Fixed Gas & Flame Detectors

Open Path Gas Detection

Egypt, May 2023

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Agenda

- **Brief History of MSA**
- Additional Layers of Protection with
  - Open Path Gas Detectors – Laser based
  - Ultrasonic Gas Leak detectors

History

- MSA Safety – fixed gas & flame detection and a wide range of PPE
  - Established in 1914 near Pittsburgh, USA
  - Bought GM in 2010
  - Bought Senscient (UK) in 20176
  - Bought Sierra Monitors (USA) in 2019
  - Bought Bacharach (USA) 2021

Together, more than 300 years of experience!

The largest fixed gas and flame detector manufacturer in the world!

FGFD – Types of technology

Fixed Gas Detectors:

- Point Gas Detectors
  - Toxic & Combustible gas detectors
    - MOS, Electrochemical, Catalytic Bead, Infrared
- Open Path Gas Detectors (OPGD)
    - Infrared, Laser
- Ultrasonic Gas Detectors
  - Acoustic detection technology

FGFD – Types of technology

Self contained Gas Detection Systems:

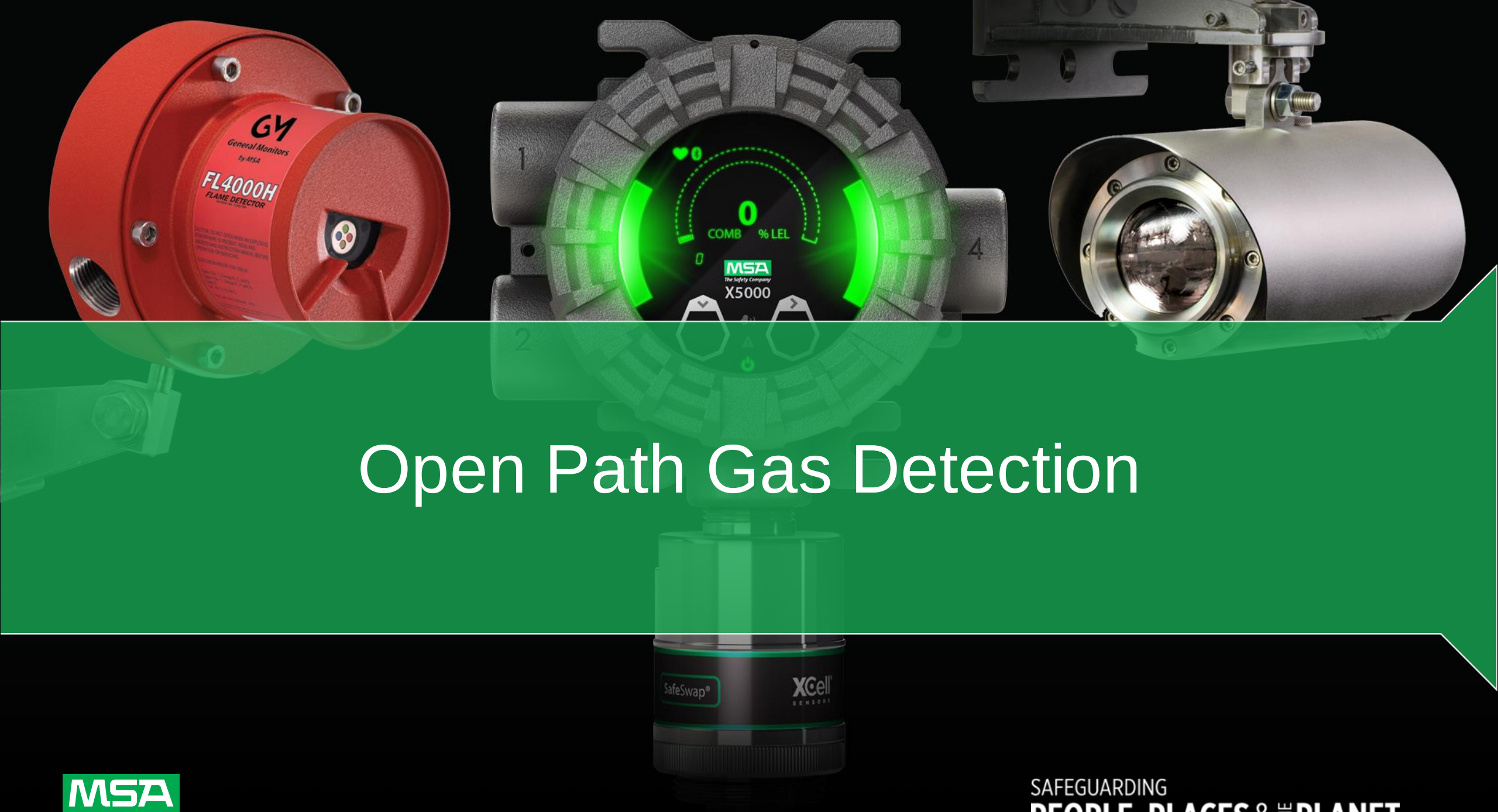
- Refrigerant gases and toxics/combustible
  - Photoacoustic Infrared, Standard sensor technology

Flame detectors:

- For hydrocarbon-based fuels and Hydrogen
  - UV/IR, UV/IR + H2, Multi IR

Controllers (Fire & Gas Panels)

Sample Systems



Open Path Gas Detection

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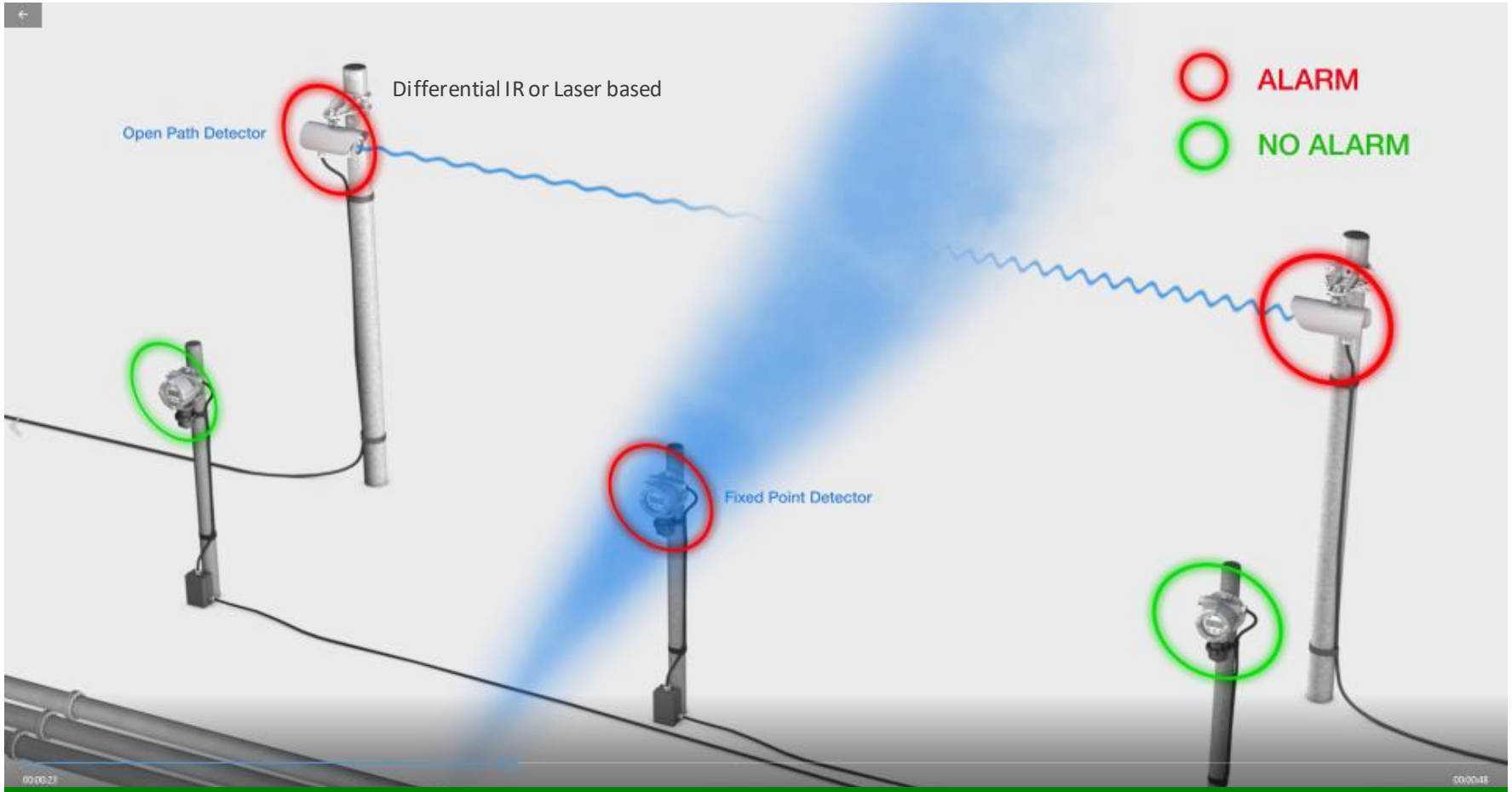
Agenda

- Additional layers of Protection with Open Path Gas Detectors (OPGD)
  - Why OPGD are required and their benefits
  - Basic difference between IR & Lased based OPGDs
  - Applications
  - Summary

Ideal Gas Detection Scenario for Fixed Gas Detectors vs OPGD

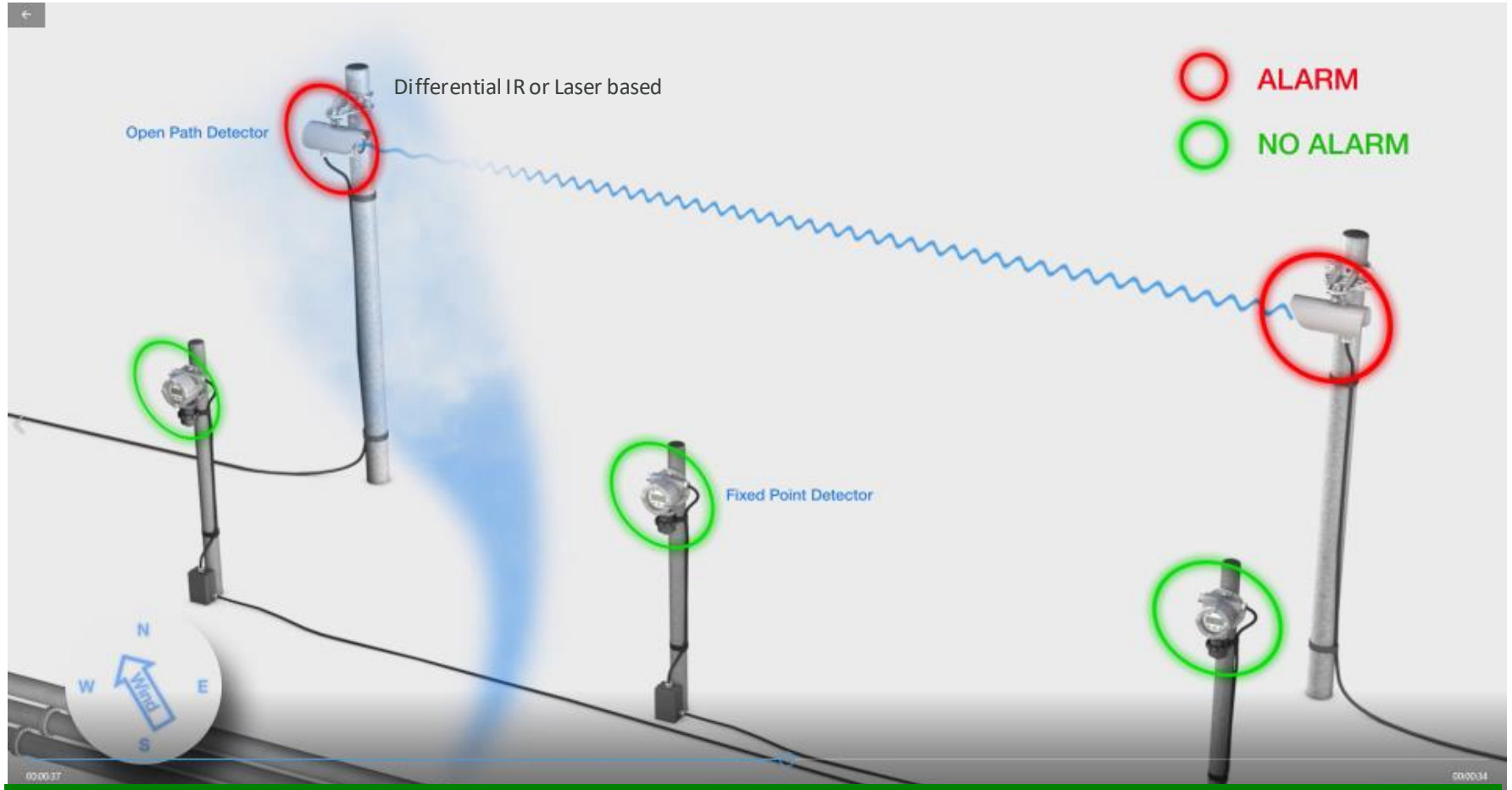
High Pressure Release- Running into the Post & gas leak detected



All devices detect gas release

High Pressure Release

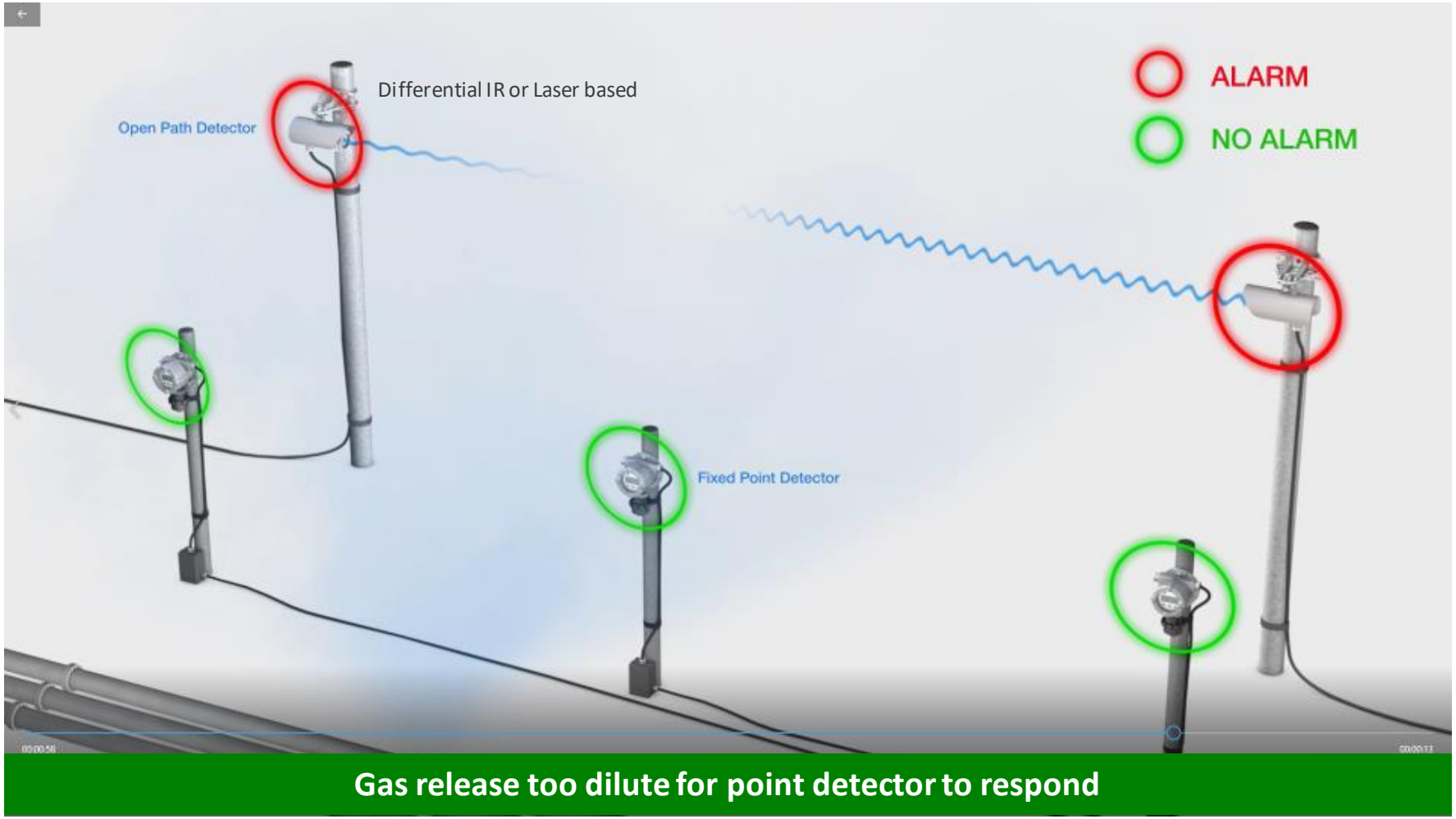
Changing Wind Direction- – Sneaking out between the Posts



Gas release fails to reach point detectors

Low Pressure Release

Rapid Dilution-



Gas release too dilute for point detector to respond

Why OPGD technologies got developed?

- Point Gas Detectors (PGD) can miss gas leaks, sometimes for minutes, sometimes for far longer. It is no longer recommended to only use PGD for high risk OGP applications.
- To increase the probability of detecting the gas leak in open area when only using PGD, the number of additional PGD required is unrealistic and calls for higher CAPEX and OPEX. So, OPGD not only reduces the nos. of PGDs but also increases the probability of detection.
- This also reduces the number of I/Os at the control System as well as the OPEX costs.
- PGDs are still required to give a better indication of the leak source and also the concentration of the gas cloud . OPGD were developed to compliment Point gas detectors and increase the probability of detecting the gas leak.
- Studies and post gas release investigations have found that many gas leaks go undetected.

Findings of the HSE report RR1123

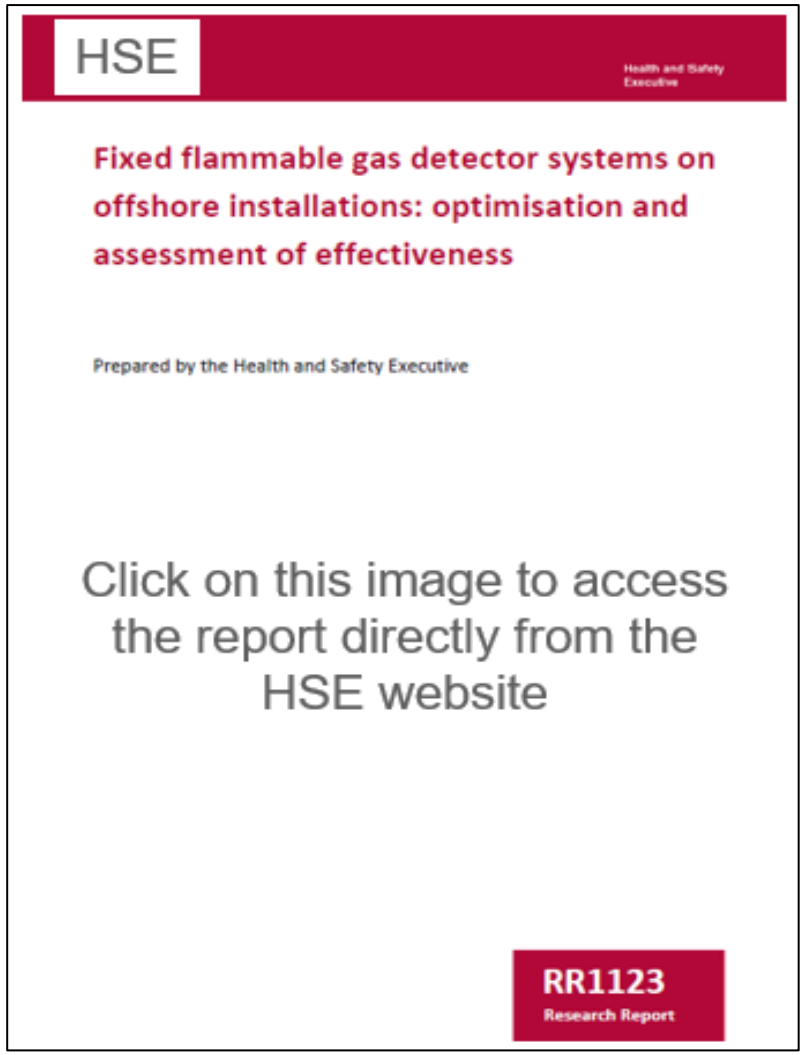
This 2017 report by the HSE states:-

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



Effectiveness and suitability of 3 types of gas detectors

Stages of release and detection approach		Suitability of detector		
		UGLD	OPGD	POINT GD
Incipient	Detect releases before the formation of gas plumes	✓ ✓		
Dispersing	Detect dispersing gas plumes along dispersion paths		✓ ✓	✓
Accumulating	Detect gas in accumulation zones		✓	✓ ✓

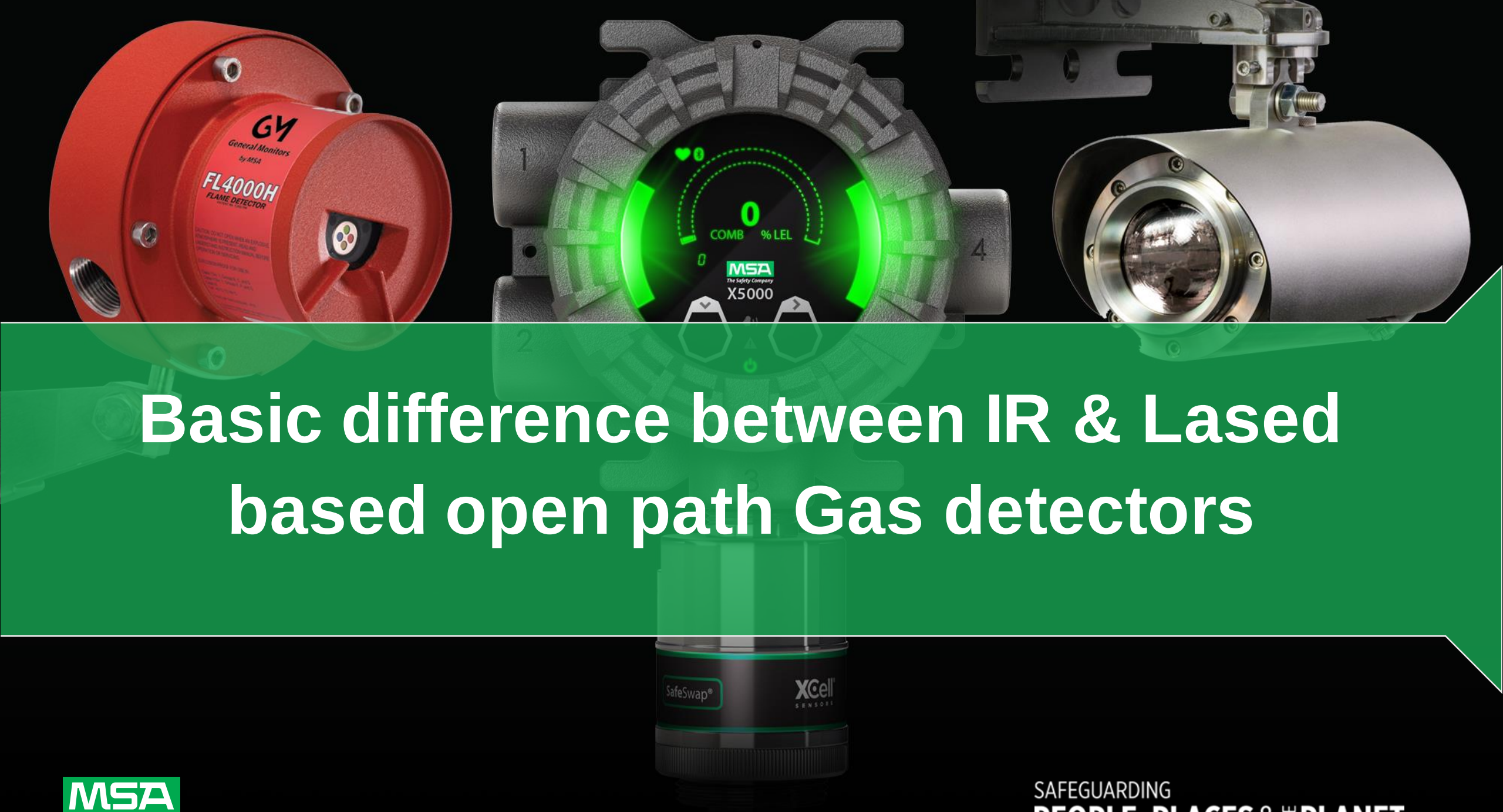
No single perfect solution !

Open Path the preferred choice for open areas …

For high pressure gas systems / applications, UGLD devices increase the detection probability even higher.



The optimum solution!



Basic difference between IR & Lased based open path Gas detectors

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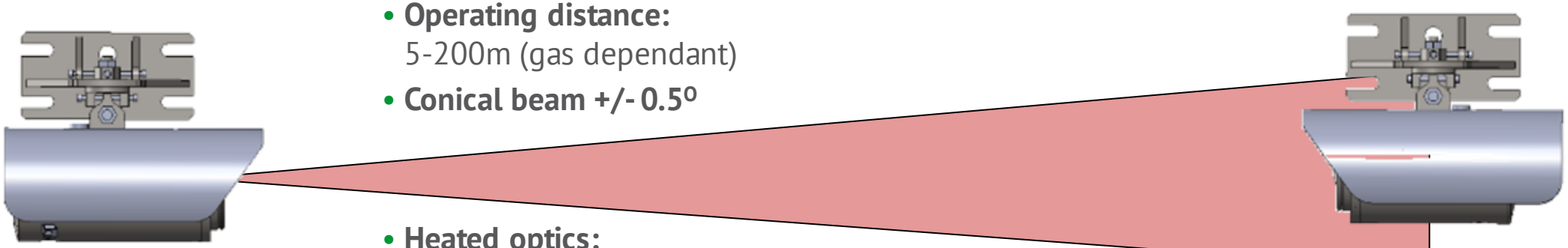
Typical OPGD System Architecture

- **Hazardous area approved:**
  ATEX, IECEx, FM/CSA/UL + Others
- **Construction:**
  316 Stainless steel, IP 66/67
- **Operating distance:**
  5-200m (gas dependant)
- **Conical beam +/- 0.5º**



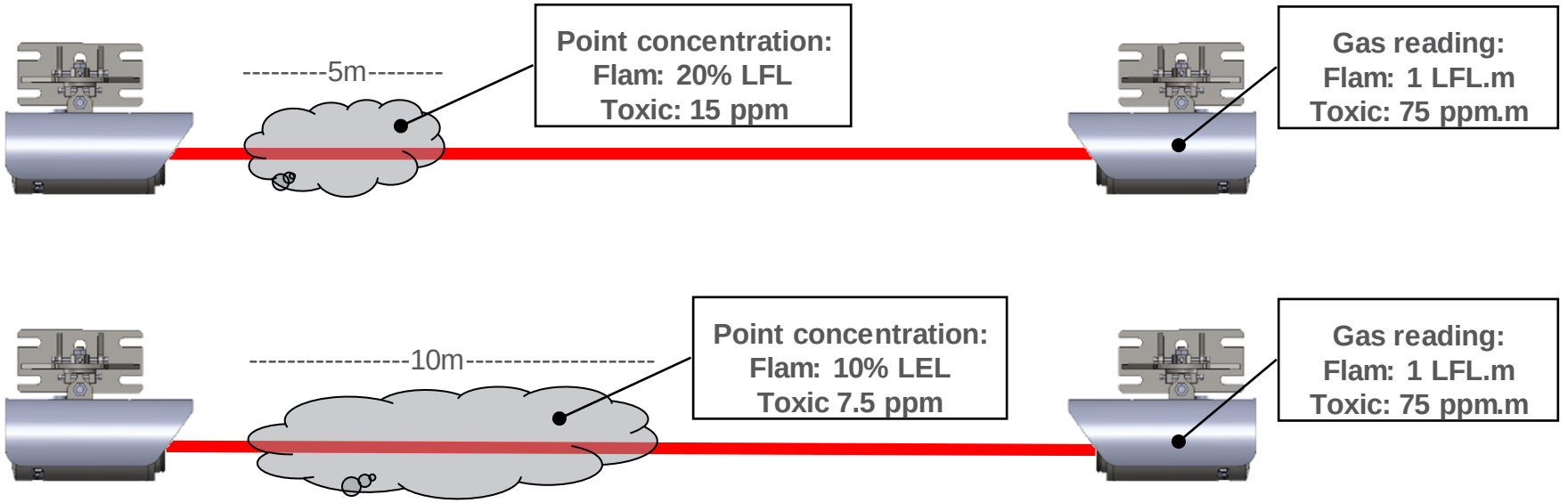
Transmitter

Receiver

- **Heated optics:**
  Tx & Rx
- **Units of measure:**
  ppm.m & LEL.m (gas dependant)
- **Mounting:**
  Pole/surface bracket with alignment screws
- **Electrical:**
  24V DC operation of Tx & Rx
  (no interconnecting communication cable)
- **Outputs:**
  4-20mA (Low signal, Beam block & Fault) + HART. Relays: IR5500 only

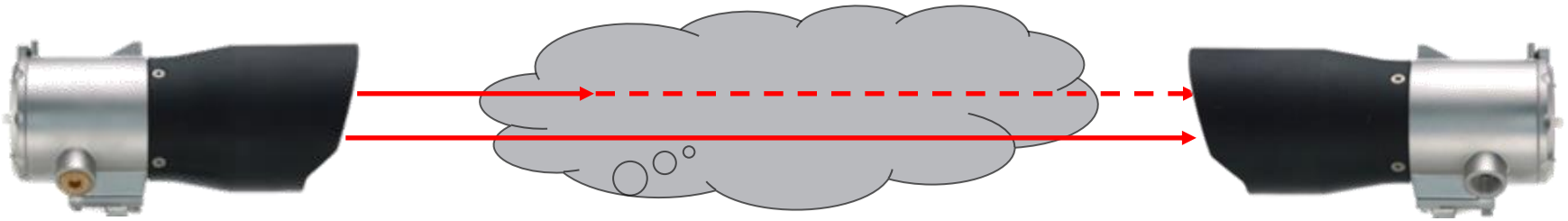
Differential IR
or
Laser based

Units of Measure: LFL.m & ppm.m



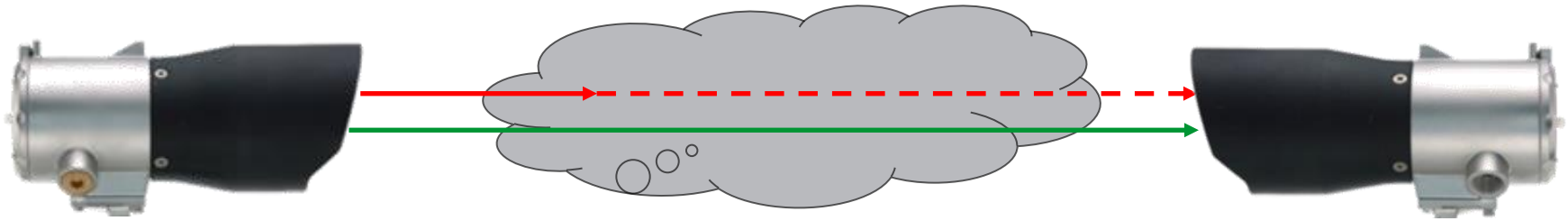
- OPGD gas readings: point concentration x distance.
- OPGD able to detect:
  - Small / High concentration and Large / Low concentration clouds.
- Benefits over point detection:
  - Detects Large / Low concentration clouds
  - Greater area of coverage
  - Reduced quantity of field devices and lower maintenance costs.

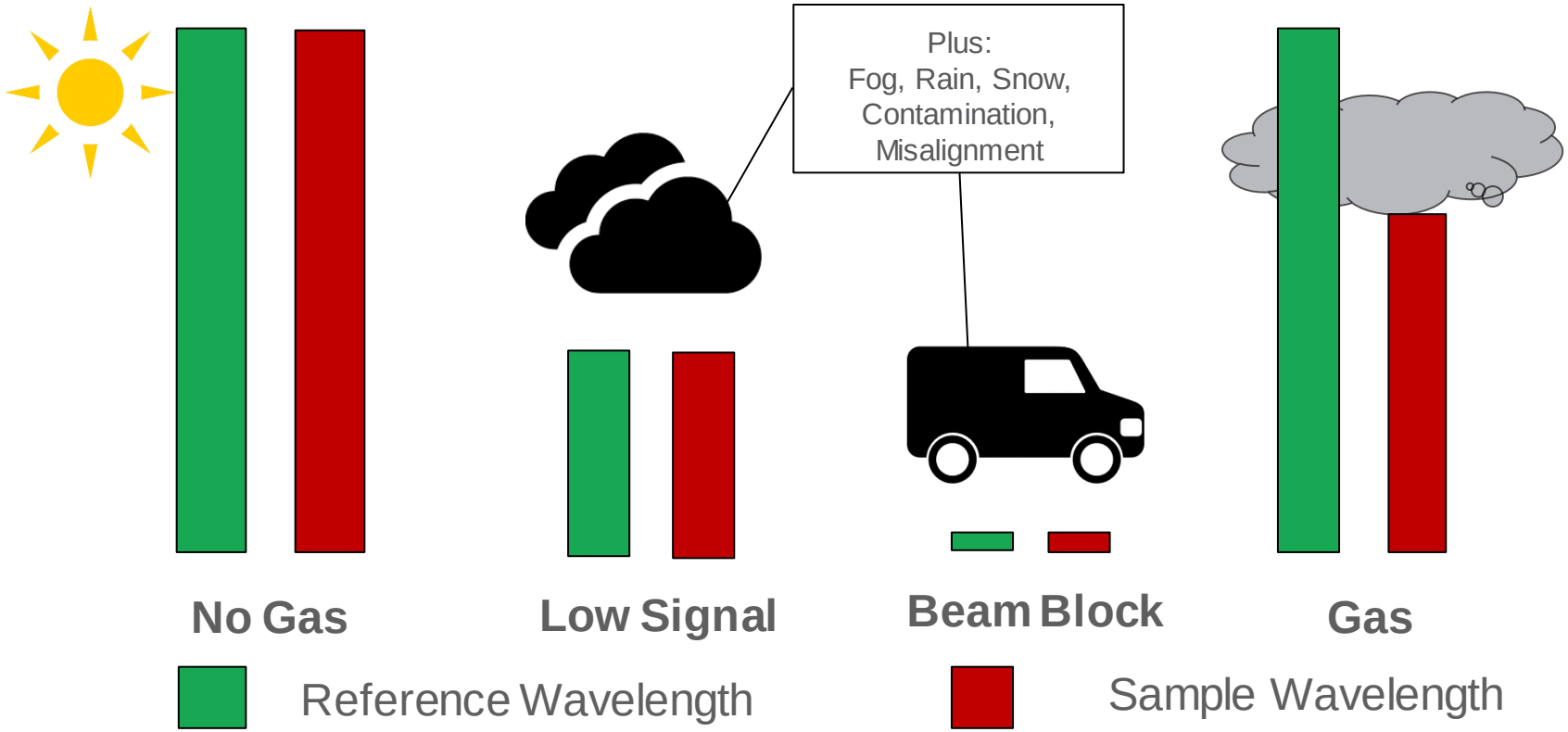
Principle of Detection: Differential IR



- Hydrocarbons absorb specific wavelengths of IR radiation
- Two wavelengths are used: Sample & reference
- Signal ratio of wavelengths is proportional to gas concentration
- Gas reading = Concentration x distance
- Concentration values: ppm.m or LFL.m

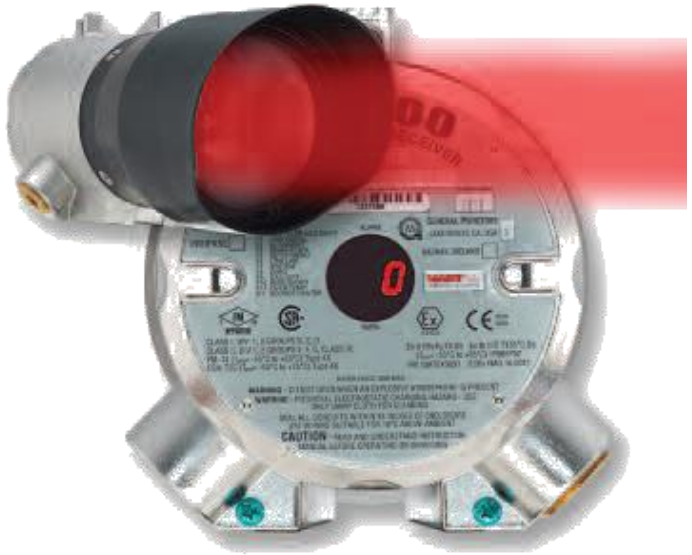
Principle of Detection: Differential IR





IR5500 Key / Differentiating Features

- Dual measuring range (ppm.m & LEL.m)
  - Methane range: 0-5,000 ppm.m & 0-5 LEL.m
  - Propane range: 0-2,000 ppm.m & 0-1 LEL.m
- Outputs
  - 2 x Analogue outputs + HART & Modbus
  - Optional split range single mA output
  - Integral gas concentration display
  - 4x 8A SPDT relays
- Temp Range
  - -55°C to +65°C
- Approvals
  - SIL3 certified
  - Performance (FM6325 / IEC 60079-24-4)



Limitation : Reduced availability in rain & fog
Routine manual testing

Senscient ELDS™
Laser Open Path Gas Detector

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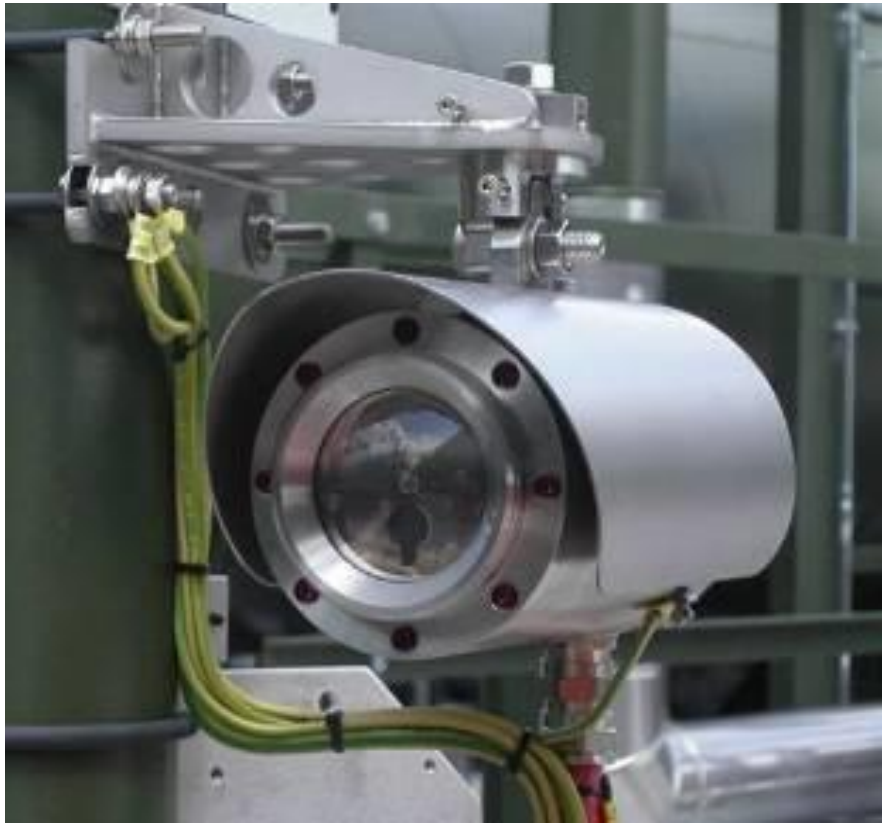
Open Path Gas Detectors – Laser

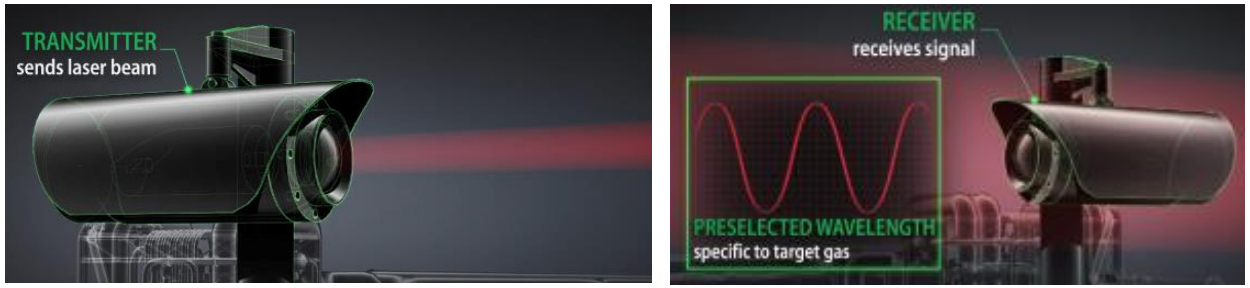
- **Senscient Laser OPGD**
  - Enhanced Laser Diode Spectroscopy (ELDS™)
  - Toxics: H_2S, HCl, NH_3, CO_2
  - Combustibles: Methane, Ethylene
  - Combination, dual gas: H_2S+CH_4
  - Measurement range in LEL.m and PPM.m
  - T-90 between 1 and 3 seconds – model / gas dependent
  - No calibration, no testing, no time in hazardous area
  - Target gas specific – no unwanted False alarms
  - Path length up to 200 metres, CH_4 & C_2H_4
  - Duct mount option for Methane (only)



How the Senscient ELDS Works

Harmonic Fingerprint

1. Laser beam traverses the open path from the Transmitter (Tx) to the Receiver (Rx)



2. The pre-selected wavelength is specific to a single target gas

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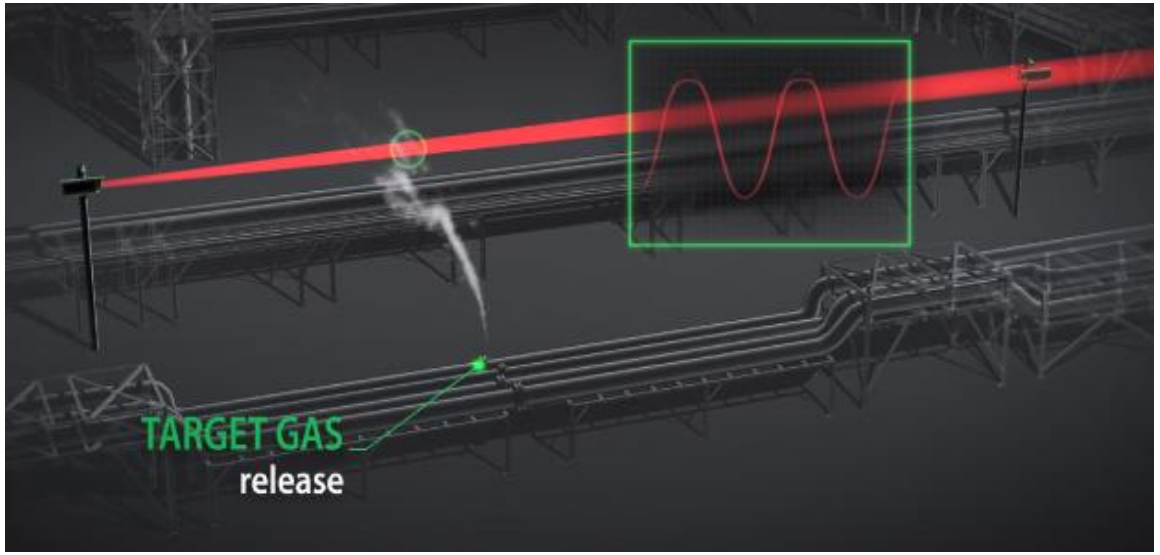
How the Senscient ELDS Works

Harmonic Fingerprint

3 Gas migrates into the laser beam



4 Wavelength is unaffected until the gas reaches the laser beam

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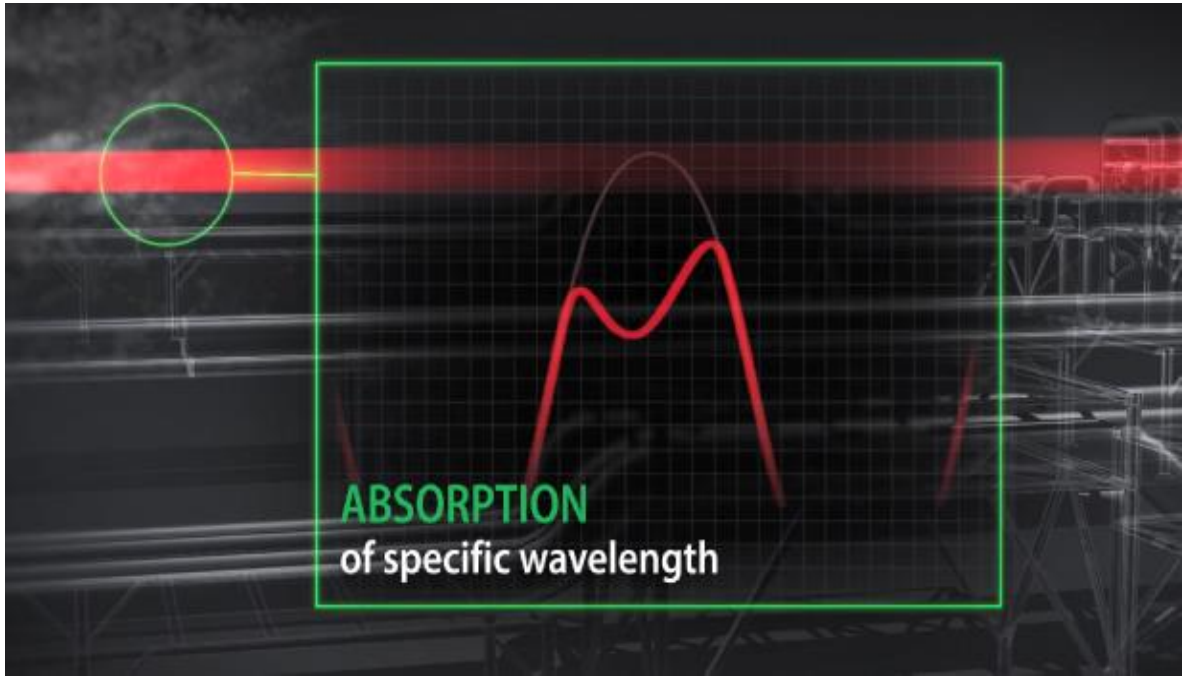
Harmonic Fingerprint

5 Absorption of specific wavelength by the target gas



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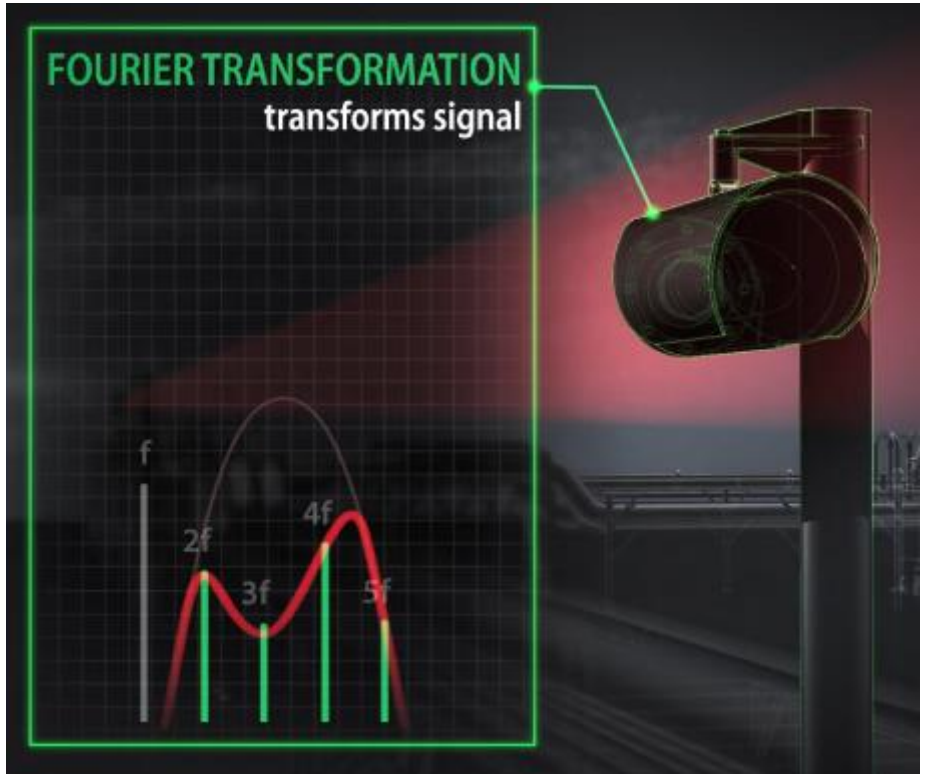
Harmonic Fingerprint

6 Fourier transform converts the absorption signal into four component harmonics (Harmonic Fingerprint)



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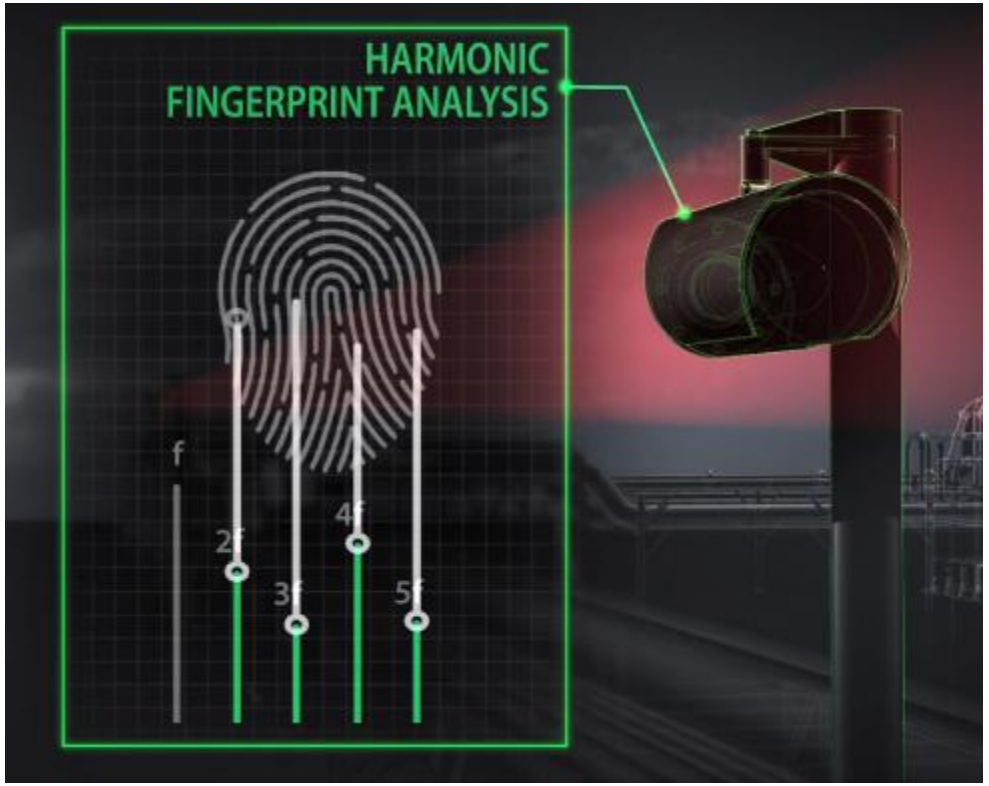
Harmonic Fingerprint

7

The Receiver fingerprint analysis compares signal fingerprint with a pre-programmed fingerprint



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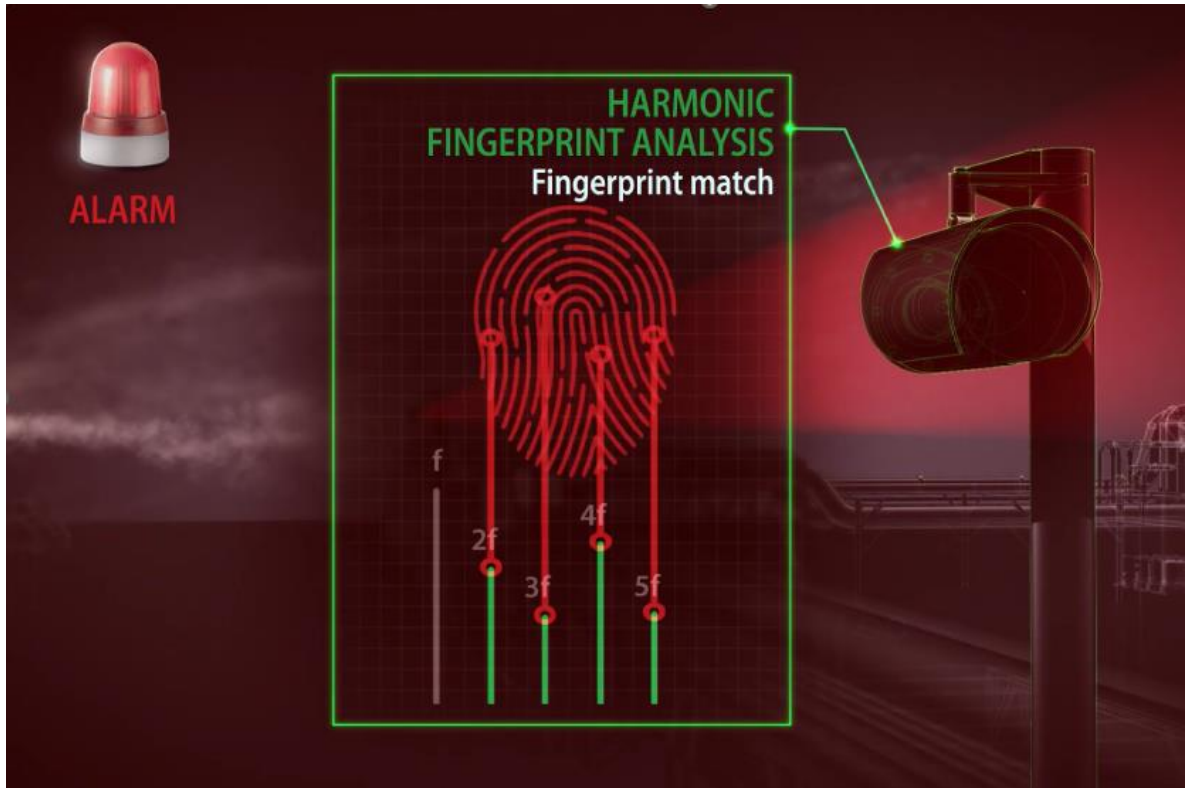
How the Senscient ELDS Works

Harmonic Fingerprint

8

If signal and pre-programmed fingerprints match, then an alarm output is initiated



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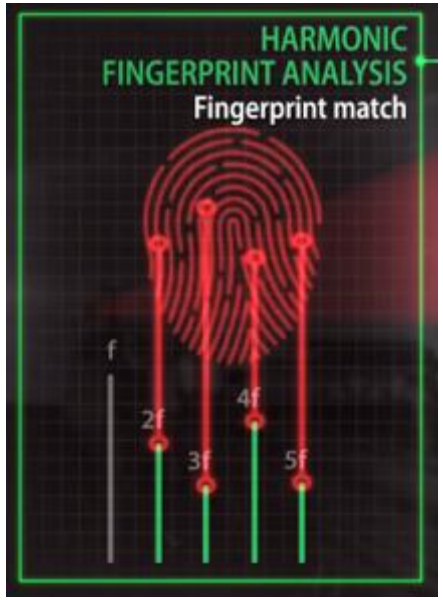
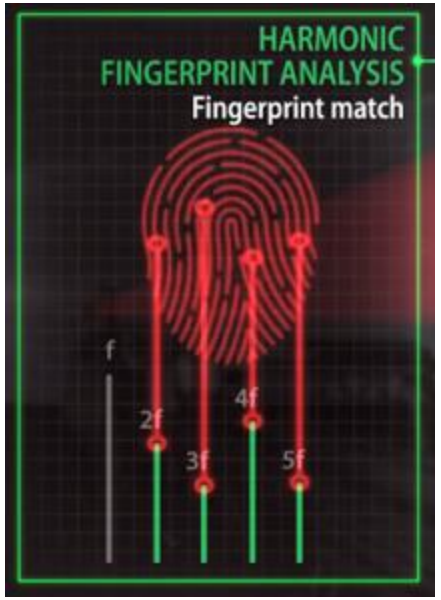
How the Senscient ELDS Works

Harmonic Fingerprint

9 The H_2S and Sour Gas ($H_2S + CH_4$) versions are based on the same principle but have 2 lasers. The lasers of the H_2S model are set to different wavelengths.





Requiring the harmonics on both wavelengths to match before an alarm output is initiated, increases reliability and reduces the probability of a false alarm.

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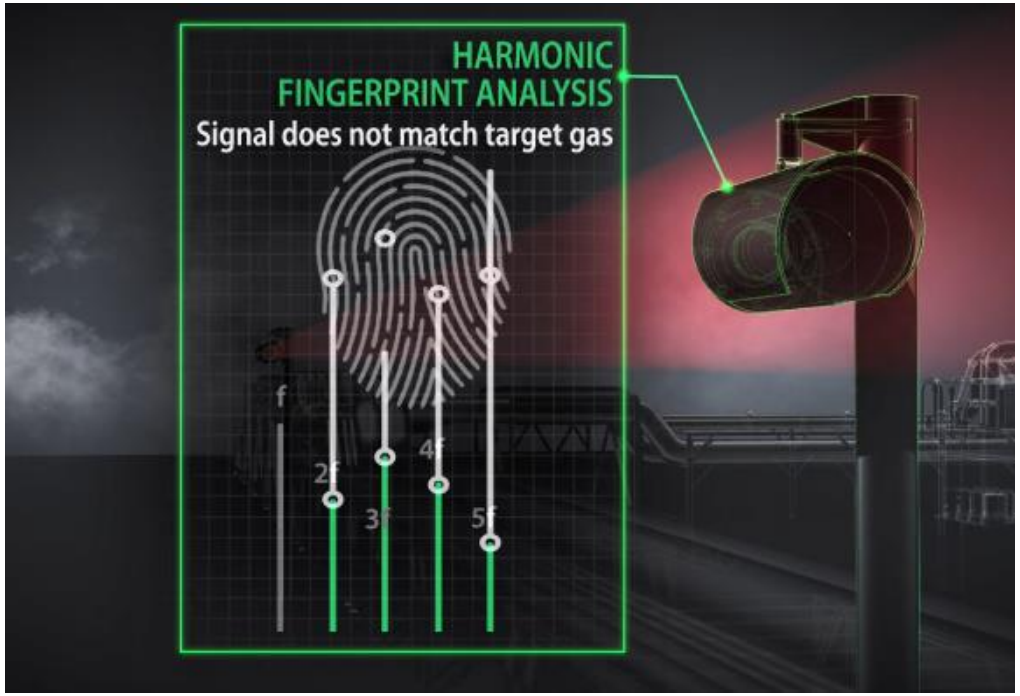
How the Senscient ELDS Works

Harmonic Fingerprint

10 Absorption signals resulting from interferent gases or adverse environmental conditions will have different harmonic fingerprints and are ignored



Being able to reject substances other than the single specific target gas means less false alarms, less unwanted shutdowns, and less loss of production

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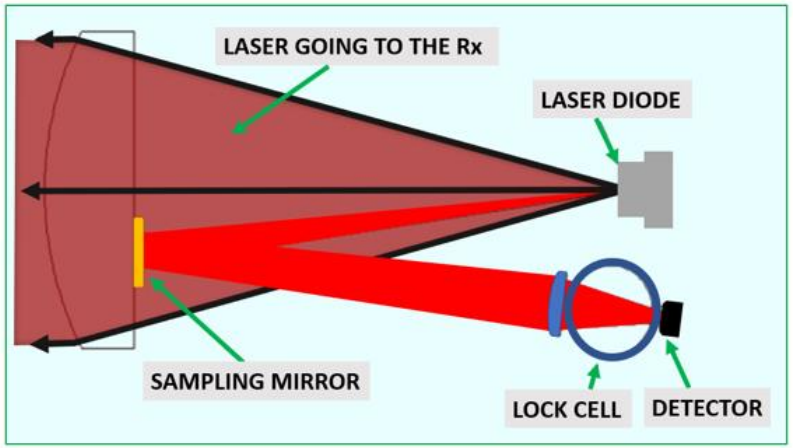
How the Senscient ELDS Works

Lock Cell

- Open Path Gas Detectors are factory calibrated requiring no field re-calibration
- All lasers naturally drift from their operating wavelength
- ELDS uses a target gas filled reference cell "Lock Cell" to ensure the laser remains locked on the detection wavelength
- The Lock Cell is part of a feed back control loop within each transmitter
- The control loop ensures the laser remains locked on its detection wavelength
- This technique removes the possibility of an unrevealed failure associated to laser systems that don't use the target gas as a locking reference

The Lock Cell for different gases

Diagram of Transmitter optical path



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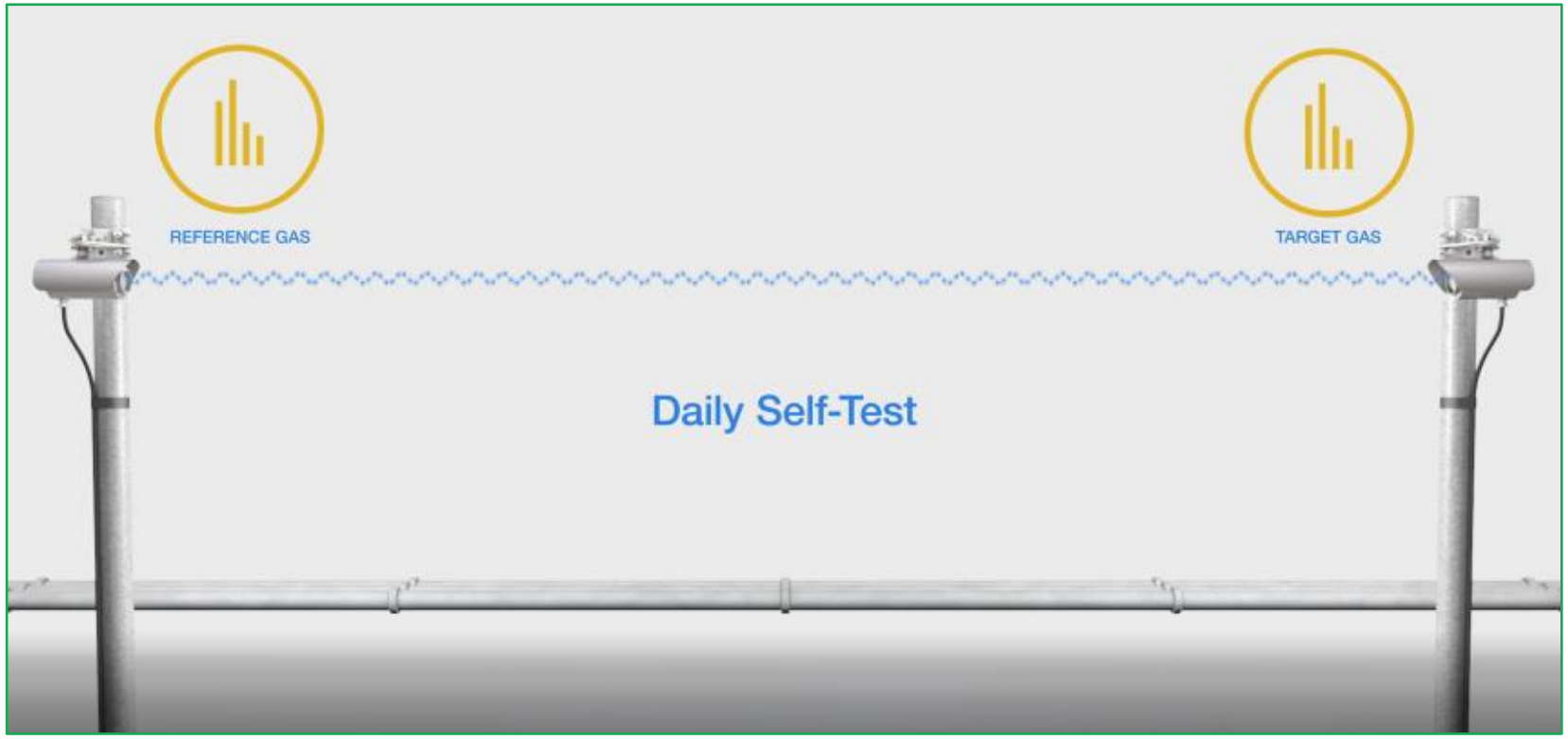
How the Senscient ELDS Works

SimuGas™

Routine functional testing of any gas detector is common practice

To avoid service engineers frequently going into the hazardous area, the ELDS performs an automatic end to end test - called SimuGas - every 24 hours



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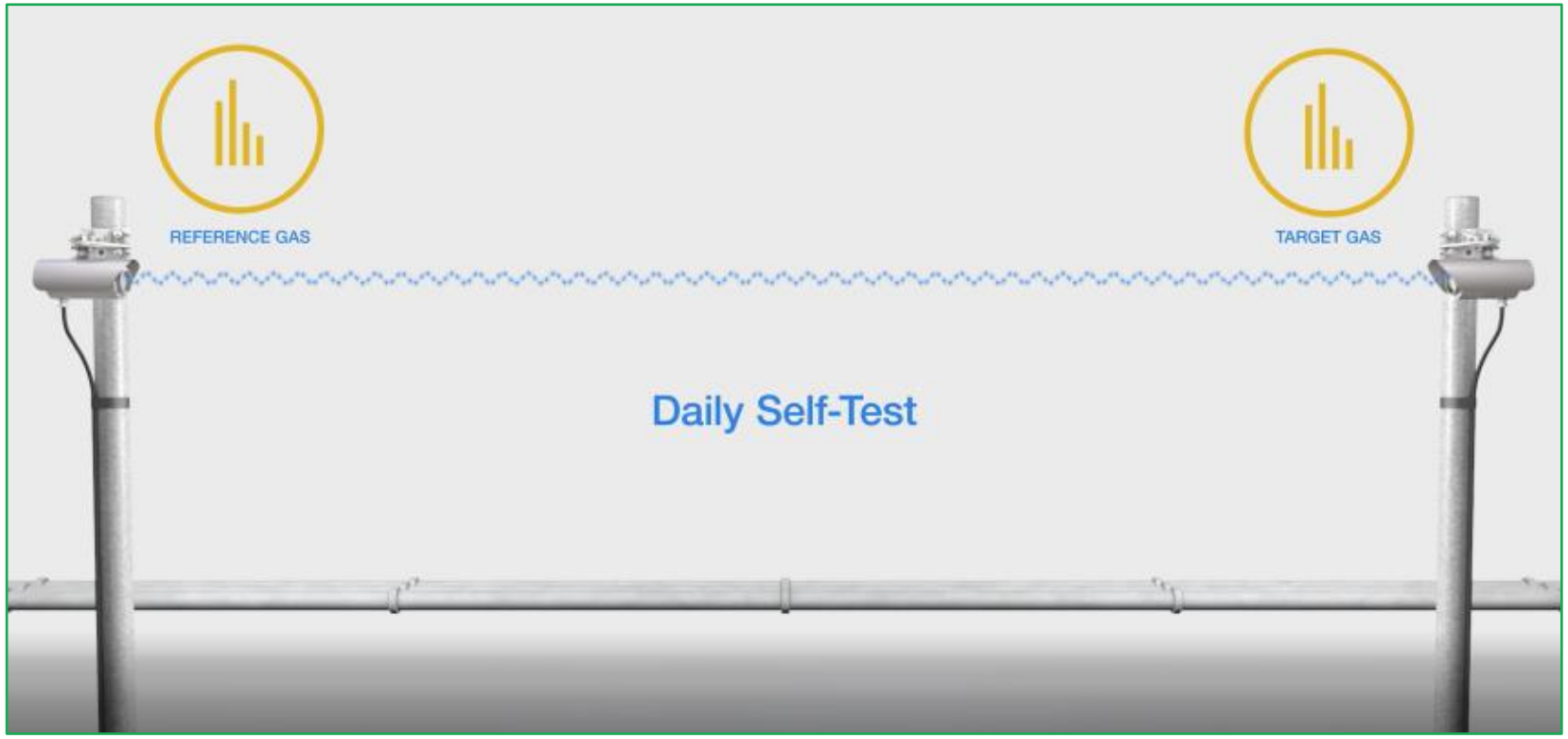
How the Senscient ELDS Works

SimuGas™

The ELDS self-test is called SimuGas and tests the system for 50 seconds

A signal is sent from the Tx to inform the Rx to expect what will appear to be the laser having been absorbed by the target gas

To avoid a gas alarm being initiated, the output is held during the test



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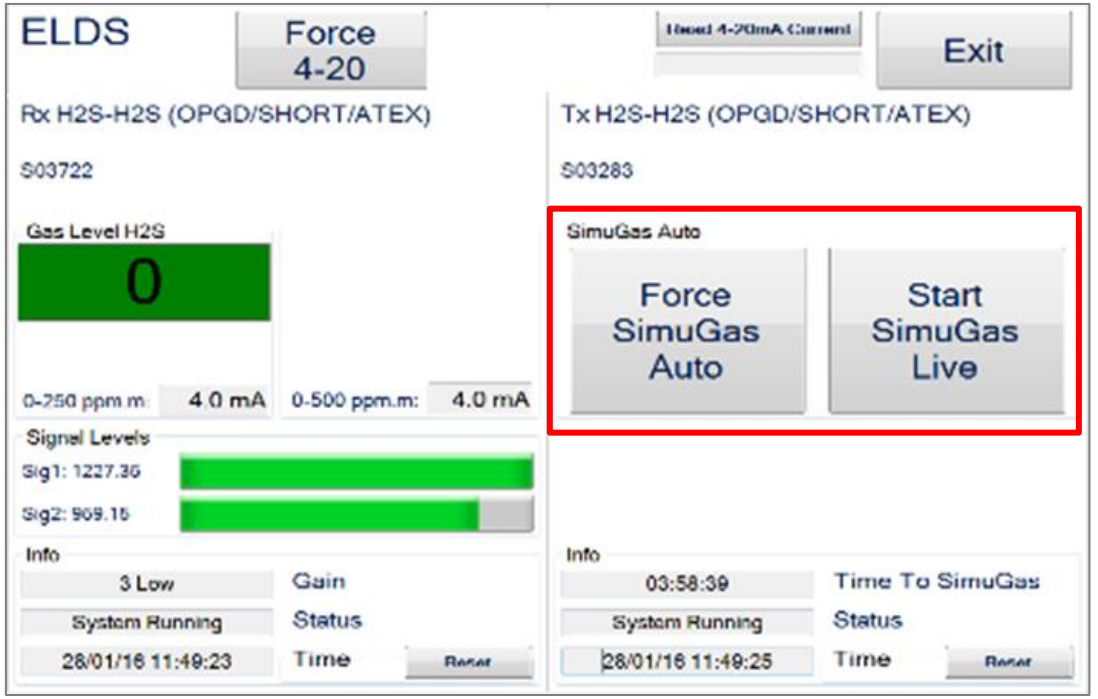
How the Senscient ELDS Works

SimuGas™ using Bluetooth

Testing can also be on demand using the Bluetooth Tablet

- SimuGas Auto – analog output held during the test
- SimuGas Live – full functional test with alarm signal initiated to the control system



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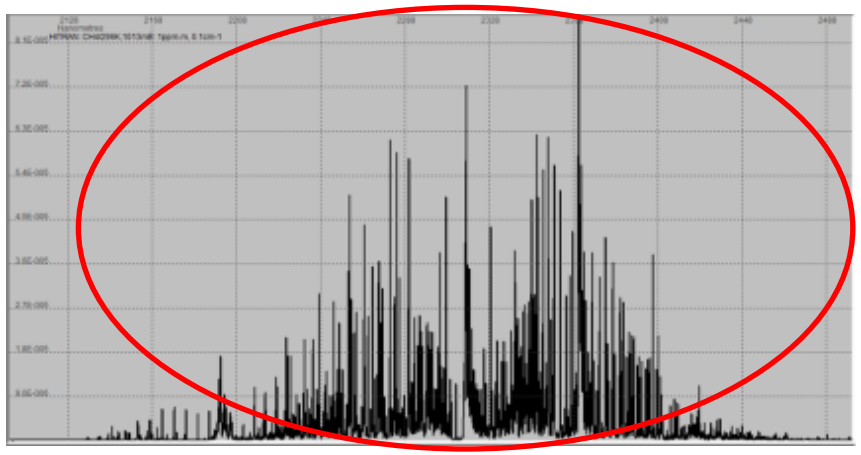
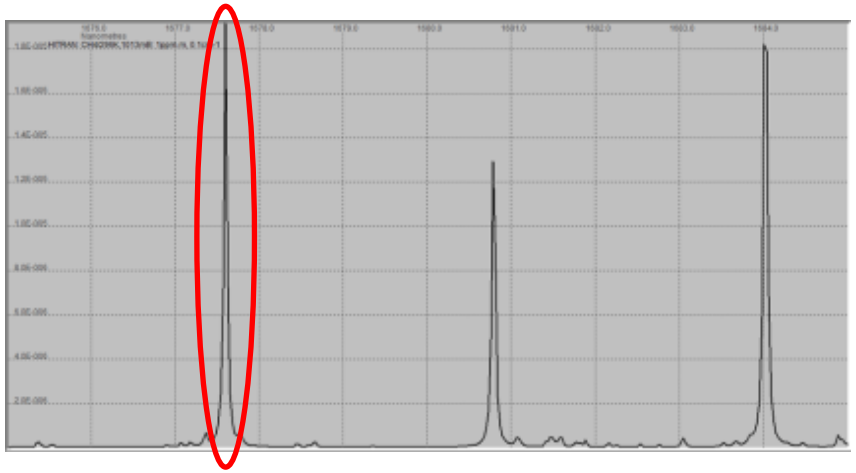
ELDS OPGD vs Differential IR OPGD – Gas Specific

Differential IR CH_4 absorption



- A traditional IR OPGD detects multiple hydrocarbon gases, over a wide absorption band width ~ 150 nm
- Best solution when multiple hydrocarbon gases need detecting in the same area
- Reduced availability in rain & fog

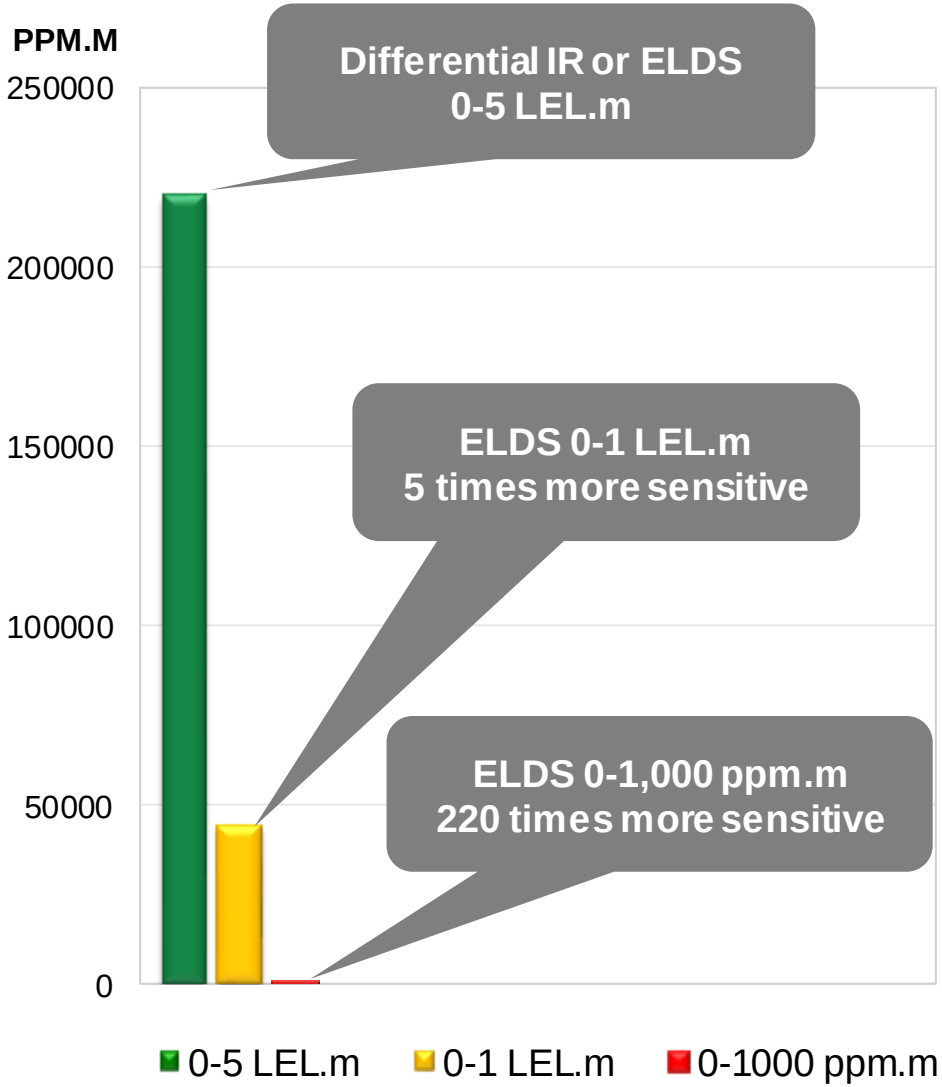
ELDS™ CH_4 absorption



- ELDS detects a single absorption line bandwidth ~ 0.1 nm (1,500 x better discrimination)
- No cross interference from other Hydrocarbon gases
- When Methane (or Ethylene) is the only gas risk, ELDS is the best solution
- Improved availability in rain & fog

ELDS: Best solution for single specific Hydrocarbon detection, when either Methane or Ethylene is the target gas

ELDS OPGD vs Differential IR OPGD – Sensitivity



- ELDS is up to 220 x more sensitive than IR OPGD
- Able to detect more diluted, lower concentration gas leaks
- Provides fastest response time and earlier alarms/plant shutdown
- Quicker Mitigation action = less gas released = lower risk of explosion

1% v/v = 10,000 ppm
CH_4 LEL = 4.4% v/v = 44,000 ppm
44,000 ppm = 1 LEL.m

ELDS OPGD vs Differential IR OPGD – Comparison

	Senscient ELDS	Differential IR
Gases	Methane specific or Ethylene specific	Detects various Hydrocarbons
Measuring ranges	0-1, 0-5* LEL.m 0-1,000*, 0-10,000** ppm.m	0-5 LEL.m
Speed of response	<3 seconds	<5 seconds
Fog resilience	Good	Poor
Routine testing	Daily auto test	3 month manual test

The ELDS benefits

- Target gas specific detection (CH_4 or C_2H_4)
- Ventilation inlets (2% LEL alarm capability)
- Faster shutdown (increased sensitivity)
- Improved uptime in fog (Lowest H_2O absorption)
- Lower cost of ownership

** Methane specific, ** Ethylene specific*

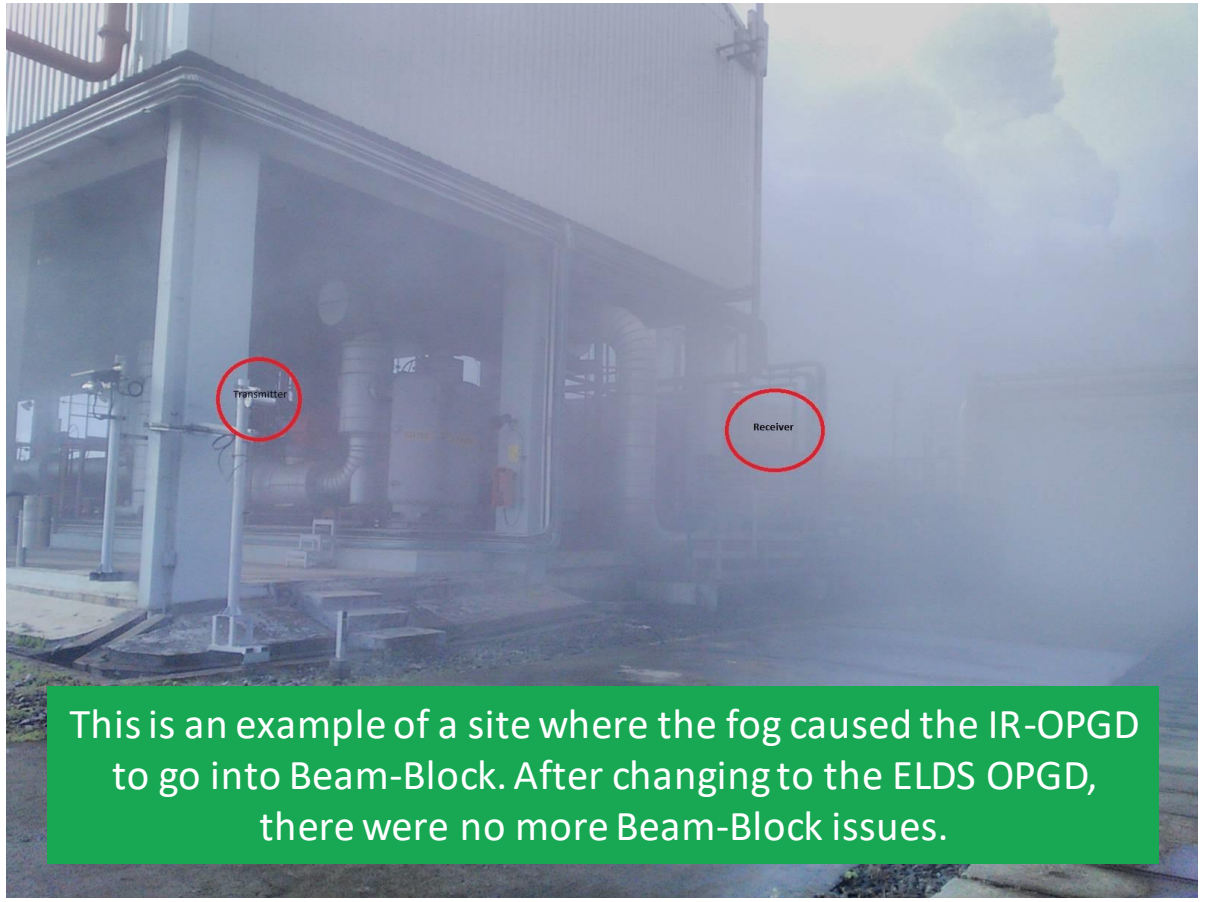
ELDS OPGD vs Differential IR OPGD

Performance in Rain / Fog

The IR beam of all Differential IR OPGD is absorbed by moisture i.e. fog or rain

In these conditions, the OPGD will go into Beam-Block and not be able to detect gas

ELDS lasers operate at different wavelengths to that of differential IR detectors making it less prone to water vapour absorption



This is an example of a site where the fog caused the IR-OPGD to go into Beam-Block. After changing to the ELDS OPGD, there were no more Beam-Block issues.

ELDS Applications

Sour gas (H2S)

- Sour oil & gas production
- Gas sweetening plants
- Refineries
- Waste water treatment

High risk, harsh weather (CH4: OPGD, VZ, XD)

- Oil & gas production
- Gas terminals
- Gas treatment plants
- Gas compressor stations
- Gas fired power stations
- FPSOs

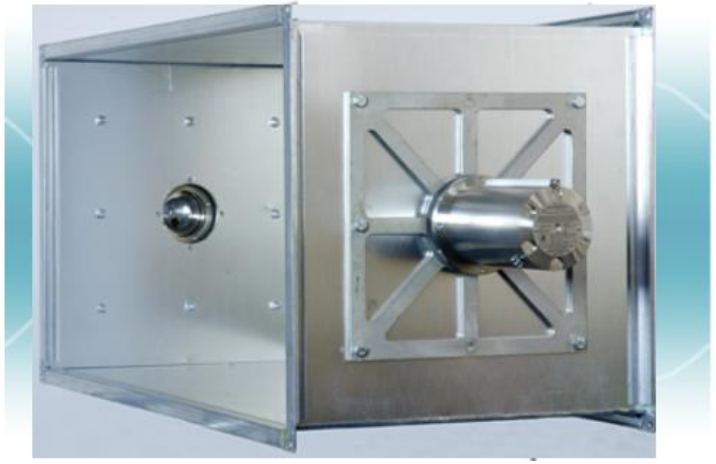
Exotic Toxics (NH3, HCl, CO2)

- Fertilizer plants
- Tank Farm storage area
- Chemical plants
- Aluminium plants
- Refrigeration plants
- Brewing
- Carbon capture plants

ELDS Applications

Open Area / Multiple HVAC intakes

Cross Duct (Methane only)
0.5 to 5m path length
T90 <1 s



HVAC inlets - Gas detection requirements

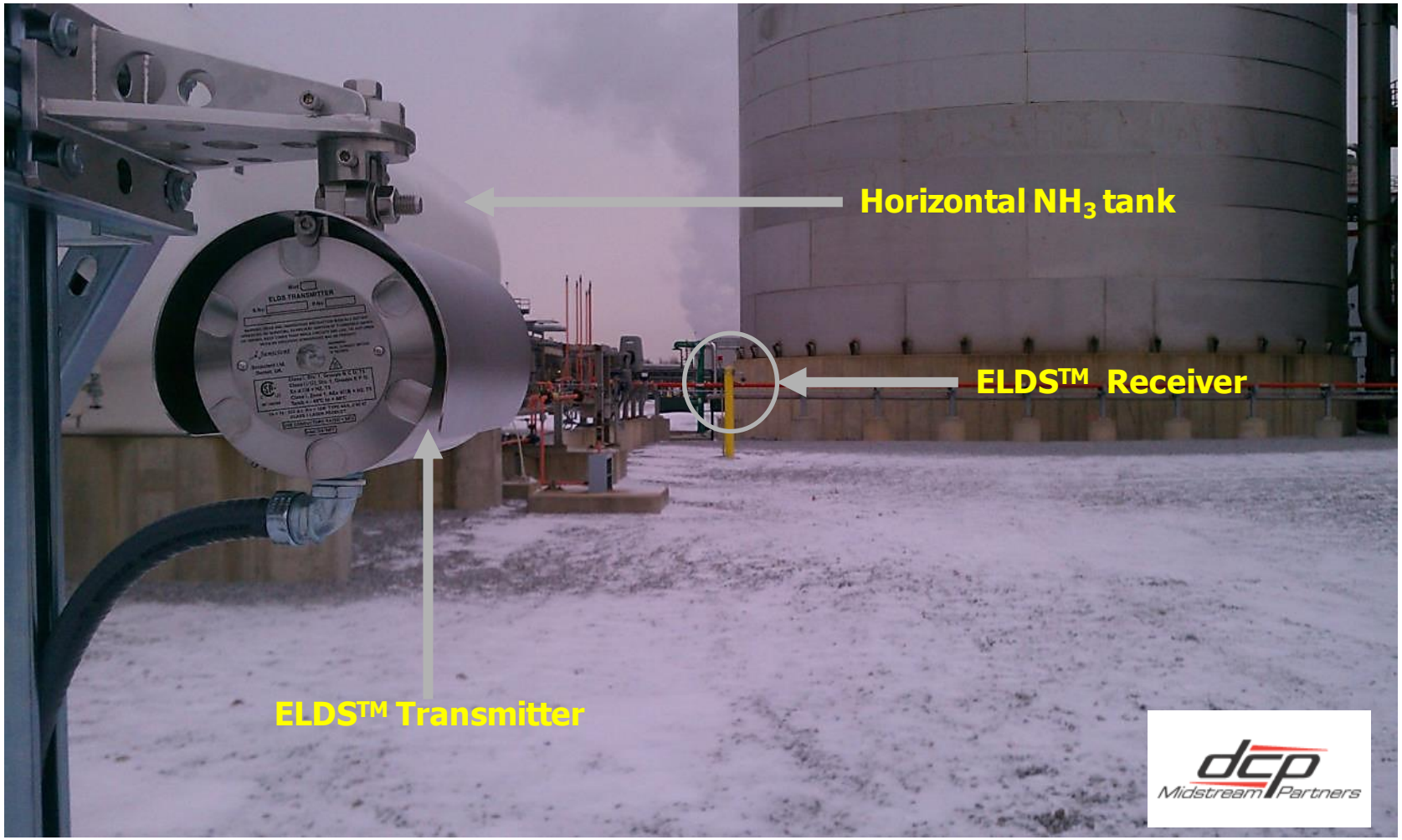
Application requirements	Detection solution requirements
▪ Fast damper closure	Fast speed of response, high sensitivity
▪ Simplified routine testing	Remote Calibration/Self testing
▪ Fail safe operation	Self diagnosing detection failure
▪ Minimal maintenance	Longer sensor life/No consumable parts
▪ Ease of maintenance	Mounting position and accessibility w/o opening the duct & Shut down
▪ No unwanted damper closure	Target gas specific
▪ High detection reliability	Voted 2oo3

A demanding application requiring an effective solution …

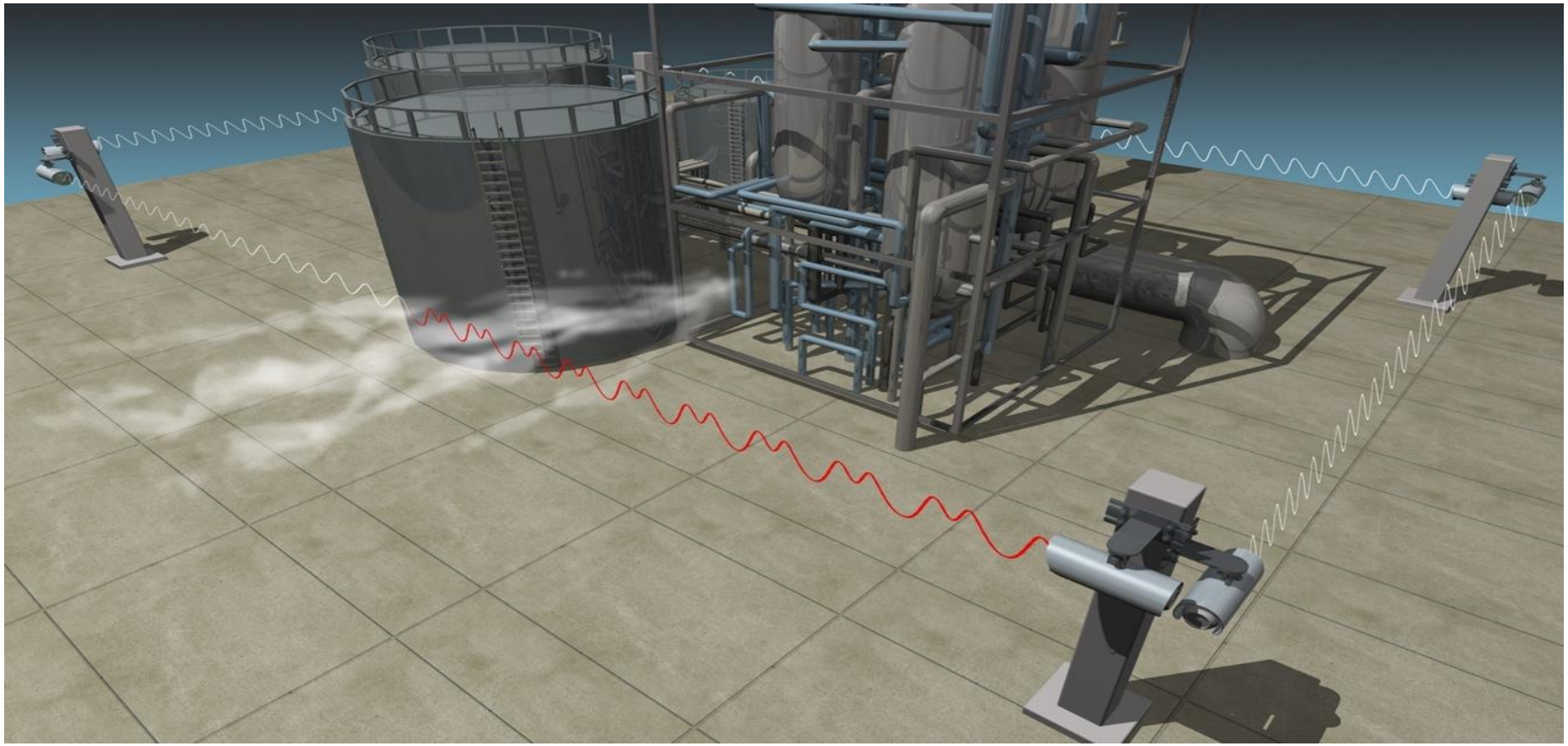
Typical Fence Line Monitoring

ELDS™ open path gas detector

NH_3 detection at a Fertilizer plant



Process unit – OPGD Application



ELDS™ open path gas detector

H_2S detection in UAE – Sour Gas Fields

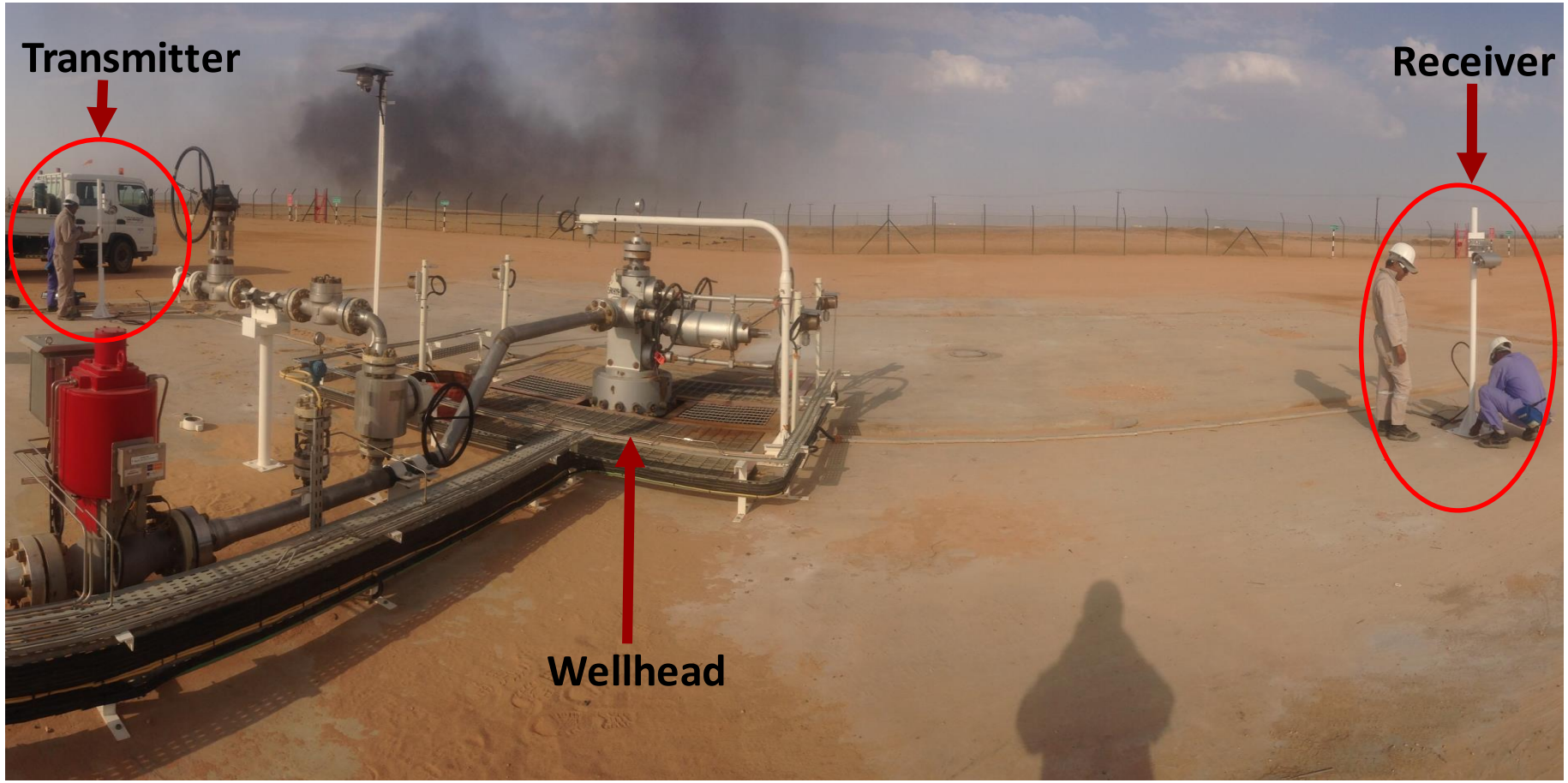
Shah Gas Development

United Arab Emirates, 2011-2013

- US$10b investment
- Four trains of sulfur recovery units that process one billion cubic feet of sour gas per day
- H_2S concentration in feed gas > 23%
- > 100 units of ELDS™ H2S

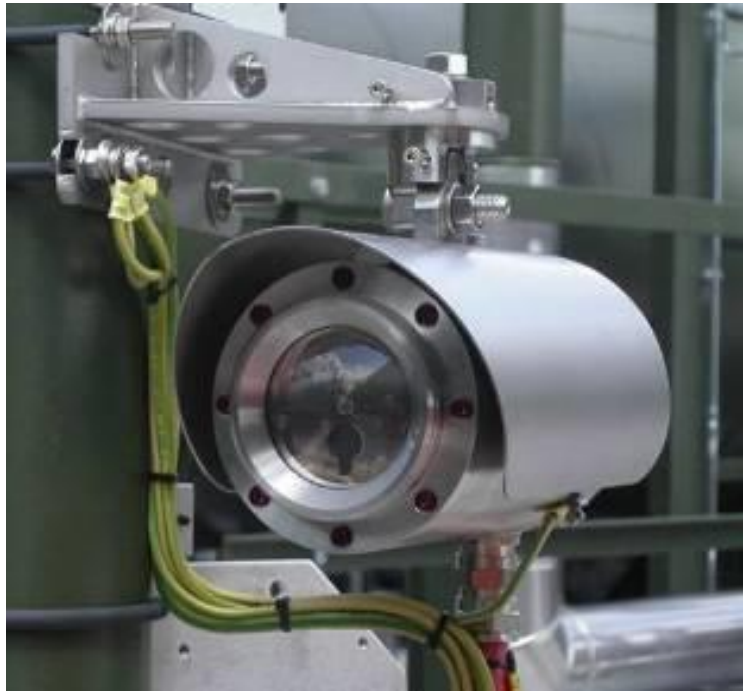
- Very high risk operating environment

Installation – On shore / Wellhead



Benefits of OPGD

- **Reduced Capex (OPGD):**
  - Wide area of coverage
  - Reduces point detection count
  - Reduced system I/O count
- **Reduced Opex (ELDS):**
  - Reduced routine manual testing
  - No routine calibration
  - No need for test gas
- **Increased safety (ELDS):**
  - Target gas specific* – no unwanted alarms
  - SimuGas* – removes personnel from risk areas
- **Increased performance (OPGD):**
  - Increased sensitivity – fastest plant shut down
  - Best uptime in rain & fog (ELDS)



MSA ELDS & IR5500 The Widest Capability in Open path Gas Detection…

Thank You

At MSA, we know what's at stake.

MSA
The Safety Company