtesy of Honeywell Process Solution white paper 'An Integrated Approach to Safety: Defense in Depth'

As shown in Figure 1, the individual elements of the safety system mirror the layers of an onion, each encompassing the previous layer(s) and adding to the safety case. Each acts independently so that an individual failure does not affect more than one layer.

At the core of a layered architecture is a well-structured and well-implemented process design that is the embodiment of the business, safety and production levels necessary for effective operations. The procedure must be controlled by a secure process control network that extends across the entire plant and business networks. Managing the plant's assets ensures that the operation design continues to function as intended, while protecting the plant from pending incidents with an early indication of failing assets.

As one moves through the layers of protection further away from the core of process design, mitigating risk due to human error is the key to ensuring safety. Implementing tools and procedures (such as boundary and alarm management and early event detection) for the purpose of managing abnormal situations reduces incidents and prevents escalation

Appropriate operating windows need to be defined and managed, and properly designed emergency shutdown systems must be in place as preventive measures in the event that an incident escalates beyond the inner layers of the sphere of protection.

Across the various layers of protection, a plant or facility must operate in a secure and safe atmosphere, including safeguarding of the perimeter, facility,

people and assets. With the adequate work practices and technology in place, if an abnormal situation does occur which disrupts safety operations, an emergency response plan can be executed, controlled and monitored to minimise the impact of the incident.

To maximise plant efficiency and to maintain adequate safety levels, a systematic approach to safety is required. This procedure can minimise risks to safety and security, and it requires that independent and interrelated layers of protection are in place across an organisation. For the fire and gas detection system, gas detection and flame detection can be seen as two separate layers. If the gas detection layer fails to detect a gas leak and a fire ignites, flame detection comes into play.

# GAS DETECTION TECHNOLOGIES

**SEARCHPOINT**  
Plus Point Infrared Gas Detector



**SEARCHLINE EXCEL**

**FS24X**  
Flame Detector



**SEARCHZONE**  
Sonik Ultrasonic Gas Leak Detection

For more information on the different types of gas detection under discussion – infrared point flammable gas detectors, open path flammable gas detectors, ultrasonic gas leak detectors – please consult the literature or visit [www.honeywellsafety.com](http://www.honeywellsafety.com).





# A TECHNOLOGY MIX APPROACH

The following table shows a comparison between three gas detection technologies (point infrared flammable hydrocarbon gas detection, open path infrared flammable hydrocarbon gas detection and ultrasonic gas leak detection).

## GAS DETECTOR: POINT INFRARED

<p><b>Deployment</b></p>	<ul style="list-style-type: none"> <li>• Points of risk of gas leaks (valves, flanges, pumps) within a few metres of a leak source. (Risk assessment.)</li> <li>• The objective is to cover the area via deployment to detect a 5 m<sup>3</sup> mass of gas. That is the calculated size of a gas cloud that could cause structural damage in case of an explosion.</li> <li>• Generally voted 2 oo N. Several instruments in an area (zone) are connected into the DCS system and it then takes two of these instruments to activate action or alarms.</li> </ul>
<p><b>Advantages</b></p>	<ul style="list-style-type: none"> <li>• Uses a physical rather than chemical technique. Less sensitive to calibration errors than catalytic sensors.</li> <li>• Limited undetected failure modes.</li> <li>• Can be used in inert atmospheres.</li> <li>• Detection at that point clearly indicates where the gas is.</li> <li>• Covers all flammable HCs (range of cross-sensitivities across risk gasses so set for most hazardous risk).</li> <li>• Safety = Is there gas? 'yes or no'.</li> <li>• Gives accurate quantification of actual gas concentration at a point in space and time. Multiple point gas detectors provide an accurate map of the event.</li> <li>• Clearly indicates where the gas is (i.e. at the detection point).</li> <li>• With a 1m/s wind 100% LEL = 50 l/s detection. So &gt;100 l/s leaks can be detected in typical outdoor conditions.</li> <li>• Works in adverse weather conditions such as fog, rain and mist.</li> <li>• Generally, this is seen as the industry-preferred secondary gas detector (after the open path devices).</li> </ul>
<p><b>Disadvantages</b></p>	<ul style="list-style-type: none"> <li>• Flammable gas detection in %LEL range.</li> <li>• Measures the concentration of flammable gasses which, later on, should be related to the flammability of the gas.</li> <li>• Positioning is critical.</li> <li>• Medium power consumption.</li> <li>• To be detected, gas has to reach the detector point.</li> <li>• Doesn't detect if the sensor is buried or covered.</li> <li>• Requires annual inspection and cleaning. For verification, end users will bump-test.</li> <li>• High sensitivities can trigger nuisance alarms at low amounts of the most sensitive gas.</li> <li>• Time for gas to reach the detector. Most gas leaks are 100% v/v; detection is remote from that leak (diluted).</li> <li>• Potential hazard decision. Indoors is easier.</li> <li>• Wind in the wrong direction may take the gas cloud away from a detector (hence, use in matrix).</li> <li>• High wind speeds dissipate gas. A serious leak may not be detected (even though at that moment the cloud isn't explosive).</li> </ul>

## GAS DETECTOR: OPEN PATH INFRARED

<b>Deployment</b>	<ul style="list-style-type: none"> <li>• Deployed on the same principle as point infrared (risk assessment).</li> <li>• Increased chance of detecting a gas leak.</li> <li>• Less sensitive than point detectors to wind speed and direction.</li> <li>• Boundary protection becomes practical with moving air and a 2D detection.</li> <li>• Area coverage, reduced number of point detectors.</li> <li>• Same risk reduction as point detectors with fewer devices.</li> </ul>
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• Area coverage gives a better chance of detecting a gas leak.</li> <li>• Positioning is not as critical as for point detectors.</li> <li>• Good for boundary detection.</li> <li>• No unseen failure modes.</li> <li>• Can detect low gas concentrations. Integrates the threat to size and concentration.</li> <li>• Failsafe. Cooperative transmitter and receiver units.</li> <li>• Covers 5 m to 200 m line.</li> <li>• Covers all flammable HCs. (There is a range of cross-sensitivities, so set for most hazardous risk.)</li> <li>• Doesn't need to be near the leak source (with some air movement). Note: Still air is typically below 1 m/s.</li> <li>• Detection typical conditions &gt;50 l/s.</li> <li>• Generally, this is seen as the industry-preferred, primary gas detection method.</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• Higher initial purchase cost than Point IR.</li> <li>• Not suitable for use in smaller areas.</li> <li>• Detection path can be obscured, but this is detected and reported.</li> <li>• Maintenance required is guided by instrument. For verification, end users will bump-test.</li> <li>• Longer-range devices and still air can cause instruments to trigger alarm with small gas discharges. In still-air conditions, the alarm can be generated with very low levels of gas (non-hazardous levels).</li> <li>• It takes time for the gas to reach the detector. Gas has to physically pass between the transmitter/receiver pair.</li> <li>• Detection is remote from the source. Still affected by wind speed and direction but less so than point detectors.</li> <li>• Reduces disadvantages of point detectors in windy conditions but doesn't eliminate them.</li> <li>• Availability in certain environmental conditions (thick fog).</li> </ul>

## GAS DETECTOR: ULTRASONIC (ACOUSTIC)

<b>Deployment</b>	<ul style="list-style-type: none"> <li>• Area protection.</li> <li>• Increased chance of detecting gas leak.</li> <li>• Area coverage. Typically, a 20-m range on axis. +/- 90-degree field.</li> <li>• Easy to deploy over area with valves, flanges, pumps, etc.</li> <li>• Need to be aware of other sources of high-pressure non-hazard/expected gas or vapour releases (e.g. air, steam).</li> <li>• Offers a third level of detection.</li> <li>• Gas does not have to 'reach' the detector-like point or open path detection.</li> <li>• Eliminates the dilution and wind direction effect.</li> <li>• A major advantage is that it does not depend on a gas cloud to accumulate.</li> </ul>
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• Area coverage.</li> <li>• Detects high-pressure gas release (any gas) within typically a 20-m range.</li> <li>• Not affected by wind speed or direction.</li> <li>• Easy to deploy.</li> <li>• No calibration required with Honeywell Searchzone Sonik.</li> <li>• More likely to detect very small leaks than a point IR (detects lower leak rates), e.g., 10 l/s.</li> <li>• Detects the sound of the leak – i.e., no transport time – it is immediate. High speed of response.</li> <li>• Isn't affected by rain, mist or fog.</li> <li>• <b>Excellent addition to the gas protection layer in conjunction with point and open path devices.</b></li> <li>• <b>Tertiary detection supporting point and open path.</b></li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• Gas needs to be pressurised.</li> <li>• Not all leaks produce ultrasound, especially large holes and small pressures.</li> <li>• Need to be aware of potential ultrasonic noise sources (must be taken into account because background ultrasonic noise reduces the detection range).</li> <li>• Potential systematic nuisance alarm in the presence of an ultrasonic noise.</li> <li>• Non-specific, will react to any high-pressure gas release that creates a broadband ultrasonic sound within range.</li> <li>• Higher initial cost.</li> <li>• Not as effective for multiphase gas streams; i.e., containing droplets or liquids, which dampen the ultrasound signal.</li> <li>• Does not provide an indication of the gas concentration. Ultrasonic gas leak detection provides notification of the leak only.</li> </ul>



By combining the above three technologies, it is possible to achieve the optimal coverage and detection of a gas leak, mitigate the hazard and thereby protect life, property and the environment in the real world.

## SUMMARY

Open path IR is often employed as the primary flammable gas leak detection

- a. Boundary protection.
- b. Process areas.

Point IR often deployed as secondary flammable gas leak detection

- a. At risk points; e.g. valves, pumps/compressors, flanges.

Ultrasonic as tertiary flammable gas leak detection

- a. At risk points – compressors, valves when high air flows can reduce the chance of point gas detection.
- b. Metering skids.

Together, these provide a robust detection system with each technology delivering to its strengths. Improving the safety case is achieved by using technologies in combination, thus increasing coverage and hence the chance of detecting gas, while reducing nuisance alarms and systematic faults, resulting in improved event confirmation and analysis.



# CONCLUSION

In order to detect a flammable gas leak, point IR and open path IR need the gas to reach the detection point. While this confirms the location of the leak area, air movement can take a gas cloud away from a detection point or dilute it to a lower, safe level.

Ultrasonic gas leak detectors cover an area and do not need the gas cloud to reach the detector as they hear the pressurised gas leak. This means fast detection of a high-pressure gas leak within the covered area. In conclusion, the recommendation is to deploy integrated technologies within the gas protection layer and then a flame detection layer above it as the next protection layer.

Honeywell's Searchzone Sonik™ ultrasonic gas leak detector delivers fast, reliable detection of high-pressure gas leaks and does not need field calibration, thus reducing operational costs. Searchzone Sonik™ complements Searchpoint® Optima Plus and Searchline Excel, delivering a comprehensive solution to gas-layer safety systems in the most demanding environments.

# REFERENCES

Honeywell Process Solutions white paper. 'An Integrated Approach to Safety: Defense in Depth' [https://www.honeywellprocess.com/library/marketing/whitepapers/Integrated\\_Safety\\_WhitePaper.pdf](https://www.honeywellprocess.com/library/marketing/whitepapers/Integrated_Safety_WhitePaper.pdf)

Honeywell Industrial Safety Gas Book. A detailed gas detection reference book: [https://www.honeywellanalytics.com/~media/honeywell-analytics/documents/english/11296\\_gas-book\\_v5\\_0413\\_lr\\_en.pdf?la=en-gb](https://www.honeywellanalytics.com/~media/honeywell-analytics/documents/english/11296_gas-book_v5_0413_lr_en.pdf?la=en-gb).

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