Fire and Gas **System Solutions**

Application Note

MSA
The Safety Company

An introduction to

Open-Path-Gas-Detection

Because every life has a ***purpose…***

WORKING PRINCIPLE OF THE OPEN PATH GAS DETECTOR

Hydrocarbon gases are organic compounds made up of carbon and hydrogen atoms. Other organic compound gases such as alcohols will include also oxygen atoms in addition to the carbon and hydrogen atoms. The atoms forming an organic compound molecule are held together by interatomic bonds called covalent bonds. These bonds are not rigid sticks or rods, but are like stiff springs that stretch and bend at their own natural frequency.

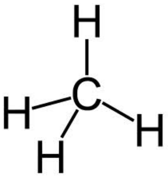

Figure 1: Molecular structure of methane gas

Virtually all organic compounds absorb radiated infrared (IR) energy that resonates with the natural frequency of its stretching and bending of its covalent bonds and the vibration motions of its component atoms. These organic compounds are termed as IR reactive.

Since each hydrocarbon gas has its own unique combination and arrangement of atoms, the IR absorption spectrum associated with it is also unique, like a fingerprint. The IR absorption spectrum can therefore be used to identify the gas with good accuracy. This is the general approach used in IR spectroscopy to identify individual gases in a gas sample.

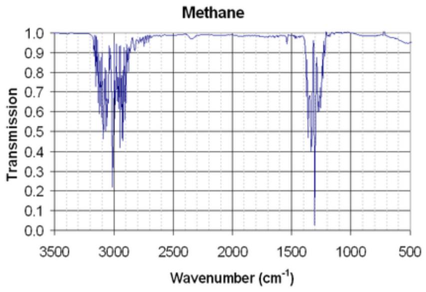

Figure 2: IR absorption spectrum of methane gas

Unlike IR spectroscopy however, the open path gas detector (OPGD) is not designed to identify individual gases in a sample. But it uses the same IR absorption nature of hydrocarbon/organic gases as the basis of detecting its presence within a space. By measuring the energy transmittance of an IR beam, the OPGD can reliably determine if there is a concentration of hydrocarbon/organic gas between the IR beam Source and the Receiver.

The OPGD is typically calibrated to a specific target gas so that it responds most accurately to the presence of this gas. But its sensing is non-specific. It will also sense other IR reactive hydrocarbon or organic gases, albeit less accurately. Since the OPGD is a safety instrument designed to detect and alarm the presence of any gas that may combust, this non-specificity is not usually a major issue.

The amount of IR energy transmittance from the Source to the Receiver depends on the type of hydrocarbon gas, the gas concentration, and the total length of gas cloud that the IR beam passes through. The relationship between energy transmittance (T) and these three factors can be stated as, $T=T_0 \exp(-acl)$ where T_0 is the transmittance of IR energy when there is no absorbing medium.

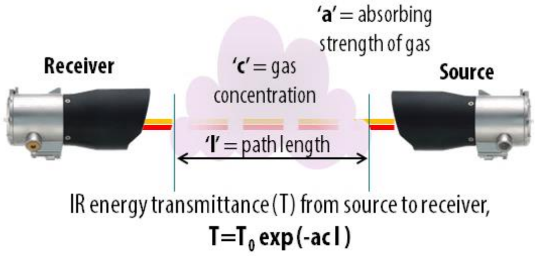

Figure 3: Typical setup of an open path gas detector

The absorbing strength of a gas depends largely on the mass of individual atoms and the types of covalent bonds (eg. C-C, C=C, C-H, C-O, C=O, O-H) that exist in a molecule of the gas. The stronger the absorbing strength of a gas is (i.e. larger 'a') the lower will be the transmittance of IR energy from the Source to the Receiver.

The gas concentration 'c' and path length 'l', determine the number of gas molecules that 'block' the IR beam and absorb energy from it. The higher the concentration is, or the longer the path length is, the greater would be the IR radiation energy that is absorbed.

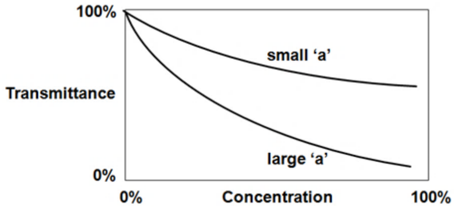

Figure 4: Relationship between transmittance, gas concentration and absorbing strength

For the OPGD, both the gas concentration and the path length 'l' are measurement variables. Therefore, it cannot determine the actual concentration of the gas or the size of the gas cloud. For example, it is possible for a small gas cloud with higher concentration to absorb the same amount of IR energy as a larger but lower concentration gas cloud. It is also possible for a series of small gas clouds of uniform concentration to absorb the same amount of energy as a single large cloud with similar concentration, if the total path length 'l' for both cases is the same. For both scenarios in each of these two possibilities, the OPGD would produce the same gas reading.

In summary, the OPGD cannot:

- Determine the type of gas it is measuring;
- Determine the actual concentration of the detected gas;
- Determine the size of the gas cloud;
- Determine if it is a single gas cloud or a series of gas clouds;
- Determine the position of the detected gas cloud.

INSTRUMENT DESIGN

MSA's OPIR5/IR5500 uses a single beam, dual wavelength method of IR absorption detection. The gas absorbs one wavelength but not the other, which is the reference wavelength. By comparing the signals from these two wavelengths, the detector computes gas readings. The reference wavelength is chosen to compensate for interferences that can otherwise occur from atmospheric variation, such as humidity, rain, dust, snow, fog, steam, and temperature. This method of detection comes under what is commonly known as the non-dispersive IR (NDIR) absorption principle.

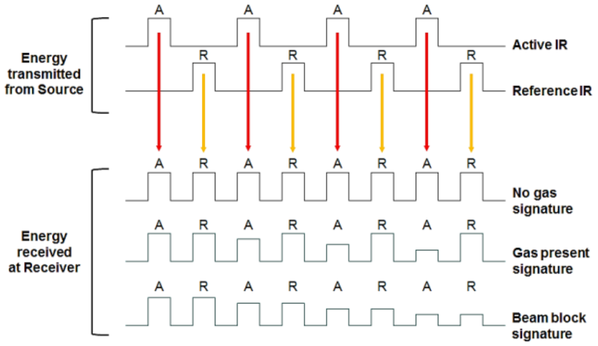

Figure 5: Illustration of active and reference IR

When both the active and reference IR wavelengths are interrupted at the same time, such as when the beam is blocked by an object, a person, extremely dense fog or steam, the OPGD will interpret this as a beam block. Being able to detect a beam block is highly critical for the OPGD since its operation depends on a clear line-of-sight between the Source and Receiver unit.

However, since a blockage may be due to a temporary and short duration cause (e.g. blockage by a passing person or vehicle), a delay is typically set on the OPGD so that it does not immediately report the beam block as a fault condition. A beam block fault is only reported if the blockage persists after the delay expiry.

Most open path gas detectors today use the separated Source and Receiver approach such as shown below. This approach is known to be more reliable under a variety of site conditions.

▪ Instrument design:	Separated Source and Receiver Single beam, dual wavelength
▪ Measures:	Light hydrocarbon gas (CH_4) Heavy hydrocarbon gas (C_3H_8)
▪ Measuring ranges:	0-5000ppm.m/ 0-5LEL.m (CH_4) 0-2000ppm.m/ 0-1LEL.m (C_3H_8)
▪ Measuring distance:	Up to 150 meters
▪ PFD (1oo1):	1.7×10^{-4} (SIL3, SFF>99%)
▪ Body material:	SS 316
▪ EX classification:	II2GD, Exd IIB+H_2 T4 Gb Ex tb IIIC T135°C Db, IP66/67 (T_{amb}= -55°C to +65°C)
▪ Agency approval:	IECEx, ATEX, FM, CSA, GOST, INMETRO, DNV

In some older OPGD designs, the IR Source and Receiver electronics are contained in a single housing and a reflector is mounted at the far end of the beam path to reflect and return the beam to the Receiver. But this approach is known to be susceptible to spurious faults, usually caused by dust coating or precipitation on the reflector. Very few instruments follow this design approach these days.

CALCULATING GAS READINGS

Most OPGD measure and display readings in LEL.m scale. But a high sensitivity OPGD like the OPIR5/IR5500 can measure gas concentrations and display readings in both ppm.m and LEL.m scales. The advantages of the ppm.m scale will be discussed further on in this application note. Table 1 and Table 2 below illustrate how gas readings on OPGD are derived.

Size of Gas Clouds	Ultima OPIR-5 Display
20% LEL x 1 meter	0.2 LEL•meter
10% LEL x 2 meters	0.2 LEL•meter
100% LEL x 2½ meters	2.5 LEL•meter
50% LEL x 5 meters	2.5 LEL•meter
100% LEL x 1 meter	1.0 LEL•meter
50% LEL x 2 meters	1.0 LEL•meter
25% LEL x 4 meters	1.0 LEL•meter
10% LEL x 10 meters	1.0 LEL•meter

Table 1: Calculating LEL.m readings

Size of gas cloud	Ultima OPIR-5 Display
50 ppm x 2 meters	100 ppm•meter
25 ppm x 4 meters	100 ppm•meter
10 ppm x 10 meters	100 ppm•meter
100 ppm x 5 meters	500 ppm•meter
50 ppm x 10 meters	500 ppm•meter
500 ppm x 5 meters	2500 ppm•meter
100 ppm x 25 meters	2500 ppm•meter
5% LEL x 1 meter	2500 ppm•meter
1% LEL x 5 meters	2500 ppm•meter
.5% LEL x 10 meters	2500 ppm•meter

Table 2: Calculating ppm.m readings

Setting Warn & Alarm Thresholds

A conservative approach for WARN and ALARM thresholds on the OPIR5/IR5500 would be:

For OPGD intended for methane gas release detection:

- WARN (ppm): 500ppm x 5 meters = 2500ppm.m
- WARN (LEL): 0.2LEL x 5 meters = 1.0LEL.m
- ALARM (LEL): 0.5LEL x 5 meters = 2.5LEL.m

For OPGD intended for propane gas release detection:

- WARN (ppm): 200ppm x 2 meters = 400ppm.m
- WARN (LEL): 0.2LEL x 2 meters = 0.4LEL.m
- ALARM (LEL): 0.4LEL x 2 meters = 0.8LEL.m

Adjusting Pan-Tilt

Most OPGD instruments today come with mounting arms or mounting base assemblies that permit pan-tilt adjustments. Pan-tilt adjustments are needed so that the Receiver and the Source units can be aligned with relative ease.

But the design and sturdiness of the pan-tilt mechanics on the assembly are crucial. The design must allow *fine* pan-tilt adjustments so that it is easier to achieve accurate alignment, especially when the separation distance between the Source and Receiver is long. Over a long distance, a small step change in pan or tilt angle of the Source, would translate into a corresponding large lateral or vertical movement of the IR beam at the Receiver end. Therefore it is very helpful if final adjustments can be done in very fine small steps. Otherwise the process of alignment would be difficult and arduous. Fine pan-tilt adjustment is standard on both the arm and base type assemblies of the OPIR5/IR5500.

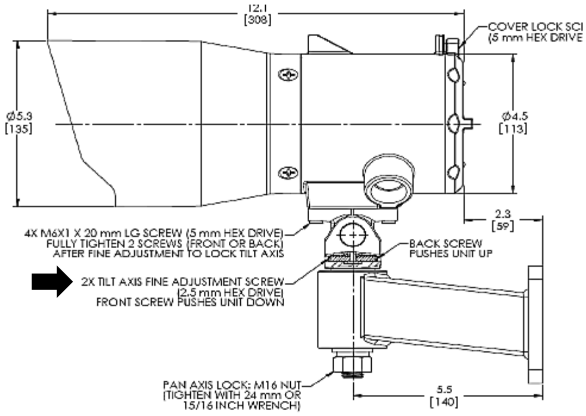

Figure 6: Pan-tilt arm assembly with fine adjustments

Additionally, the pan-tilt mechanics on the mounting arm or base must be sturdy enough so that the perfect alignment that was fixed during instrument setup is maintained even though the instrument experiences vibrations during operation. Otherwise, because of vibrations the IR beam may gradually shift from perfect alignment during operation and this would lead to an OPGD optical fault eventually. Both the arm and base assemblies of the OPIR5/IR5500 are certified to FM6325 performance standard.

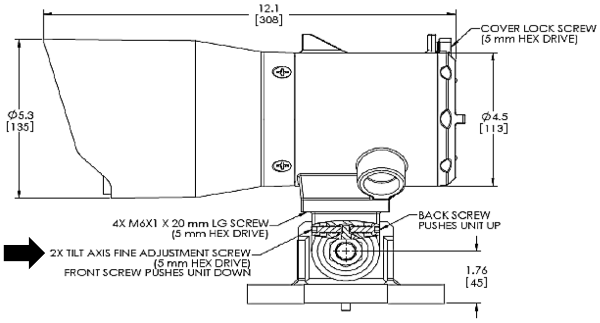

Figure 7: Pan-tilt base assembly with fine adjustments

FM 6325 performs *vibration tests at a frequency range of 10 Hz to 30 Hz at a total excursion of 1mm and 31Hz to 150 Hz at a 2 g acceleration peak for a period of 1 hour in each of three mutually perpendicular directions. The rate of change of frequency does not exceed 10 Hz/min.*

The gas reading of the OPIR5/IR5500 remains accurate up to a misalignment angle of ±0.5 degrees. The OPIR5/IR5500 passes the alignment test criteria of IEC 60079-29-4 which requires that *at the stated misalignment angle, the equipment shall not generate any false alarms and the measured values of the integral concentration for each gas shall not differ from the nominal values by more than ±10% of the measuring range or ±20% of the measured value, whichever is greater.*

ALIGNING SOURCE AND RECEIVER UNITS

The goal of this process is to align as accurately as possible the optical centre-line of both Source and Receiver units. This is to ensure that the signal that is received by the OPGD Receiver is as strong as possible and above the minimum requirement for a given monitoring distance.

The OPIR5/IR5500 Receiver unit has an accurate method of determining if the signal received is adequate. During the alignment procedure, the Receiver indicates the actual signal strength received as an AJ value on the local indicator.

Figure 8: Receiver unit with built-in alignment indicator

Std Config Range (20-100 m)	20 m	30 m	40 m	50 m	60 m	70 m	80 m	90 m	100 m
Extended Path Range (80-150 m)	n/a	80 m	90 m	100 m	110 m	120 m	130 m	140 m	150 m
AJ value	72 to 67	65 to 60	59 to 54	53 to 48	49 to 43	45 to 38	43 to 35	39 to 32	35 to 30

Table 3: Optimal AJ value band for a given monitoring distance

The wide misalignment angle of the OPIR5/IR5500 at ±0.5 degrees also means that this instrument is easier to align than other OPGD with narrower misalignment angles.

POSITIONING SOURCE AND RECEIVER UNITS

When two or more units of OPGD are positioned to monitor adjacent spaces, care must be taken to avoid measurement errors caused by IR interference from one unit to the other. There are two scenarios where this could easily happen.

First, when two OPGD units are positioned side by side and because of cabling or other reasons both Receiver units are located at the same end. This is illustrated in the diagram below. In this scenario, the nearer OPGD may pick up additional IR energy from the adjacent IR Source thereby producing a reading error.

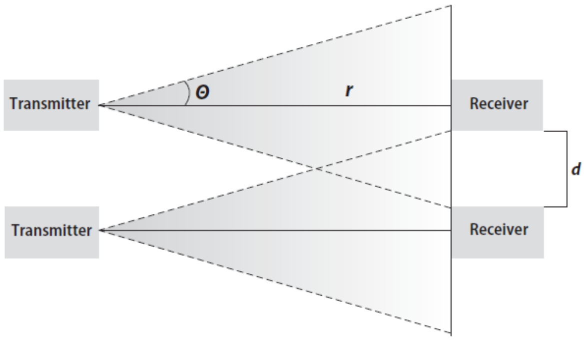

Figure 9: IR interference when two adjacent OPGD units have Receivers at the same end

One way to eliminate this problem is by separating the two sets by a minimum distance d. Assuming the Source is oriented so that the Receiver is barely aligned, the minimum separation is given by $d = 2r\tan\theta\cos\theta$ where r is the open path length and θ is the misalignment tolerance angle.

LINE OF SIGHT DISTANCE M (FT)	MINIMUM SEPARATION, M (FT)	LINE OF SIGHT DISTANCE M (FT)	MINIMUM SEPARATION, M (FT)
10 (33)	0.5 (2)	110 (361)	5.8 (19)
20 (66)	1.0 (3)	120 (394)	6.3 (21)
30 (98)	1.6 (5)	130 (427)	6.8 (22)
40 (131)	2.1 (7)	140 (459)	7.3 (24)
50 (164)	2.6 (9)	150 (492)	7.9 (26)
60 (197)	3.1 (10)	160 (525)	8.4 (27)
70 (230)	3.7 (12)	170 (558)	8.9 (29)
80 (262)	4.2 (14)	180 (591)	9.4 (31)
90 (295)	4.7 (15)	190 (623)	9.9 (33)
100 (328)	5.2 (17)	200 (656)	10.5 (34)

Table 4: Calculated minimum separation distance *d* of two adjacent OPGD units if both Receivers are at the same end

If there is no cabling or any other constraint, a better solution would be to mount both Receivers at opposite ends, as illustrated in the diagram below. This will completely avoid cross interference between two adjacent OPGD units.

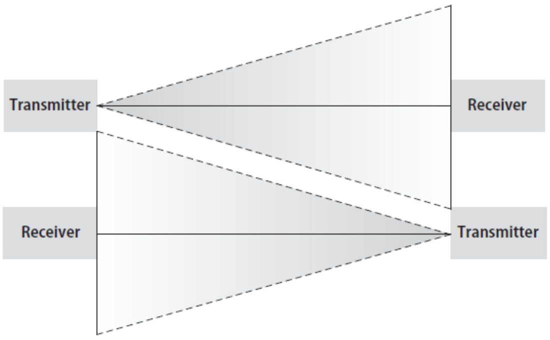

Figure 10: No IR interference when two adjacent OPGD units have Receivers at opposite ends

The second scenario where interference can happen is when two OPGD units are in a straight line, such as when two sets of OPGD are used to monitor a very long boundary line. When both Source units are facing the same direction, like in the top diagram of Figure 11, one Receiver unit may see IR radiation from both Sources. To prevent this from happening, the Source units of adjacent OPGD units should be positioned to face opposite directions, like in the lower two diagrams.

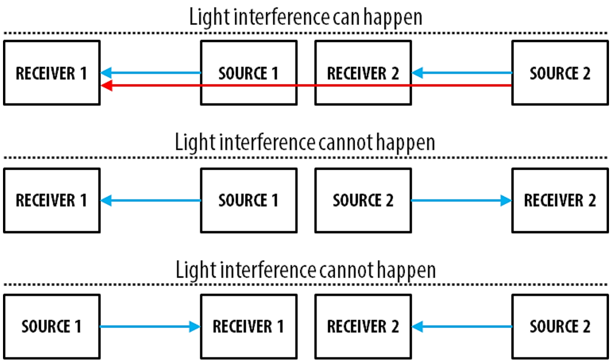

Figure 11: Avoiding IR interference when two OPGD units are positioned in a line

APPLYING OPEN PATH GAS DETECTORS

There are 3 common ways of applying OPGD:

1) Leak Points Monitoring

In this application, the OPGD IR beam is positioned over a line or cluster of potential leaks points, such as a row of compressors, pumps, valves, pipe joints, flanges or transfer hose nozzles.

Shown below is an example of OPGD monitoring (white dashed line) over a line of LPG offloading transfer nozzles on a FPSO. The OPGD is positioned to detect formations of propane gas cloud due to LPG spillage during offloading.

Figure 12: Leak point monitoring of offloading nozzles at a FPSO LPG offloading area

The second example below illustrates the use of OPGD to monitor a long line of valves at a LPG storage area.

Figure 13: Leak point monitoring of a row of valves at a LPG storage area

2) Boundary Line Monitoring

In this application, the OPGD IR beam is positioned to form a boundary line on one side of a zone where gas leaks could occur. Such monitoring is more common for heavier than air gases which spread close to ground.

Shown below is an example of OPGD monitoring at the boundary of a LPG storage area. The boundary line divides the storage area from a vehicle access road which is typically an unclassified zone. The OPGD is positioned at the boundary line to detect propane gas clouds that disperse from the tank area toward the unclassified zone.

Figure 14: OPGD monitoring at boundary of LPG storage tank farm

Unlike in leak points monitoring, in boundary line monitoring the OPGD IR beam is typically positioned at a distance away from the potential leak points. Because of natural diffusion and dilution by wind, the concentration of the dispersing propane gas cloud will decrease as it spreads out and away from the leak Source. Under light breeze conditions (3 to 5 mph wind speed, Beaufort scale no. 2) the concentration of the gas cloud, particularly at the outer fringes of the cloud, is likely to be low in concentration and immeasurable by less sensitive OPGD instruments that measure only in the LEL.m scale.

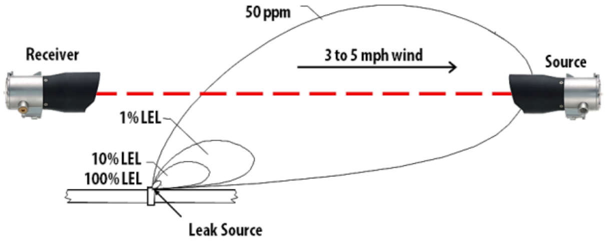

Figure 15: Decreasing gas cloud concentration under light breeze condition

A low concentration at the cloud fringes does not mean that the gas release is less dangerous. Closer to the leak source the gas cloud will be higher in concentration. And the size of this higher concentration gas cloud will grow over time if the leak rate is significant enough and sustained. For instance, gas releases at leak rates between 0.1 - 1.0kg/s over durations of 2 to 5 minutes can produce flammable gas clouds with a volume of 10 to 3000 m^3. Such gas releases are considered significant and dangerous to life and property.

HSE UK classifies a significant gas release to be a release with *"Potential to cause serious injury or fatality to personnel within the local area and to escalate within that local areas e.g. by causing structural damage, secondary leaks or damage to systems"*.

Classification	Either…	…Or	And	Gas Cloud Volume (m^3)
	Quantity Released (kg)	Mass Flow Rate (kg/s)	Duration (min)	
Minor	< 1 kg	< 0.1 kg/s	< 2 min	< 10
Significant	1 - 300	0.1 – 1.0 kg/s	2 – 5 min	10 – 3,000
Major	> 300 kg	> 1.0 kg/s	> 5 min	> 3,000

Table 5: Classification of gas releases (HSE UK)

The OPIR5/IR5500 measures propane gas concentrations on two scales, a high sensitivity 0-2000ppm.m measurement and a standard 0-1LEL.m measurement. On boundary line monitoring applications, the higher sensitivity measurement increases the likelihood of detecting distant gas releases and when it does it helps to provide an earlier warning of gas releases. These are major advantages that will help reduce gas explosion risks.

3) Volumetric Monitoring

The overall dimensions of a flammable vapour cloud before ignition directly affects the final flame speed and consequent overpressures of the vapour cloud explosion. Experiments show that a 6m long methane or propane gas cloud within an unconfined or partially confined space, that is ignited by a point source will not produce flame front speeds of greater than 100m/s or 125m/s respectively. At these flame front speeds, the overpressures that result from the gas explosion will be less than 150mbar, and deemed unlikely to cause major structural damages. Where there is greater confinement or constriction, higher flame speeds (>125m/s) could occur within 6m, and this could result in higher explosion pressures.

The aim of volumetric monitoring approach is to ensure that no gas cloud that is larger than 4-5 meters remains undetected. There is no fixed grid pattern. The layout of the monitoring grid will depend on equipment layout, structures, seasonal wind directions and type of release.

Both point gas detectors and OPGD can be applied effectively for volumetric monitoring. But the OPGD offers the advantage of larger area (or volume) coverage with a single unit hence it can be more cost effective for volumetric monitoring of a large space.

Shown below is an example where several units of OPGD are positioned adjacent to one another to form a grid of parallel IR detection beams to detect propane gas releases on the topside of a LPG FPSO. OPGD units are spaced 5 meters apart and are mounted such that the IR detection beams are at a height of 0.5 to 1.0 meters above ground. The near ground mounting height is because the target gas is heavier than air and will eventually sink. OPGD IR beams are oriented crosswise to the seasonal wind directions to maximise the likelihood of the propane gas cloud cutting across an IR beam. This design example will achieve a very high likelihood of detecting propane gas releases within the monitored space before the gas cloud size exceeds 5 meters.

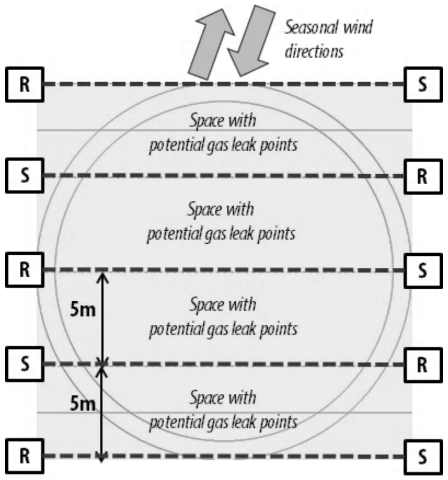

Figure 16: Plan view of an OPGD grid

Volumetric monitoring is commonly considered for process spaces where there are multiple potential leak sources and having one point gas sensor at each potential leak source is impractical.

Commonly, especially on offshore facilities, such process spaces are congested. Due to greater accelerations of flame fronts within congested spaces, gas clouds smaller than 6 meters within these spaces when ignited can produce explosion pressures that cause significant damage and other life threatening consequences.

The ability to respond faster to gas releases in congested spaces is therefore crucial. The OPIR5/IR5500 offers the benefits of early detection with its high sensitivity to gas concentrations at the ppm levels. This feature allows it to alarm gas releases a lot faster than OPGD that monitor only at LEL levels.

USING GAS MAPPING TO POSITION OPGD

Surrounding clusters of potential leak points with many units of OPGD to ensure a high degree of volumetric coverage can be very costly. A more practical and cost effective approach would be to position OPGD in volumetric spaces where there is a greater likelihood of gas clouds accumulating or passing through.

Gas mapping is an approach used to predict (best guess) the behaviour of a gas release and its subsequent dispersion through a space. Once these are understood, the task of positioning the optimal number of OPGD units for the greatest likelihood of detecting gas releases becomes much easier.

A gas mapping exercise is normally followed by a computation of risk reduction. Risk reduction is computed from the likelihood estimates of undetected gas hazards in the space, before and after placements of gas detectors. This is a discussion topic that will be covered in another application note.

To perform gas mapping for an area, the following are the key data needed:

- List of equipment that are potential leak source
- Equipment failure rates (likelihood/year)
- Rate of release (kilogram/second)
- Estimated release duration (seconds)
- Size of threat zone (meters)
- Atmospheric data (seasonal wind speed, wind directions etc.)
- Seasonal wind directions
- Gas detector specifications and characteristics

Using these data, gas dispersion models of all possible gas release scenarios are computed. The computation can be complex and laborious, particularly when there are many potential leak sources in the space of study, consequently more dispersion scenarios. A software tool like KENEXIS's Effigy Fire & Gas 3D mapping software is needed to compute these complex dispersion models. The Effigy software models each scenario individually. It then layers all individual scenario models on top of each other to create a composite model of gas release hazard.

Figure 17 is an example of a composite gas release hazard model of a deck on an LPG FPSO with no gas detectors in use. Potential leak sources are the seven transfer pumps (grey rectangles). The various colours represent the areas with different likelihoods (frequency/year) of undetected gas hazard.

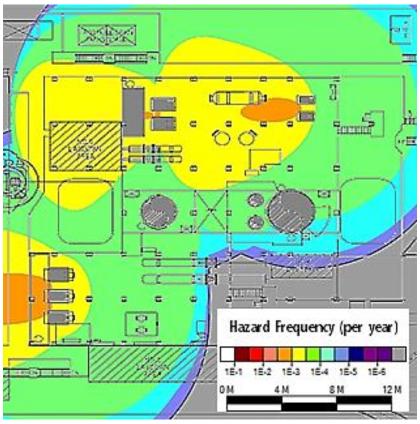

Figure 17: Composite model of gas release hazard without gas detectors

Yellow and Green for instance represent areas where the likelihood of an undetected gas release hazard is higher than 1 x 10^{-4} per year. Grey represents the areas where the likelihood of an undetected gas release hazard is less than 1 x 10^{-6} per year. This is the desired ideal.

Figure 18 is the composite model of gas release hazard when four units of point gas detectors are positioned. The situation has improved marginally since YELLOW zones are almost eliminated. But the likelihood of an undetected gas hazard for a large portion of the deck remains higher than 1 x 10^{-4}.

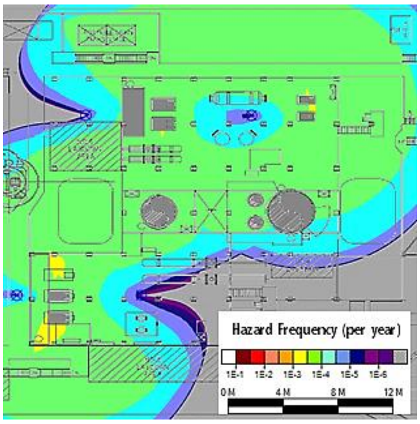

Figure 18: Composite model of gas release hazard before OPGD are added

Figure 19 is the composite model of gas release hazard when three units of OPGD (dashed white lines) were added to the four point detectors. The model shows that the positioning of the three OPGD have significantly reduced the areas where undetected gas hazard is higher than 1 x 10^{-4}. The likelihood of an undetected gas hazard for a large portion of the deck is now less than 1 x 10^{-6}.

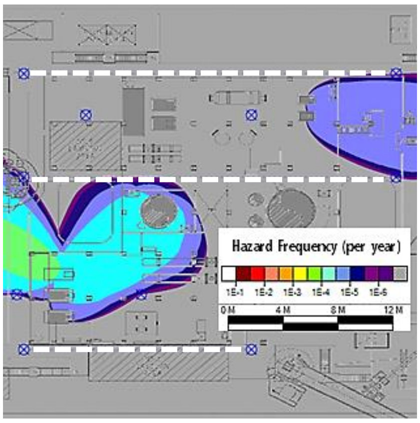

Figure 19: Composite model of gas release hazard after OPGD are added

CALIBRATING & TESTING

The OPIR5/IR5500 does not require periodical field calibration. The filters that are used for active and reference IR wavelength selection do not degrade with time so the detector will remain accurate throughout its operational lifespan. To change the detector calibration from methane to propane or vice-versa would require the unit to be returned to the factory.

The OPIR5/IR5500 uses a single beam, dual wavelength, single IR detector method of IR absorption detection. This minimizes zero drift compared with designs that use more than one IR detector in the Receiver. Zeroing adjustments are performed automatically by the detector electronics when the alignment process in completed and the AJ reading is accepted. No special tools are needed.

To test the response of the detector, test filter kits P/N329083-1 (methane) and P/N 329084-1 (propane) are used. Each part number contains one ppm.m filter and one LEL.m filter.

FOR MORE INFORMATION

Please visit our website at: http://www.msasafety.com/detection

CONFIGURING & SELECTING OPTIONS

	A	B	C	D	E	F	G	H	I	J
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
OPIR5 (IR5500)	- 1	- 1	- 1	- 1	- 1	- 2	- 1	- 1	- 1	- 1

A. ALARM-RELAYS:

0-☐	RELAYS INHIBITED
1-☐(Std)	W/ALARM RELAYS ALL DE-ENERGIZED
2-☐	W/ALARM RELAYS ALL ENERGIZED

B. ALARM-RELAY-STATES:

1-☐(Std)	LATCH HIGH, NON-LATCH LOW, NON-LATCH ppm HIGH
2-☐	LATCH HIGH, NON-LATCH LOW, LATCH ppm HIGH
3-☐	LATCH HIGH, LATCH LOW, NON-LATCH ppm HIGH
4-☐	LATCH HIGH, LATCH LOW, LATCH ppm HIGH
5-☐	NON-LATCH HIGH, NON-LATCH LOW, NON-LATCH ppm HIGH
6-☐	NON-LATCH HIGH, NON-LATCH LOW, LATCH ppm HIGH
7-☐	NON-LATCH HIGH, LATCH LOW, NON-LATCH ppm HIGH
8-☐	NON-LATCH HIGH, LATCH LOW, LATCH ppm HIGH

C. ID NUMBER OPTION:

1-☐(Std)	ID=1
2-☐	CUSTOMER TO SPECIFY ID#

D. MOUNTING ASSEMBLY:

0-☐	NO MOUNTING ASSEMBLY
1-☐(Std)	ARM ASSEMBLY
2-☐	BASE ASSEMBLY
4-☐	BASIC ARM ASSEMBLY

E. OUTPUT:

1-☐(Std)	DUAL 0-20mA/DUAL MODBUS
2-☐	DUAL 0-20mA/1.25mA HART/MODBUS
3-☐	DUAL 0-20mA/3.5mA HART/MODBUS
4-☐	SPLIT RANGE 0-20mA/DUAL MODBUS
5-☐	SPLIT RANGE 0-20mA/1.25mA HART/MODBUS
6-☐	SPLIT RANGE 0-20mA/3.5mA HART/MODBUS

F. RANGE:

1-☐	5-30 METERS
2-☐(Std)	20-100 METERS
3-☐	80-150 METERS (ALIGNMENT SCOPE MAY BE REQUIRED)

G. IR-SOURCE/THREAD TYPE:

0-☐	NO SOURCE
1-☐ (Std)	3/4in NPT
2-☐	25mm
3-☐	3/4in NPT W/VISIBLE LIGHT FILTER
4-☐	25mm W/VISIBLE LIGHT FILTER

H. IR-RECEIVER/GAS TYPE/THREAD TYPE:

0-☐	NO RECEIVER
1-☐ (Std)	METHANE 3/4in NPT
2-☐	METHANE 25mm
4-☐	PROPANE 3/4in NPT
5-☐	PROPANE 25mm

I. CONNECTOR TYPE

1-☐ (Std)	PUSH-TYPE TERMINAL
2-☐	SCREW TERMINAL

J. APPROVALS:

1-☐ (Std)	FM/CSA/ATEX/IEC Ex
4-☐	NO PERFORMANCE APPROVALS
5-☐	CSA/IECEx, WHEN OPTION G3-G4-USED

OPIR5/IR5500 OPEN PATH DETECTOR ACCESSORIES

329083-1	METHANE FILTER KIT IR5500
329084-1	PROPANE FILTER KIT IR5500
954-021	ALLEN WRENCH T HANDLE 5mm X 9in BALL END
329118-1	LAMP REPLACEMENT KIT IR5500
31037-1	DOUBLE CALIBRATION MAGNET (FOR OPEN PATH)
329082-1	LONG RANGE ALIGNMENT KIT IR5500
329073-1	PAN-TILT ARM ASSEMBLY IR5500
329113-1	ATTENUATOR IR5500 (provided as std w/5-30m range)
329097-1	VISIBLE LIGHT FILTER IR5500
329123-2	BASIC MOUNTING ARM ASSEMBLY
830-004	SS TAG - DIMENSIONS 60 mm X 10 mm(max. characters - 15/tag)

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