

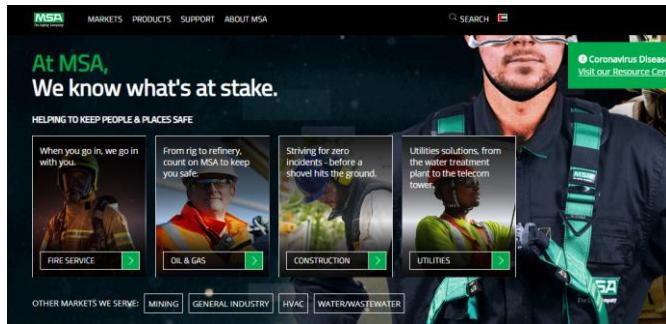


IR5500 Open Path Gas Detector

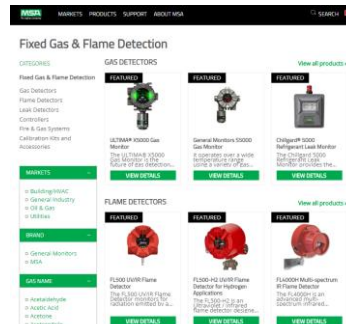
*Ian Cameron, Product Line Manager
MEAIR Region*



Resources within MSA (click on the image)



The MSA – UAE website



F&G Home Page

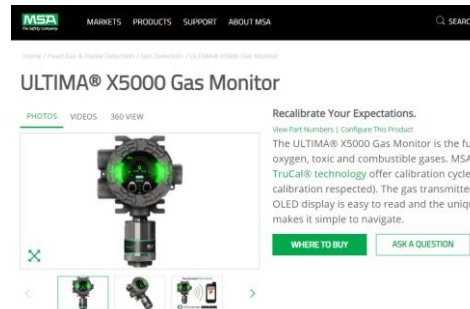


IR5500 Home Page

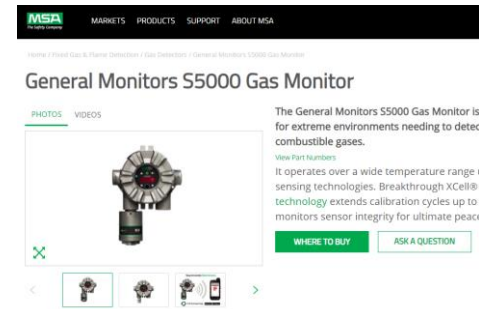
MSA Fixed Gas & Flame Detection Flame & Gas Mapping Solutions



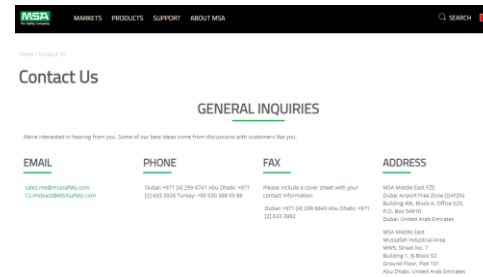
F&G Mapping Solutions - Document



MSA's 5000 Series Point Gas Detectors – the Ultra Smart detectors



5000 Series TruCal video



How to contact MSA in MEA/IRR

Why were OPGD developed?

Recent history of gas detection

TIME



- Point Gas Detection
- IR Open Path Gas Detection for Hydrocarbon gases
- Ultrasonic Gas Leak Detection
- Laser Open Path Gas Detection for Toxic & Hydrocarbon gases

Why were other technologies developed?

- Point Gas Detectors (PGD) can miss gas leaks, sometimes for minutes, sometimes for far longer
- To increase the probability of detecting the gas leak when only using PGD, the number of additional PGD required is unrealistic – higher CAPEX and OPEX
- Studies and post gas release investigations have found that many gas leaks go undetected (see next page)
- To increase the probability of detecting gas leaks, whilst keeping both the CAPEX and OPEX costs within a reasonable budget, Open Path Gas Detectors were developed.
- OPGDs cannot completely replace all the PGDs, but can usually reduce the quantity, whilst improving the probability of detection
- Other technologies to consider are Laser OPGD for various toxic and flammable gases, as well as Ultrasonic Gas Leak Detectors

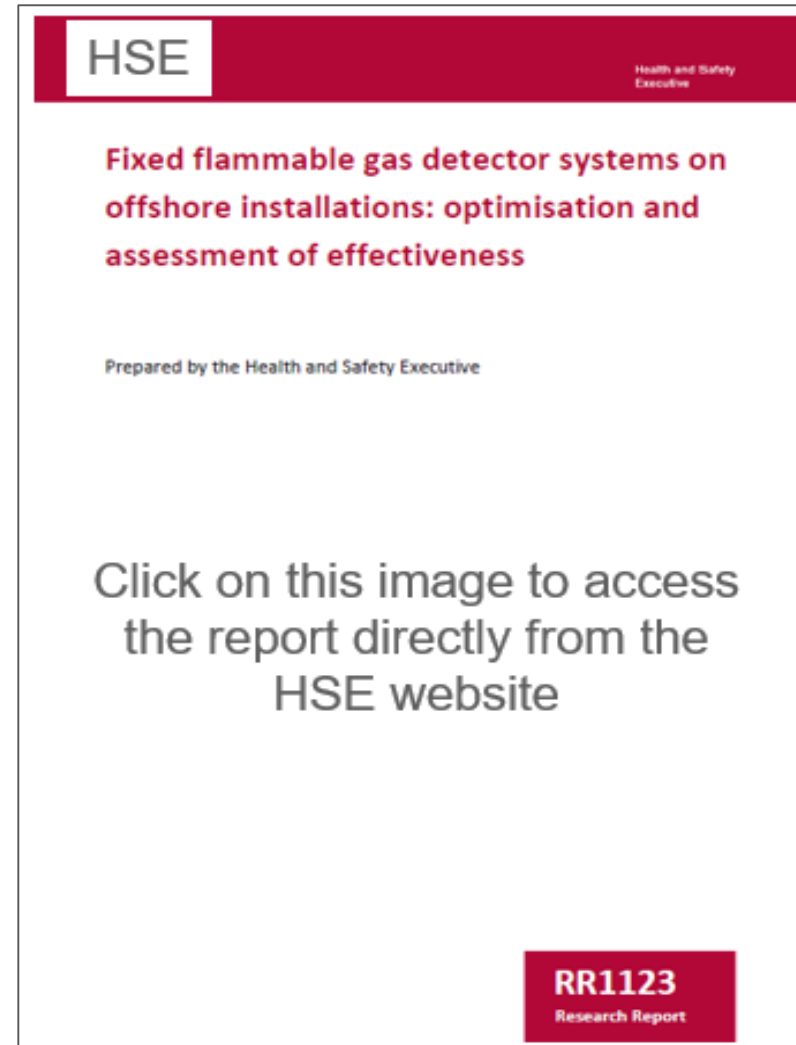
This 2017 report by the HSE states:-

An analysis of Offshore Hydrocarbons Release database (2001-2008) reveals that approximately 36% of major gas releases and 69% of significant gas releases were undetected by gas detectors.

HSE Definitions:

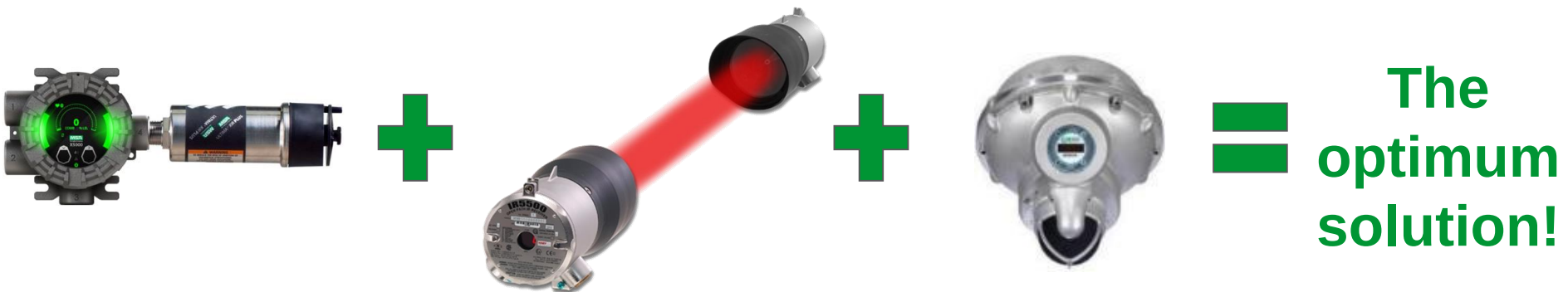
Major: >1kg/s release rate and duration >5 min or 300Kg of gas

Significant: release rates between 0.1 to 1 kg/s lasting 2 to 5 min



Conclusion on additional layers of detection

- It is no longer recommended to only use PGD for high risk OGP applications
- OPGD should also be used to increase the probability of detection and can also reduce the number of PGDs
- PGDs are still required to give a better indication of the leak source and also the concentration of the gas cloud
- This also reduces the number of I/Os at the control system, as well as the OPEX costs
- For high pressure gas systems / applications, UGLD devices increase the detection probability even higher



A common question.....

What is the detection range of MSA's PGD?

Answer: **0 metres or 0 feet**

Detection location / point of detection:



The gas cloud must reach the sensor

The gas cloud is less than a metre away, but there will be no gas detection from the PGD!

A common question.....

What is the detection range of MSA's PGD?

Answer: **0 metres or 0 feet**

Detection location / point of detection:



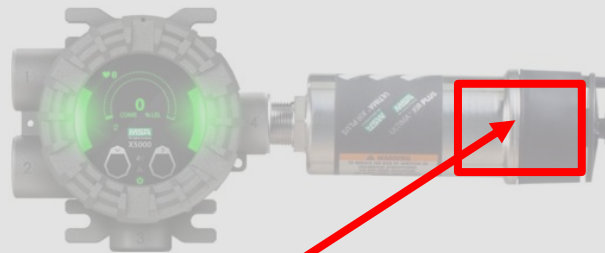
The gas cloud is very close and has reached the transmitter, but there will still be no gas detection from the PGD!

A common question.....

What is the detection range of MSA's PGD?

Answer: **0 metres or 0 feet**

Detection location / point of detection:



The gas cloud has now reached the sensor, so it will be detected

Gas has to migrate from the source of the leak to the detector and can only be detected once it is at the “**Point**” of the Sensor

This is why all PGD do not have a “detection range”.

Open Path Gas Detectors

OPGD were developed to compliment Point Gas Detectors and increase the probability of detecting the gas leak.

They are not to be used instead of Point Gas Detectors, but it may be possible to reduce the number of Point detectors.



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Like PGD, the gas must migrate towards the IR beam of the OPGD to be detected.

Open Path Gas Detectors

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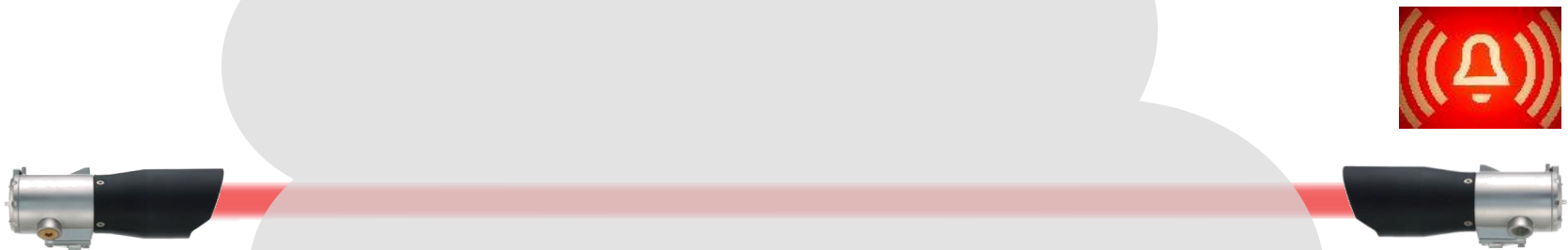


The gas cloud has now reached
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Open Path Gas Detectors

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The gas cloud can be detected anywhere along the IR beam.

OPGD were developed to compliment Point Gas Detectors and increase the probability of detecting the gas leak.

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The area/distance between the Tx and Rx is known as the “Path Length” and this is usually between 5 and 150 metres.

Users/designers typically limit it to 80 metres, due to the difficulty in aligning OPGD with longer path lengths and also because of the issues caused by fog and rain.

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The MSA – GM OPGD is the “IR5500”



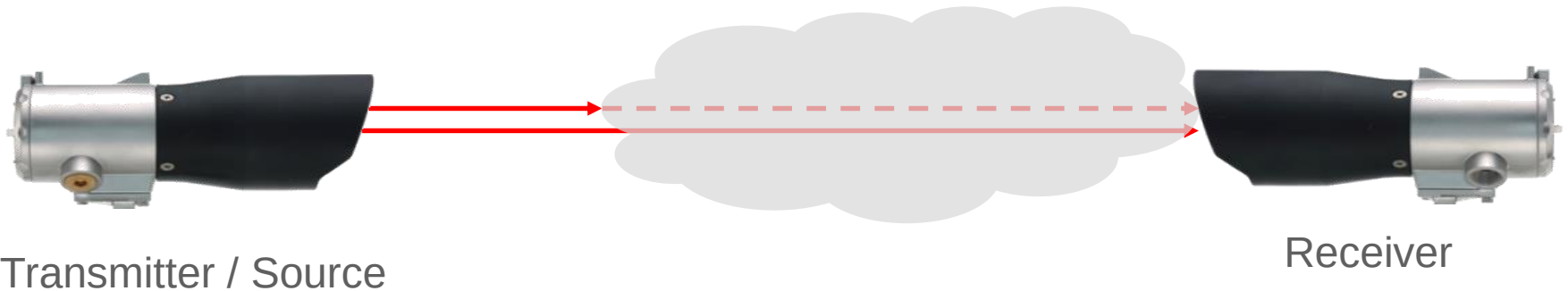
There are 3 versions of IR5500:-

Short Range: 5-30 metres | Standard Range: 20-100 metres | Long Range: 80-150 metres

Note: To minimize the issues with losing detection capability due to fog and rain blocking the beam and the difficulty in aligning >100 metres, many major International O & G companies limit the path length to 60-80 metres

IR Detection Principles

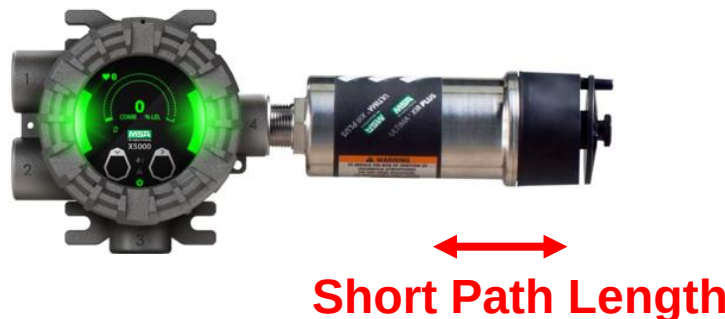
The gas detection principle for IR OPGD is the same as IR Point detectors, which is the absorption of a specific wavelength of the IR beam by the target gas



- Two wavelengths are used: Sample & Reference
 - Sample will be absorbed by the gas and the Reference will not
- Signal ratio of wavelengths determines the gas concentration
 - Difference between Sample and Reference, proportional to concentration

Measuring range – IR Point Detectors

Measuring range: % LEL

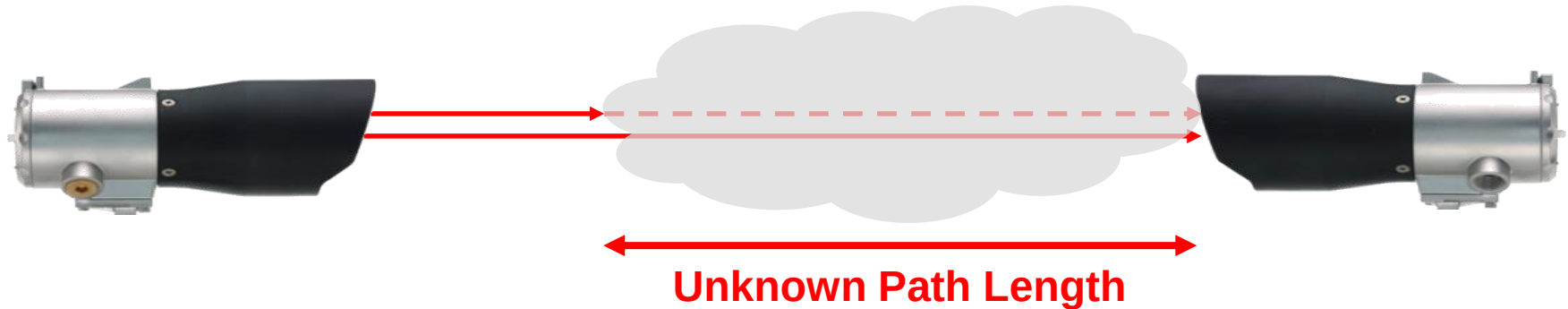


Measuring the gas concentration between 0 and 100% of the Lower Explosive Limit.

This is possible as the Path Length inside the measuring chamber is a known and fixed length.

Measuring range – IR OPGD

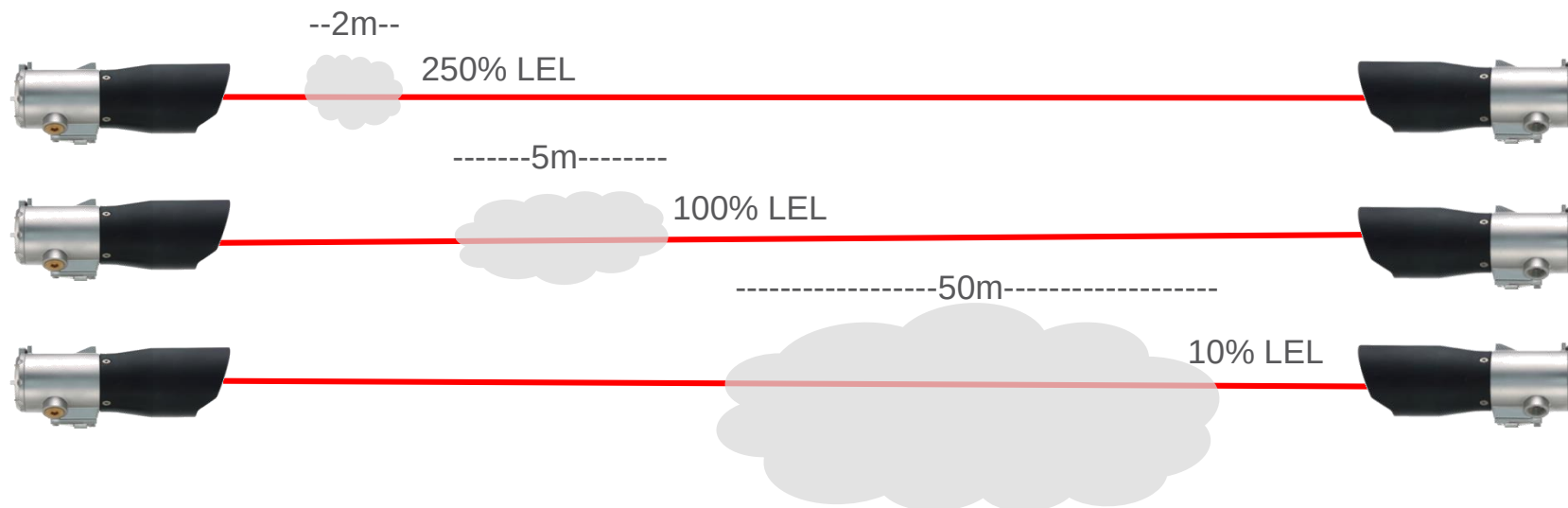
Measuring principle:



OPGD cannot measure in %LEL, as the size of the gas cloud and therefore the measuring path length of the IR beam being absorbed by the gas cloud cannot be known.

Therefore the measurement value is the amount of IR radiation being absorbed. This is based on a known path length and known gas concentration and set at the factory – for life.

Measuring concentration examples



Calculation:

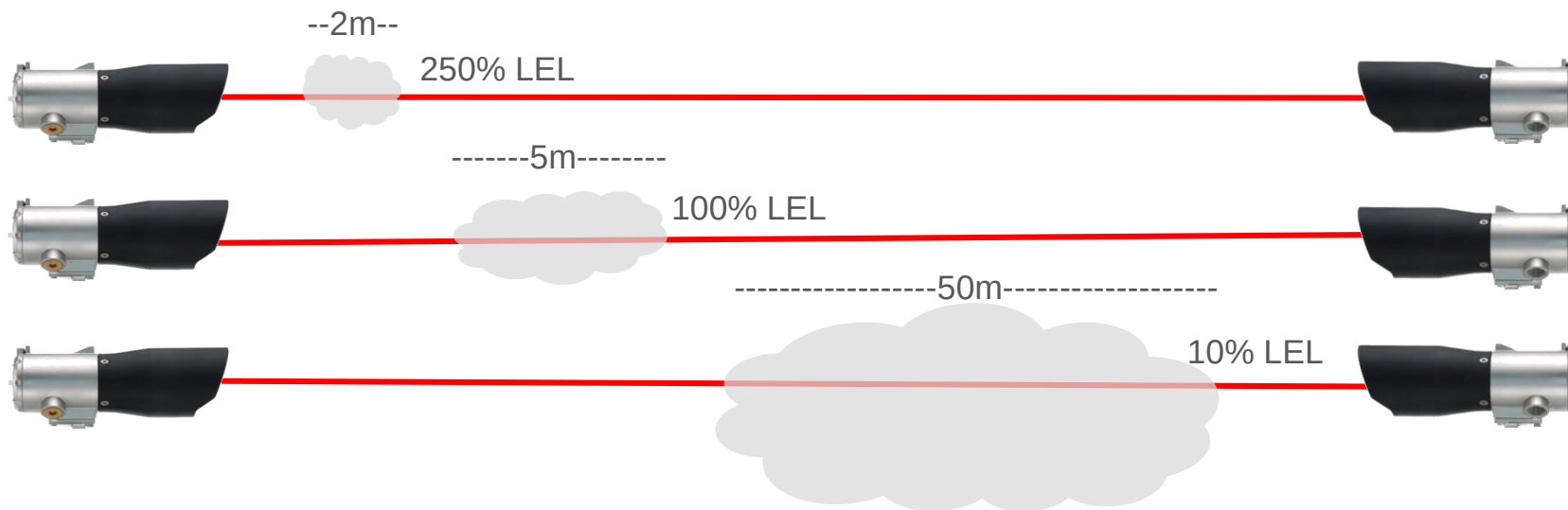
Size of gas cloud in the IR beam which is absorbing IR radiation x concentration

2m x 250%LEL or 5m x 100%LEL or 50m x 10%LEL all = 500%LEL metres

100% LEL metres = 1LEL metres

All 3 examples would therefore show **5 LEL metres** at the control room, as the Receiver would detect the same amount of IR radiation being absorbed

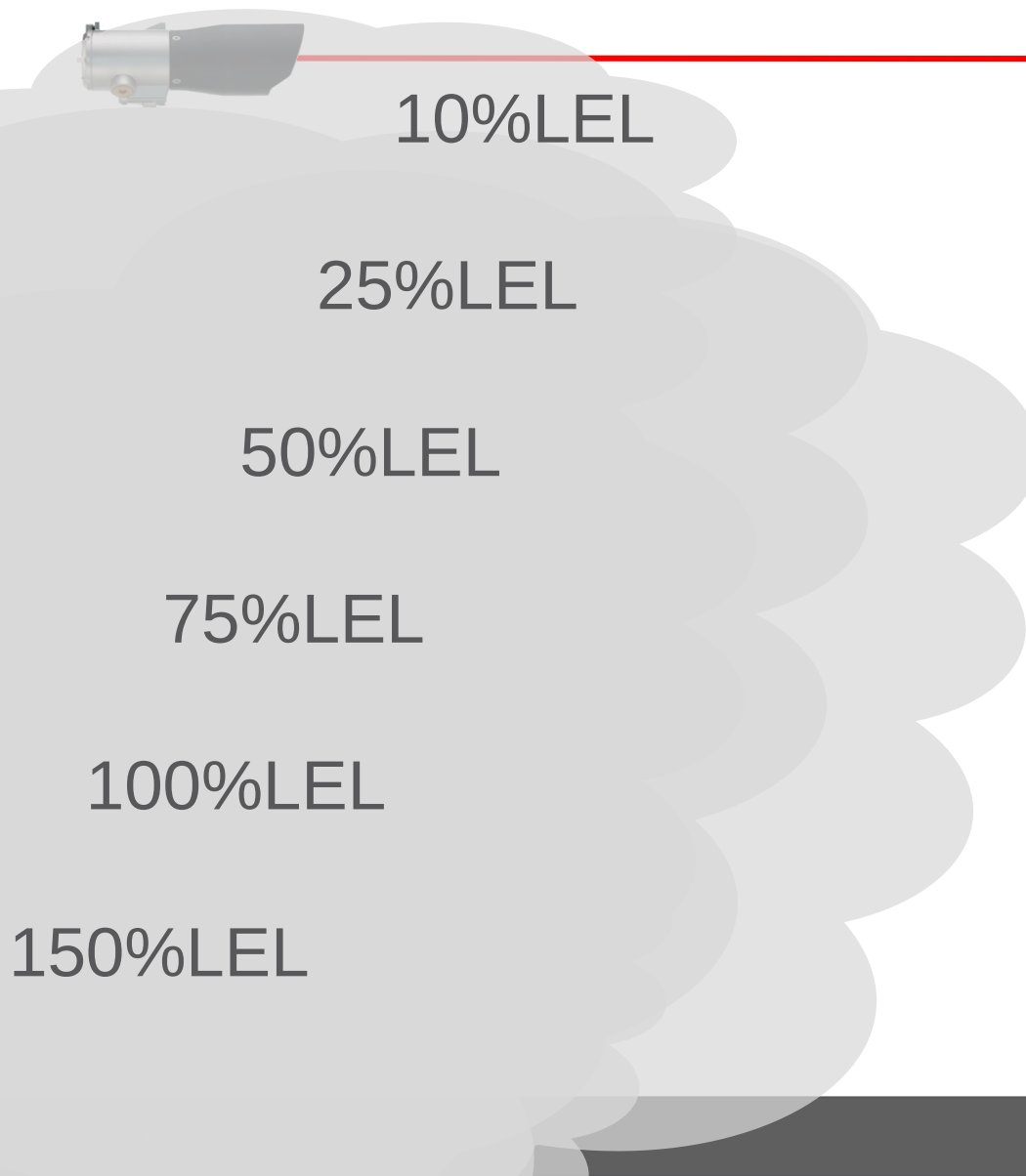
Measuring concentration examples



■ OPGD are unable to differentiate between:

- Small clouds / High concentration and Large clouds / Low concentration
- This is one reason Point detectors are still required, as they give an accurate concentration of the gas detected

Gas cloud concentration



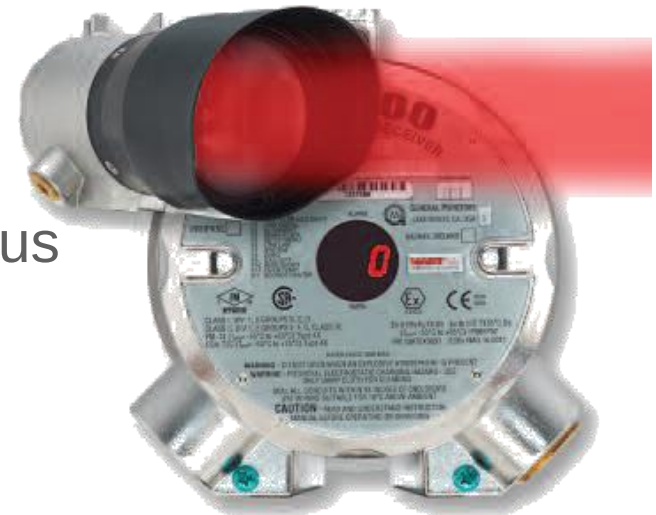
Note:

The initial gas reading may not tell the true extent of risk, the size of the gas cloud or its concentration at the source of the leak.

This is a large gas cloud and a very high concentration, but may initially will be seen as a low risk and some OPGD would not be able to detect such a low concentration.

IR5500 Features

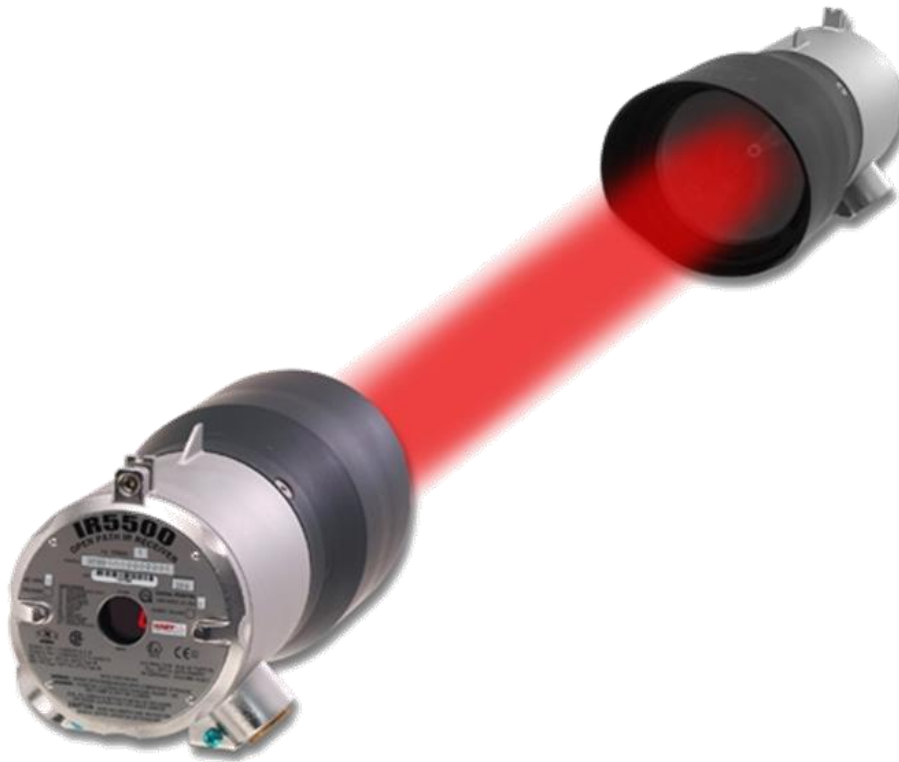
- Capable of detecting of a wide range of Heavy and Light Hydrocarbon gases
- 2 models, factory calibrated to target either Methane or Propane
- Heated Optics – avoids moisture on lenses causing “Beam Block”
- Resilient to solar radiation
- Resilient to rain and fog – FM 6325 Performance approved and immune to **95% blockage by fog**
- Rx has an integral display – for alignment, configuration and gas measurement
- 4-20mA Analogue outputs + HART & Modbus
- Warning, Alarm & Fault Relays
- SIL3 certified



IR5500 Performance Approvals

Performance approved by:-

- FM 6325 approved
- IEC 60079-29-4 approved

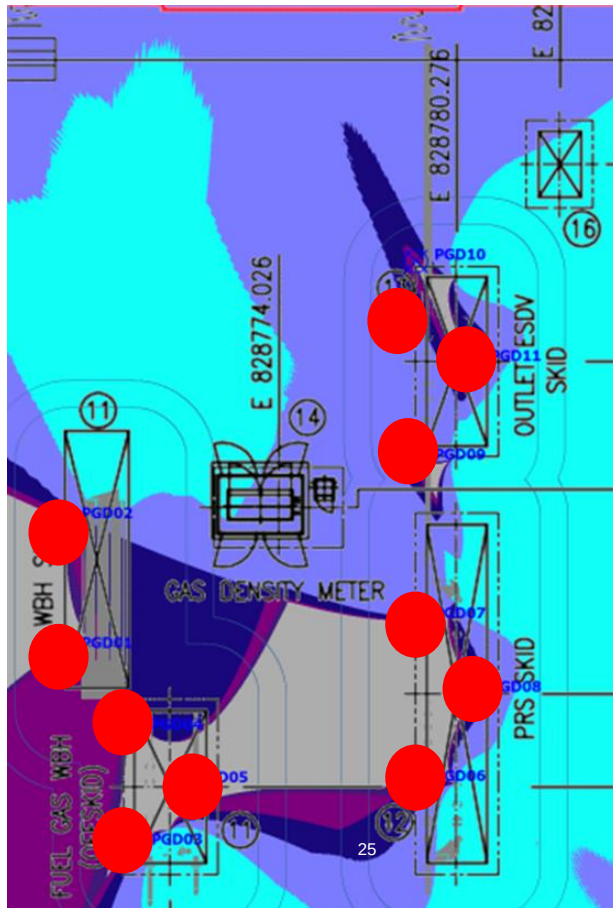


BENEFITS OF USING OPGD IN ADDITON TO POINTS

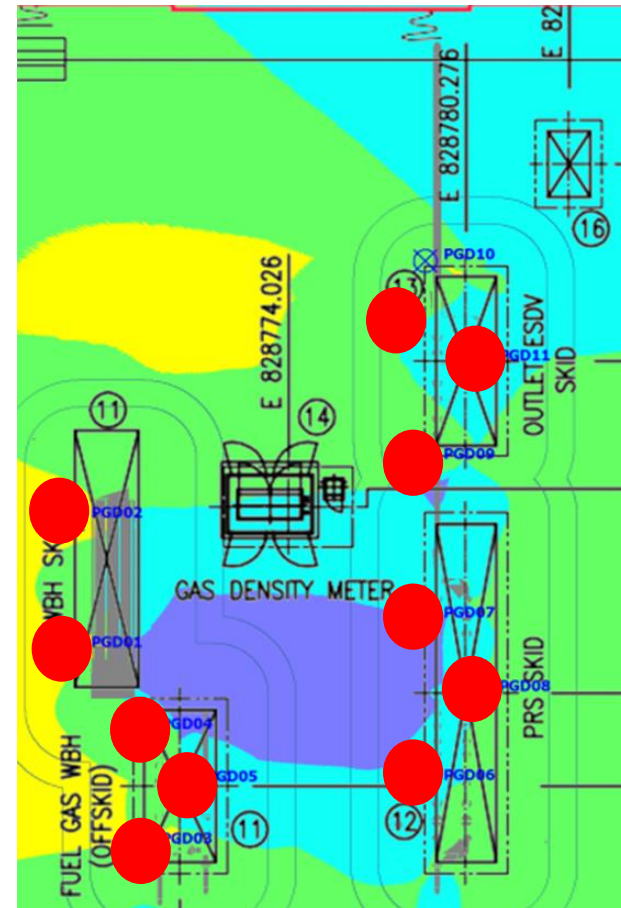
Benefits of using OPGD with Point detectors

Gas detection coverage with only 11 x PGD (Alarm threshold @ 10%LEL)

100N Scenario coverage



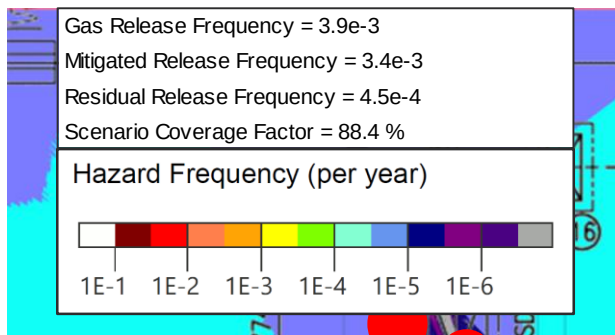
200N Scenario coverage



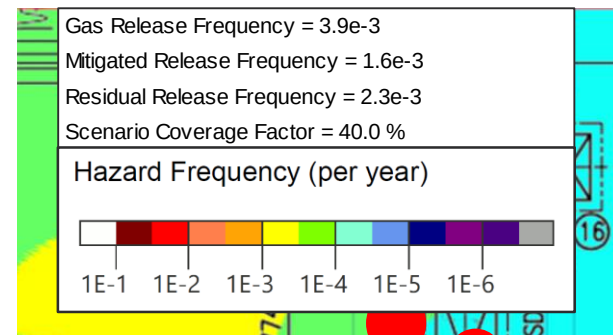
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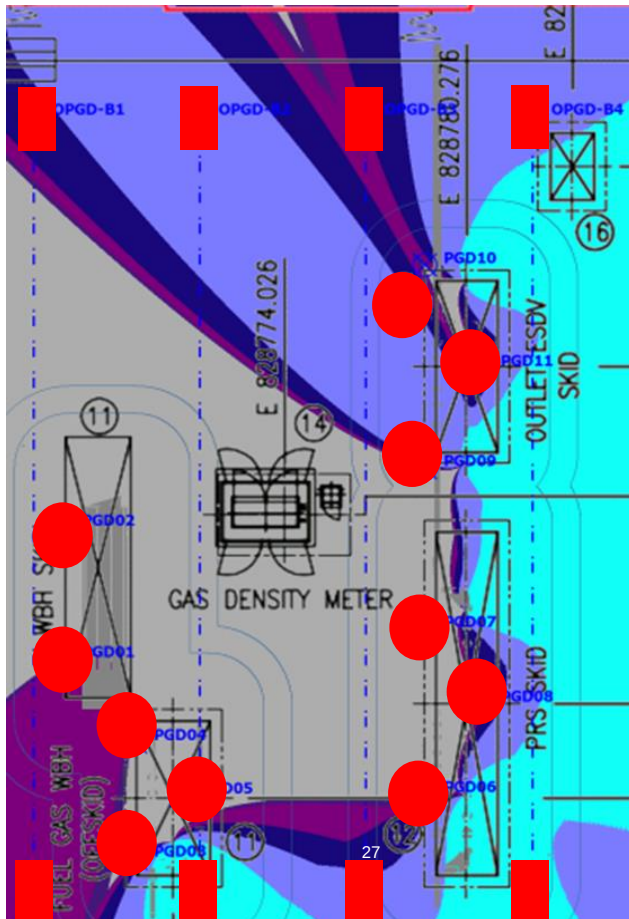
Alarming probabilities when only using Point Gas Detectors

Solution (Measuring range)	Detector Quantity	Alarm threshold	Probability of alarming (based on a 10%LEL plume from a 5mm leak, 1.5F)	
			100N	200N Voting
1. PGD (0-100%LEL)	11	10%LEL	88%	40%

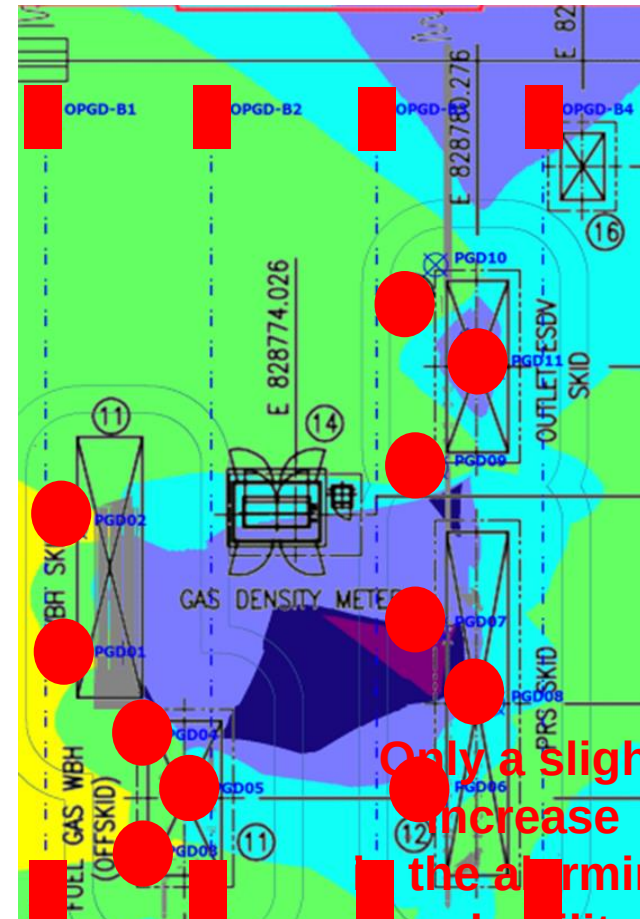
Benefits of using OPGD with Point detectors

Gas detection coverage with same 11 Points, plus 4 OPGD (0-5LEL metres)

100N Scenario coverage



200N Scenario coverage

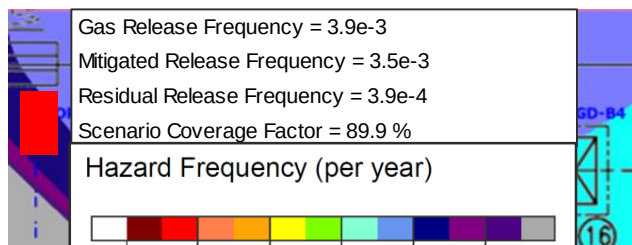


Only a slight
increase
the alarming
probability!

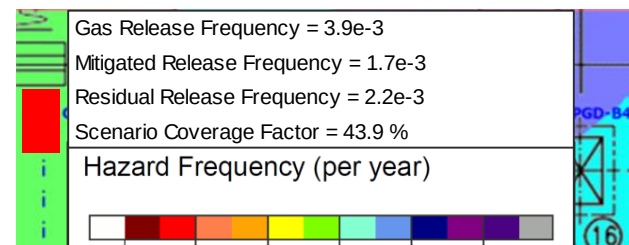
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200N Scenario coverage



Alarming probabilities of the combination solution

Solution (Measuring range)	Detector Quantity	Alarm threshold	Probability of alarming (based on a 10%LEL plume from a 5mm leak, 1.5F)	
			100N	200N
■ PGD (0-100%LEL)	11	10%LEL	88%	40%
■ PGD (0-100%LEL)	11	10%LEL	90%	44%
■ OPGD (0-5LEL.m)	04	1.0LEL.m ¹		

**Only a slight
increase
in the alarming
probability!**

¹ Set at minimum alarm threshold of device.

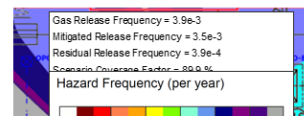
Benefits of using OPGD with Point detectors

The reason for only a **slight increase** in the probability of alarming, was the **low concentration** of the gas cloud or the small size of the cloud!

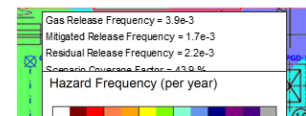
OPGD with a measuring range of 0-5 LEL metres cannot reliably or accurately detect gas clouds with low concentrations.

Gas detection coverage with same 11 Points, plus 4 OPGD (0-5LEL metres)

100N Scenario coverage



200N Scenario coverage



Alarming probabilities of the combination solution

Solution (Measuring range)	Detector Quantity	Alarm threshold	Probability of alarming (based on a 10%LEL plume from a 5mm leak, 1.5F)	
			100N	200N
■ PGD (0-100%LEL)	11	10%LEL	88%	40%
■ PGD (0-100%LEL) ■ OPGD (0-5LEL.m)	11 04	10%LEL 1.0LEL.m ¹	90% Only a slight increase in the alarming probability!	44%

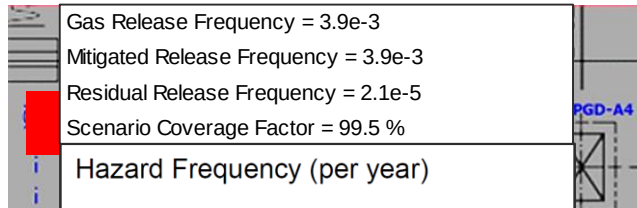
¹ Set at minimum alarm threshold of device.

General Monitors recognised this limitation, so designed the IR5500 OPGD with 2 measuring ranges – LEL metres and PPM metres.

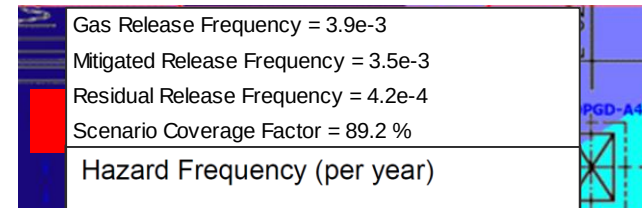
- LEL metres, like every other OPGD – to comply with existing specs.
 - 0-5 LEL metres for Methane and 0-1 LEL metres for Propane
- PPM metres, to be able to detect gas leaks much faster, as the IR5500 can detect lower concentrations / significantly smaller gas clouds
 - 0-5,000 PPM metres for Methane and 0-2,000 PPM metres for Propane

Gas detection coverage with same 11 Points, plus 4 OPGD (0-1LEL metres)

100N Scenario coverage



200N Scenario coverage



Alarming probabilities of the combination solution

Solution (Measuring range)	Detector Quantity	Alarm threshold	Probability of alarming (based on a 10%LEL plume from a 5mm leak, 1.5F)	
			100N	200N
■ PGD (0-100%LEL)	11	10%LEL	88%	40%
■ PGD (0-100%LEL)	11	10%LEL	99%	89%
■ OPGD (0-1LEL.m)	04	0.2LEL.m ¹		

¹ Set at minimum alarm threshold of device.

Summary on the benefits on PPM Metres

Solution (Measuring range)	Detector Quantity	Alarm threshold	Probability of alarming (based on a 10%LFL plume from a 5mm leak, 1.5F)	
			100N	200N
- PGD (0-100%LEL) - OPGA-A (0-1LEL.m)	11 04	10%LEL 0.2LEL.m ¹	99%	89%
- PGD (0-100%LEL) - OPGD-B (0-5LEL.m)	11 04	10%LEL 1.0LEL.m ¹	90%	44%

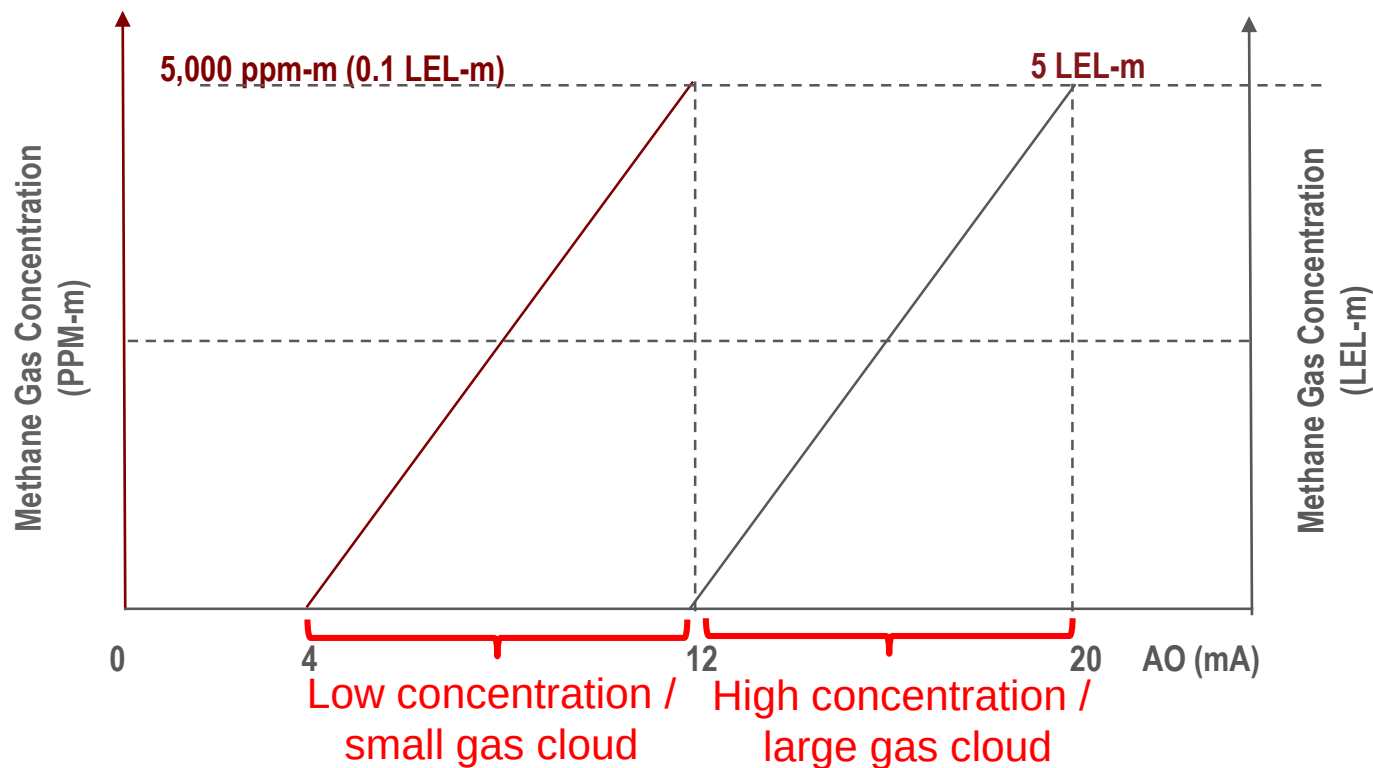
¹ Set at minimum alarm threshold of device.

Selecting an OPGD with a much lower detection range (PPM metres):-

- Increases the probability of alarming, particularly in a voting system
- When using PPM metre measurement range, the number of OPGD required to achieve the same level of coverage / probability of alarming as LEL metre OPGDs, will be significantly reduced.
- Less OPGD = less CAPEX, less installation cost, less I/Os at controller and less OPEX.

Dual range analogue output

- When measuring in PPM metres, the user can still monitor in LEL metres
- With the split range function, users can monitor the entire span of gas concentration with a single analog signal
 - Reduces wiring and commissioning costs

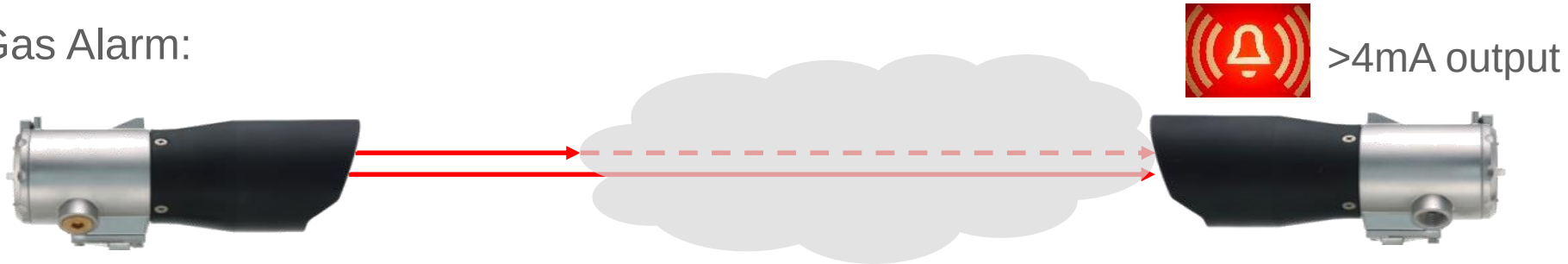


BEAM BLOCK WARNING

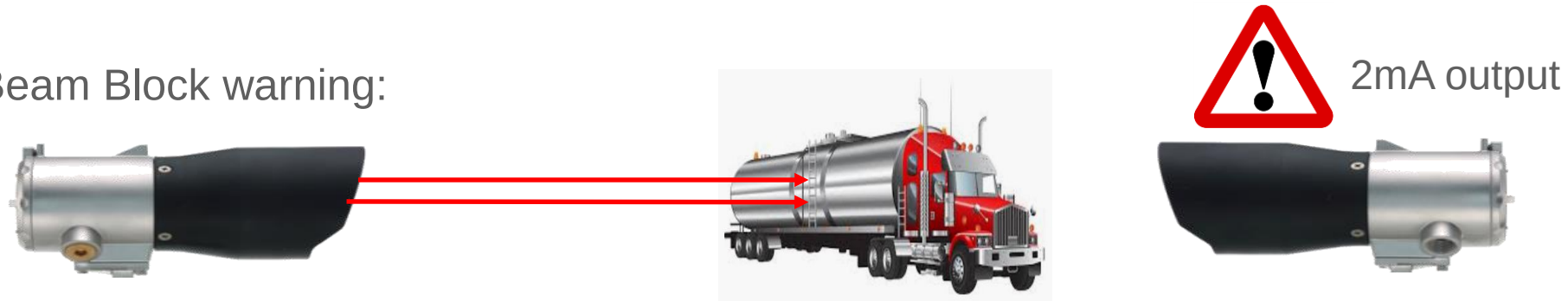
Beam Block Warning

If the beam becomes blocked and the receiver does not see the IR beam, a **Gas Alarm** output is not given to the control system. Instead a specific Beam Block warning is initiated.

Gas Alarm:



Beam Block warning:



The OPGD can be configured to introduce a delay before it initiates a warning that the beam is blocked and gas cannot be detected.

Always set a delay and always investigate a Beam Block warning!

SPECIFICATION

IR5500 Specification



Methane range:	0 to 5,000 ppm.m & 0 to 5 LEL.m
Propane range:	0 to 2,000 ppm.m & 0 to 1 LEL.m
Path lengths:	5-30m, 20-100m & 80-150m
Display:	3-digit LED
Response time:	T90 <3s
Outputs:	2 x 4-20mA, HART, Modbus
Relays:	4x 8A SPDT fully configurable
Housing	316 stainless steel
Cable entries:	2 x ¾" NPT / M25
Electrical Supply:	20 – 36 VDC
Power (max):	Source 12W Receiver 10W
Temp Range:	-55°C to +65°C
Approvals:	ATEX, IECEx: Ex d IIB + H2 T4 Gb CSA/ FM: Class I Div. 1 & 2 Group BCD DNV, SIL 3
Ingress Protection:	NEMA 4X / IP66
Visible light filter:	Optional



Fault diagnostics & Routine testing

Integral LED display of fault codes aids troubleshooting:

- Dirty Optics
- Alignment
- Beam block (+time delays)
- Low supply voltage

Routine testing:

- Use of optical test filters

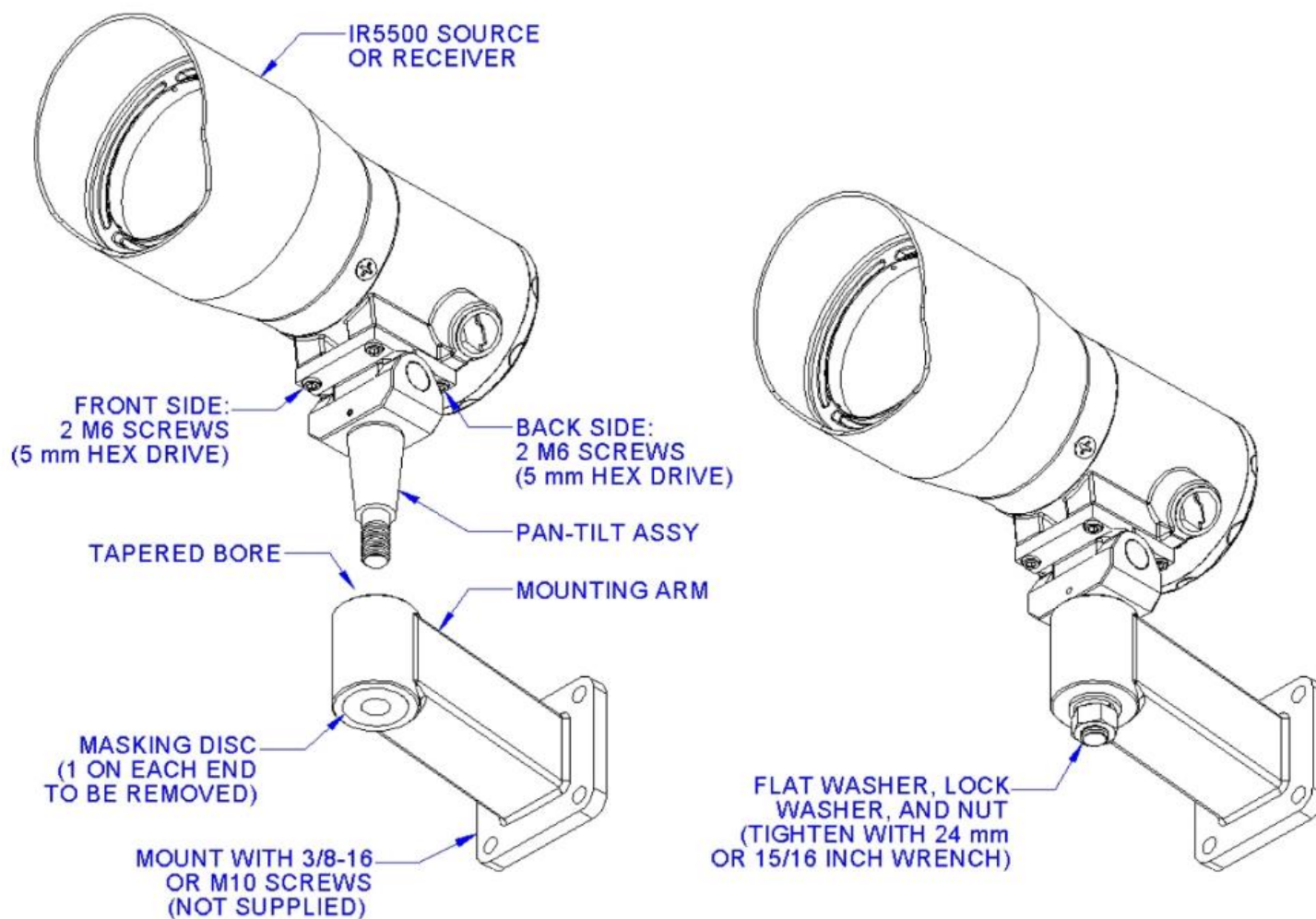


Fault Code	Description
F0	Excessive negative drift or high IR
F1	Partial beam block or dirty lens
F3	Beam block
F4	System cross talk
F6	Low supply voltage receiver
F8	Failed zeroing
F11	Receiver overheating
F12	Poor alignment
F14	Analogue output failure (LEL.m)
F15	Receiver heater failed
F20	Low set up alignment signal
F25	Analogue output failure (ppm.m)

Special note: The IR5500 can be serviced on site, so no need to return to the factory!

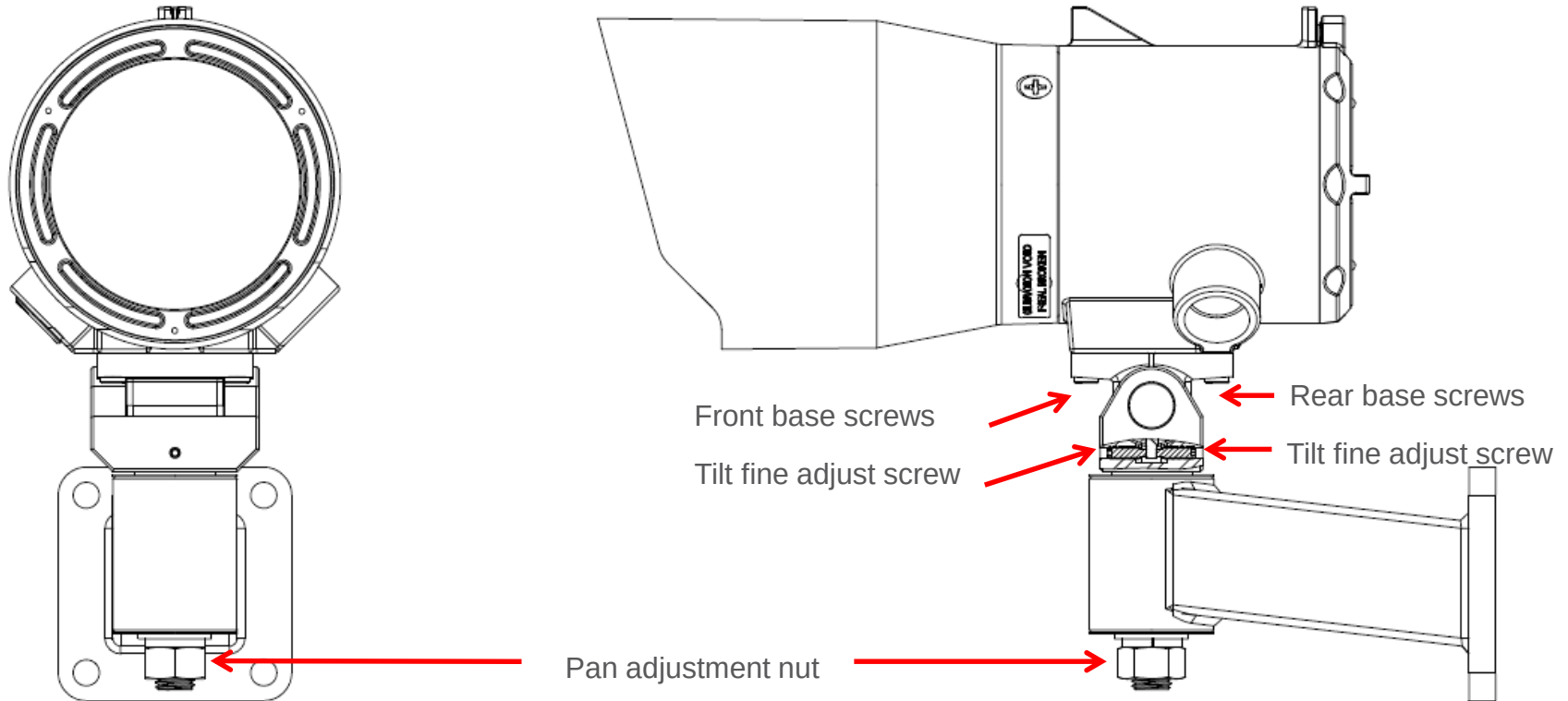
INSTALLATION & ALIGNMENT

Mounting arrangement



Installation & Alignment

Mounting adjustment



How to align the IR5500

IR5500 alignment on **You**Tube



Open Path IR Gas Detector Alignment Guidelines

General Monitors by MSA • 26K views • 5 years ago

Video demonstrates best practices when aligning the IR5500 open path IR gas detector. The IR5500 can be used in applications ...

Parallel placement

When installing any OPGD close to each other, it's important to alternate the Rx (Source) and the Rx, as shown below. This eliminates system cross talk.

Figure 1—Correct Placement

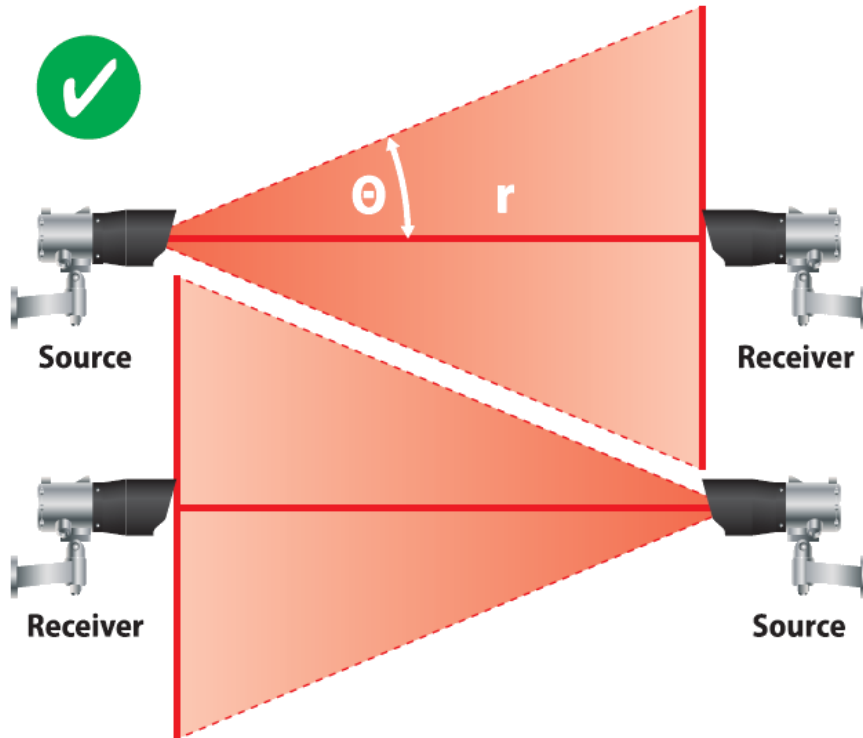
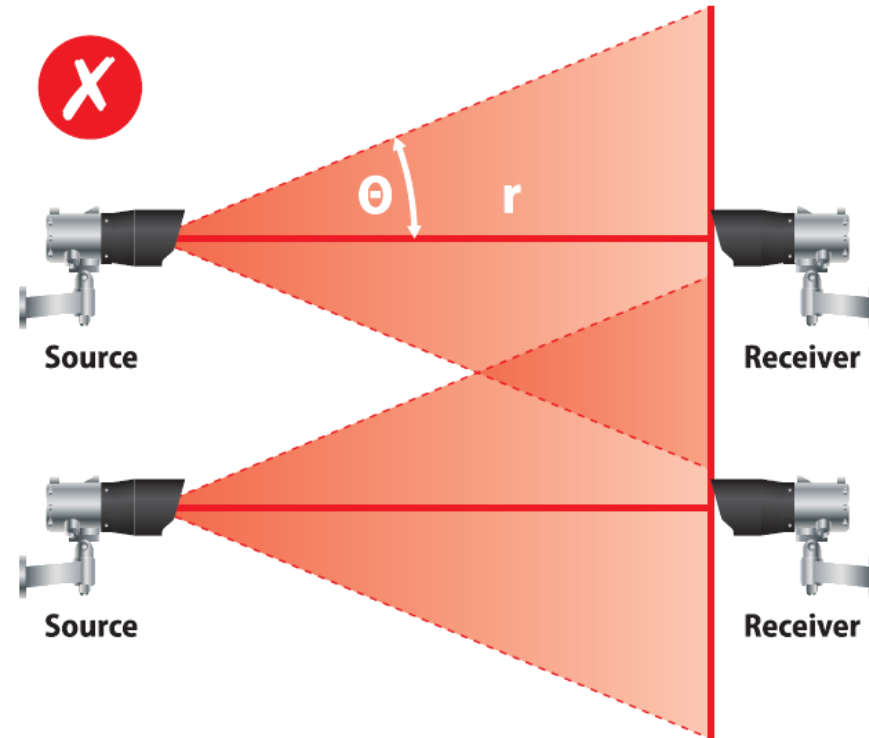


Figure 2—Incorrect Placement

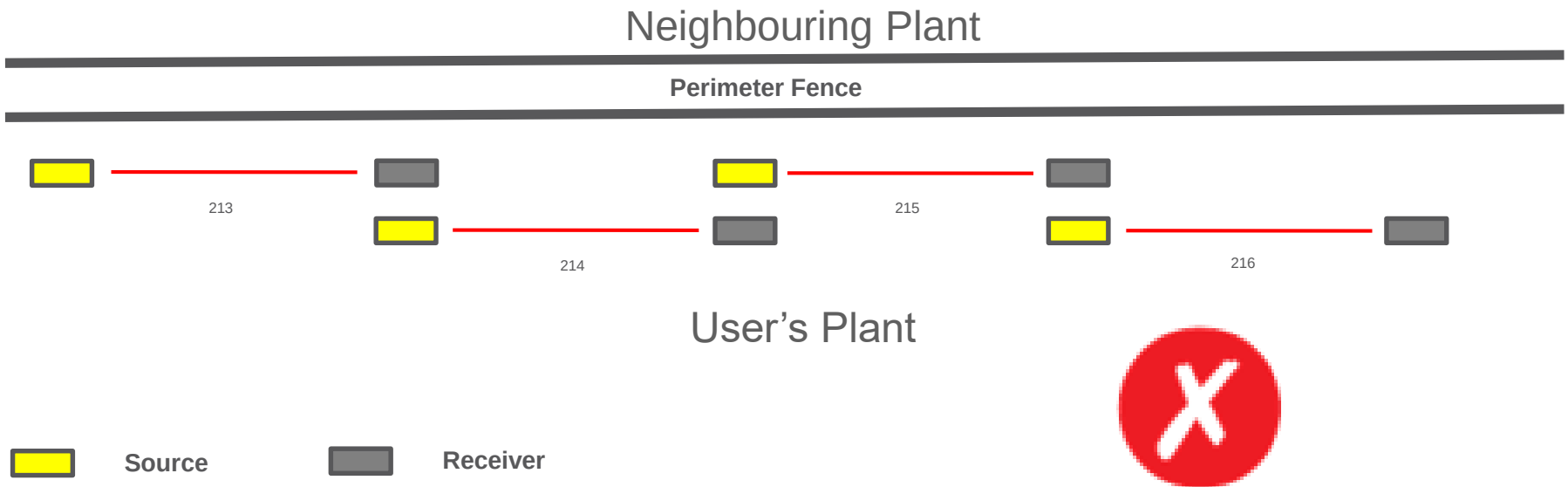


Note: The wide angle of the IR beam is for illustration purposes only!

Linear (perimeter) placement

A common application for an OPGD system is for monitoring for gas clouds on the perimeter / boundary of the site. This detects gas leaks from the users own facility, but also their neighbours.

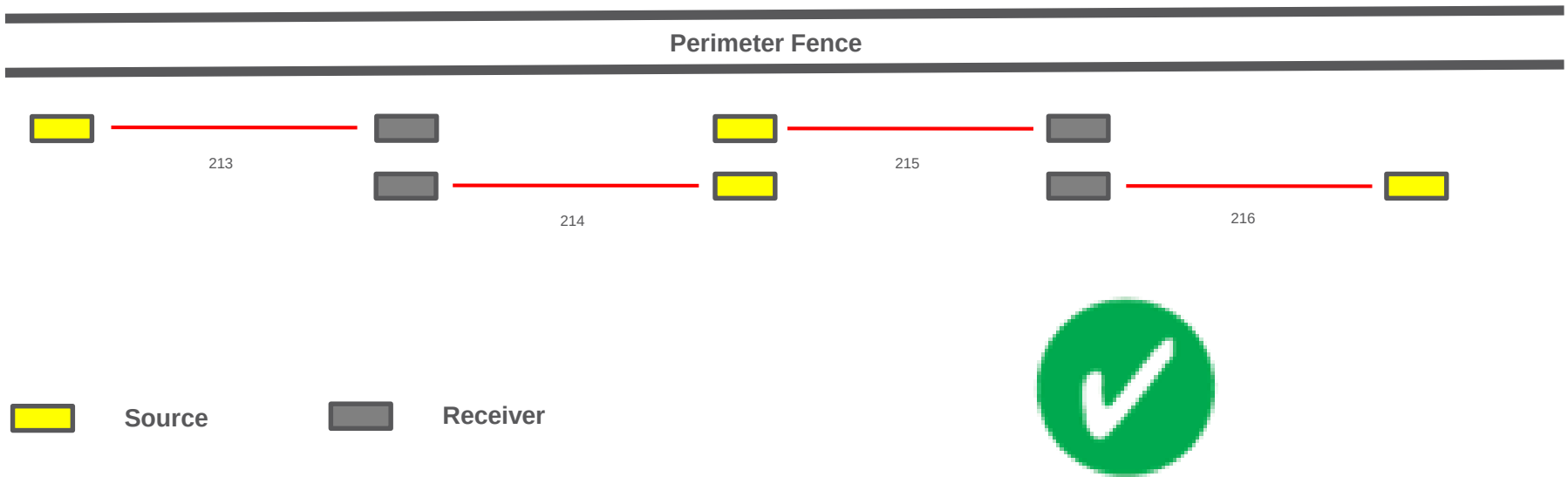
When OPGD are close to each other in a line, it's important to alternate the Tx (Source) and the Rx, **not as shown below**. This again eliminates system cross talk.



Linear (perimeter) placement

A common application for an OPGD system is for monitoring for gas clouds on the perimeter / boundary of the site. This detects gas leaks from the users own facility, but also their neighbours.

When OPGD are close to each other in a line, it's important to alternate the Tx (Source) and the Rx, **as shown below**. This again eliminates system cross talk.



APPLICATIONS

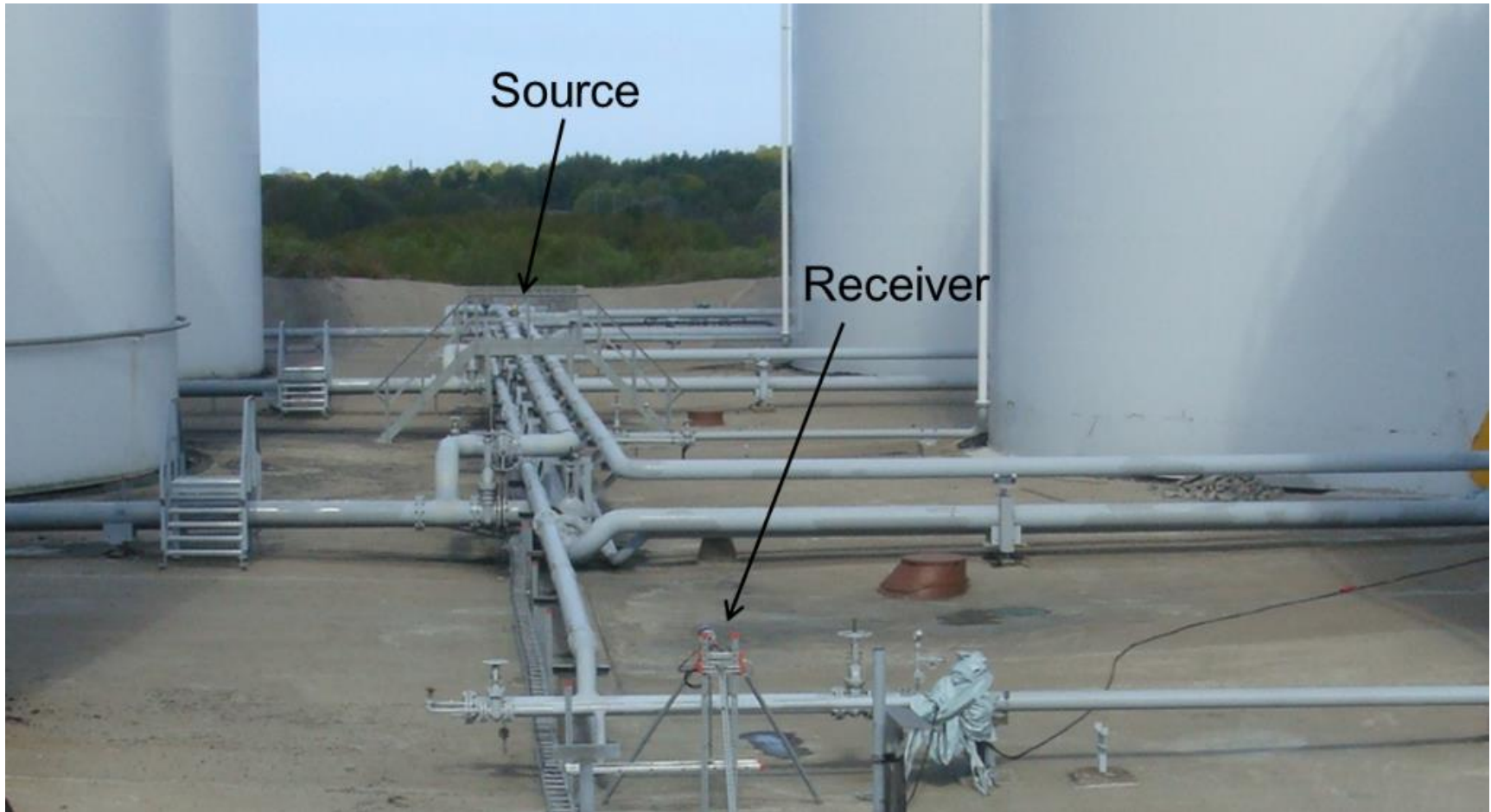
- Production platforms
- Compressor stations
- Pipe racks
- Valve manifolds
- Tank farm
- Perimeter monitoring
- HVAC ducts



Train Loading

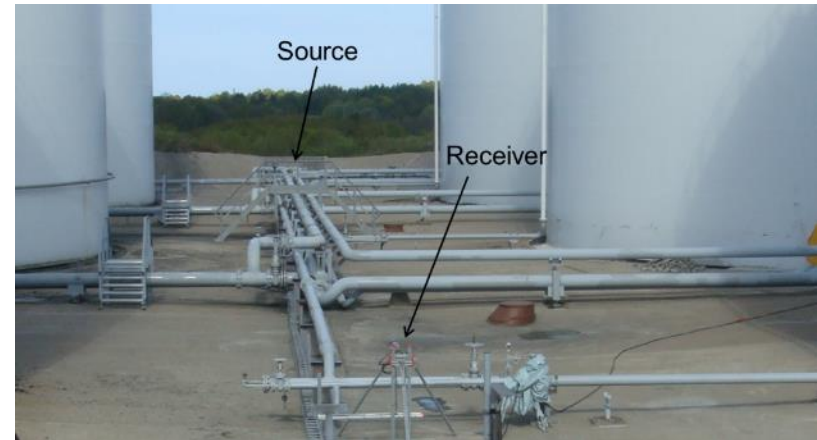


Applications – Fuel Storage Tanks



Special Note:

For fuel storage tanks containing Petrol (Gasoline), as the main ingredient is Hexane and as this is almost impossible to detect when only measuring in the LEL Metres measurement range, the probability of alarming is almost zero.



For this application in particular, the **measurement range must be PPM Metres**.

If you currently have an OPGD system that uses OPGD that can only detect in the LEL Metres range, then we strongly suggest you test the detection capability with the target fuel in the tank(s).

If you are currently designing or considering using OPGD for fuel storage tanks, then ensure you specify OPGD with PPM Metres detection / measurement range.

High Pressure Reactor



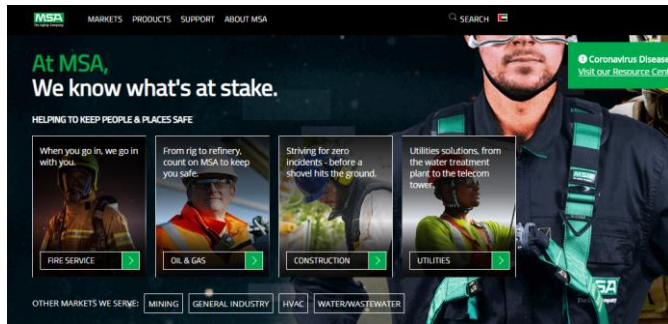
Gas production plants and storage facilities



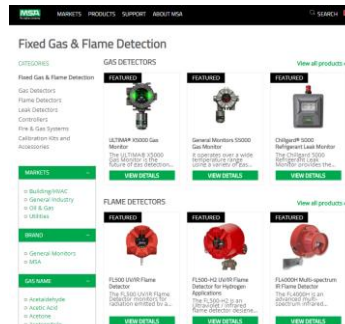
Final Thoughts!

- When designing a F & G system for high risk OGP installations, include OPGD as an “additional later of detection”
- By measuring in PPM.metres you will increase the level of safety by detecting the gas leak much earlier
- For the faster detection time and to reduce the number of OPGD required for the same level of detection, base your mapping design on the lower measurement range – PPM.metres
- Limit the path length to 60 – 80 metres, especially in areas with fog or heavy rain
- PGDs are still required to give a better indication of the leak source and also the concentration of the gas cloud
- For Petrol/Gasoline, you must select OPGD with PPM Metres
- For high pressure gas systems / applications, consider UGLD devices to increase the detection probability even higher
- If the risk is only either Methane or Ethylene, then you can also consider the Laser OPGD as another solution.

Resources within MSA (click on the image)



The MSA – UAE website



F&G Home Page

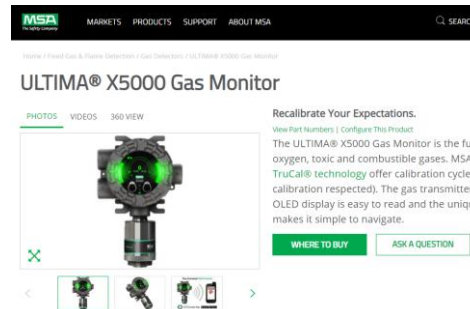


IR5500 Home Page

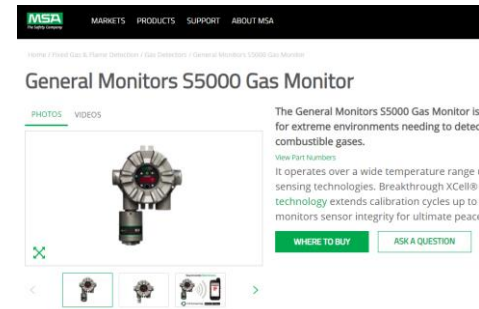
MSA Fixed Gas & Flame Detection Flame & Gas Mapping Solutions



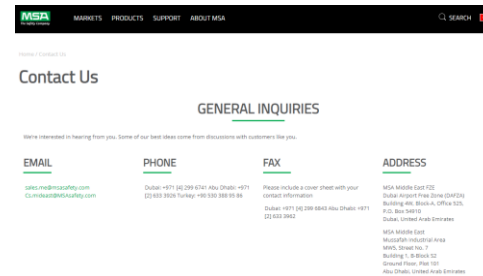
F&G Mapping Solutions - Document



MSA's 5000 Series Point Gas Detectors – the Ultra Smart detectors



5000 Series TruCal video



How to contact MSA in MEA/IR



THANK YOU!

Any questions?

