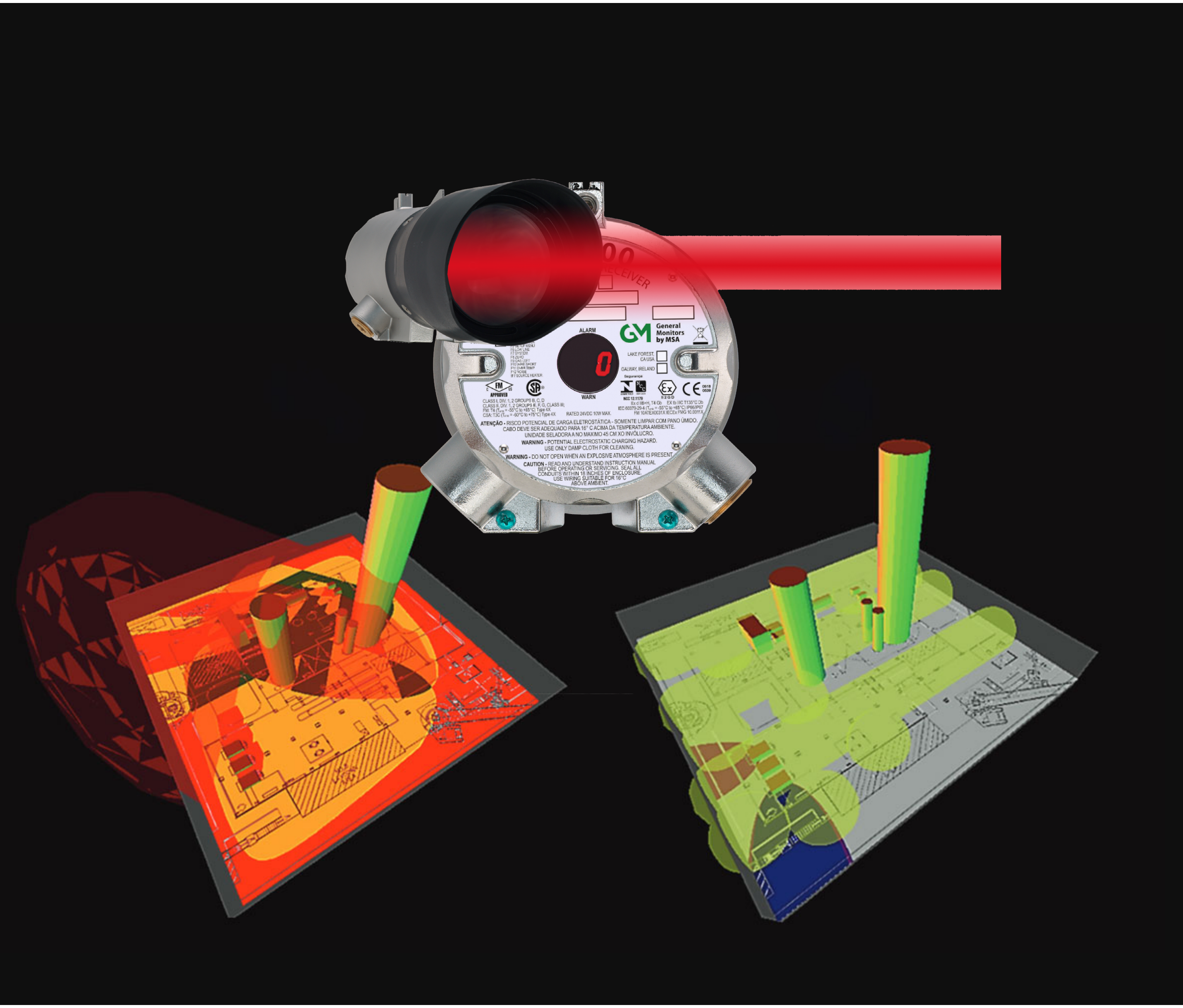
Fire & Gas Mapping Design Guide

Open Path Gas Detection



How Fixed Gas and Flame Detectors can improve mapping design

WE KNOW WHAT'S AT STAKE.

How Fixed Gas and Flame Detectors can affect mapping design and the probability of detection

This document is intended for Fire and Gas Mapping design engineers and highlights how different detectors can improve detection probability and can potentially reduce the number of detectors required without reducing the detection coverage.

This design guide covers Non-Dispersive Infrared Open Path Gas Detectors (NDIR OPGD).

NDIR (Non-Dispersive Infrared) OPGD have been used in high-risk applications since the 1980s, typically installed to complement to point gas detectors to increase the probability of detecting Hydrocarbon gas leaks. The exception to this rule is for fence-line monitoring, as using point gas detectors with OPGD along the entire boundary fence of a large facility would often not be economically viable.

When designing a new fire and gas detection system, traditional designs have been based on the following considerations:

- Where are the potential sources of gas leaks
- The location and height where the point detectors should be installed
- Simple geographical coverage, meaning a designer would determine where the best position would be for the OPGD Transmitter (or Source) and the Receiver to be positioned
- The type of gas and its properties i.e. heavier or lighter than air, which determines the height at which the OPGD system will be installed

Most traditional IR OPGD only measure gas leaks in the measuring range of 0 to 5 LEL.m (Lower Explosive Limit. metres) and require a large, high concentration gas cloud before initial detection. The difference with MSA's General Monitors IR5500, is that as well as being able to measure in the same 0 to 5 LEL.m range, it also measures in ppm.m (parts per million.metres). This enables the IR5500 to detect smaller gas clouds at lower concentrations more quickly. Once the size of the higher concentration gas cloud increases, the IR5500 will also be able to give a measurement reading in the 0 to 5 LEL.m range.

The control system is configured to show both ppm.m and LEL.m measurement ranges.

How does this affect Mapping design?

When selecting the IR5500 with ppm.m and LEL.m measuring ranges, the benefits over the traditional LEL.m-only OPGD are:

- Faster detection of gas leaks
- Increased probability of alarming in a voting system
- Potential to reduce the number of detectors to achieve the desired probability of detection/alarming
- Reduces both the CAPEX and installation cost of the system
- Fewer detector inputs reduce the size of the control system

Another benefit of being able to detect in the ppm.m measuring range is that the IR5500 can also be used to detect vapours from spills of heavier hydrocarbons such as Benzene and gasoline (Heptane). Such hydrocarbons have relatively low vapour pressures, so the vapour cloud concentration is generally low particularly at greater distances away from the spill centre. OPGDs with 0-5 LEL.m measuring range are likely to be ineffective solutions for detecting such vapour clouds because of the weaker measuring sensitivity. The IR5500 is therefore an excellent OPGD solution for tank farms with large volumes of liquid hydrocarbons storage. Its greater measuring sensitivity can also significantly improve gas alarming probability in fence-line or boundary monitoring applications.

A simple gas mapping study can be used to demonstrate the impact of measuring sensitivity on scenario coverage (alarming probability). In the example study shown below, four OPGD beam-paths were positioned across the process area.

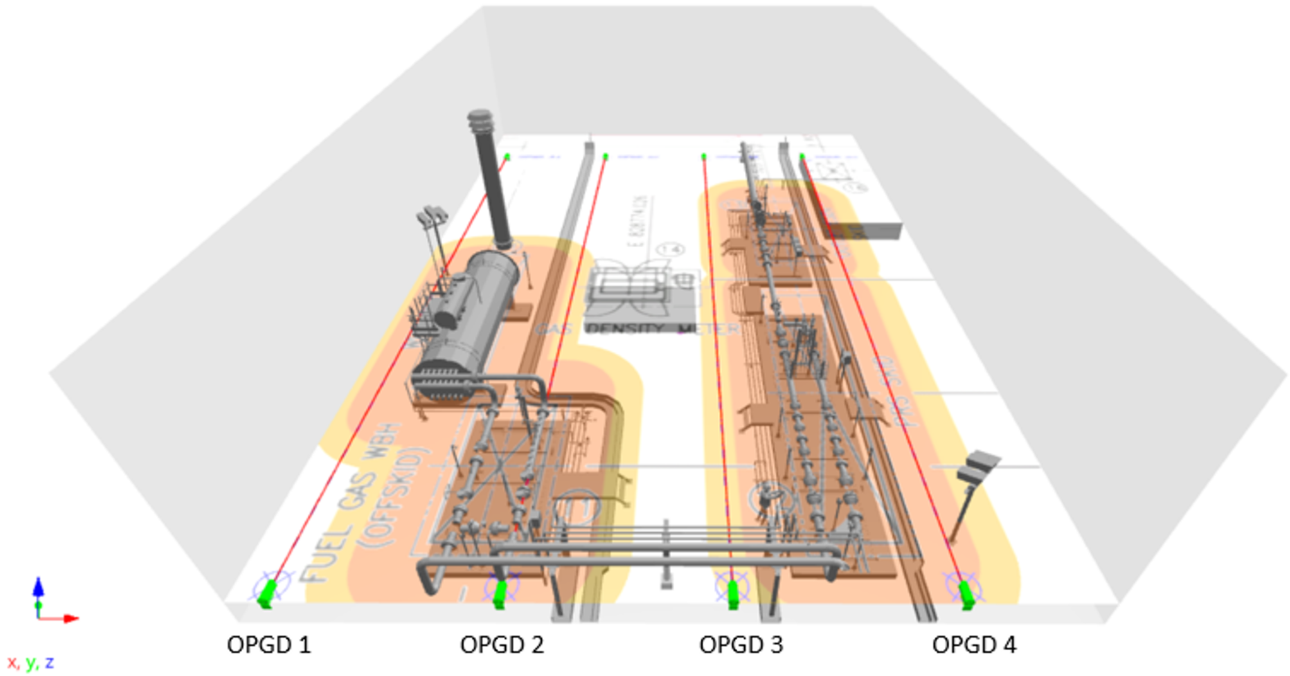


Figure 1: Layout of OPGD

Three measuring ranges were then considered in the detection probability computations. The same set of Methane (CH^4) gas compositions, process conditions, wind conditions, and gas leak scenarios were applied in the computations with each measuring range. The results from this example study are tabulated in Table 1.

Solution	Quantity	Measuring range	Alarm threshold	Leak	Gas composition	Probability of Detection – based on Scenario coverage	
						1ooN	2ooN
OPGD-A	4	0 – 5,000 ppm.m	2,500 ppm.m	5mm @ 50bars	88% CH_4	90%	35%
					79% CH_4	89%	35%
					69% CH_4	89%	35%
OPGD-B	4	0 – 1 LEL.m	0.2 LEL.m	5mm @ 50bars	88% CH_4	80%	5%
					79% CH_4	29%	2%
					69% CH_4	9%	<1%
OPGD-C	4	0 – 5 LEL.m	0.5 LEL.m	5mm @ 50bars	88% CH_4	<1%	<1%
					79% CH_4	<1%	<1%
					69% CH_4	<1%	<1%

Table 1: Scenario coverage achieved with 3 different alarm thresholds

Observations and Important Takeaways:

- OPGD-A with alarm thresholds set at 2,500 ppm.m significantly outperforms OPGD-B and OPGD-C for both 1ooN and 2ooN scenario coverages.
    - The important takeaway is the OPGD measuring range and alarm threshold can make a very significant difference to scenario coverage and increase the probability of alarming.
- The 1ooN scenario coverage factors of OPGD-A for all three gas compositions are significantly above 80%, which is often the minimum coverage factor specified for medium risk zones. Also, the 1ooN coverage factor remained high at 89% when the CH^4 content was reduced to 69%. This outcome contrasts considerably with the results produced by OPGD-B. In OPGD-B, the 1ooN scenario coverage factors decreased substantially with each reduction of CH^4 content.
    - The first important take-away is, the effectiveness of the OPGD solution (i.e., scenario coverage or alarming probability) can be affected by the percent (%) of target gas in the gas composition. It is important that the detection coverage of OPGD solutions be evaluated against the minimum percent (%) target gas in the gas composition.
    - The second important takeaway is, by lowering the alarm threshold sufficiently, the effectiveness of the OPGD solution will be less affected by unexpected changes to the percent (%) target gas.
- The 1ooN scenario coverage factors for OPGD-C with alarm thresholds set at 0.5 LEL.m has an extremely low probability of alarming based on the design criteria and gas composition for this scenario. This is an indication that a traditional OPGD with 0-5 LEL.m measuring range can potentially be ineffective at detecting low concentrations / small gas clouds.
    - The important takeaway is to carefully consider the effectiveness of OPGD with different measuring ranges, based on realistic scenarios for each application.

This mapping study shows the benefits of being able to detect very low concentrations of gas in the range of 0-5,000 ppm.m. Such early detection of a gas leak can increase the level of safety for the plant and for the people working in the hazardous areas.

To learn more about MSA's mapping capabilities and how our products can help in optimising your design, please contact us by clicking here.