Hydrogen Fixed Systems Gas and Flame Detection

Contents

- Hydrogen Characteristics
- Layered approach to detection
- Common Applications
- Summary

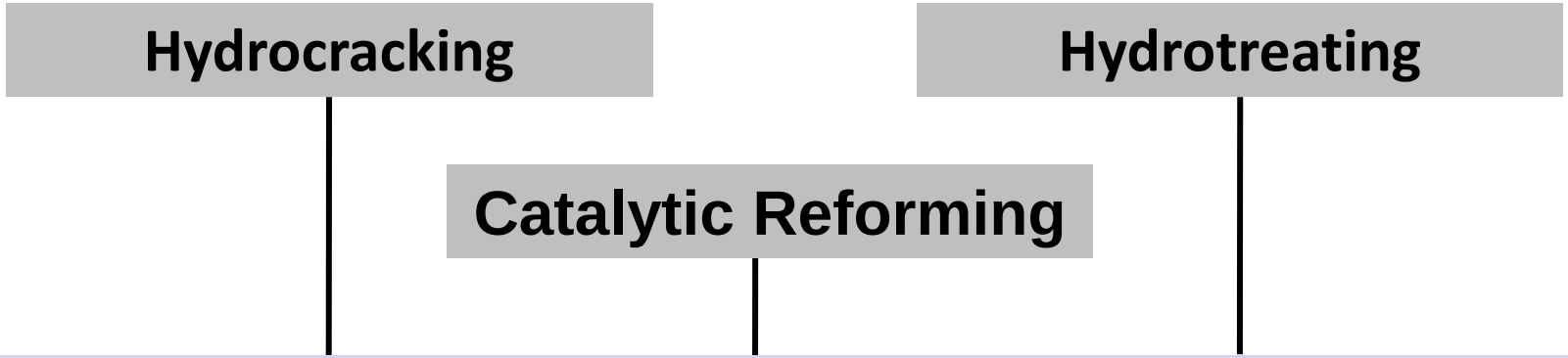
Hydrogen Characteristics

- Colorless, odorless and not detectable by human senses
- Highly flammable over wide range of compositions
- Easily ignited
- Has high propensity to leak
- Produces colorless flame

Application Overview

- Refineries
- Battery Storage and Charging Rooms
- Hydroelectric Power Stations
- Transportation

Hydrogen Applications in Refineries



Safety Issues:

- High pressure and high temperature generate great concern for hydrocarbon, hydrogen, and toxic gas leaks
- Degraded pipes from corrosive gases can lead to high pressure leaks
- Potential leaks from hydrogen processing and storage
- Rupture in reactors, separators, or pipe systems

Hydroelectric Power Stations

- H_2 is used as a coolant for electric generators in power stations. This is because of its high thermal conductivity and low "windage", so reducing frictional and turbulence losses.

Safety Issues

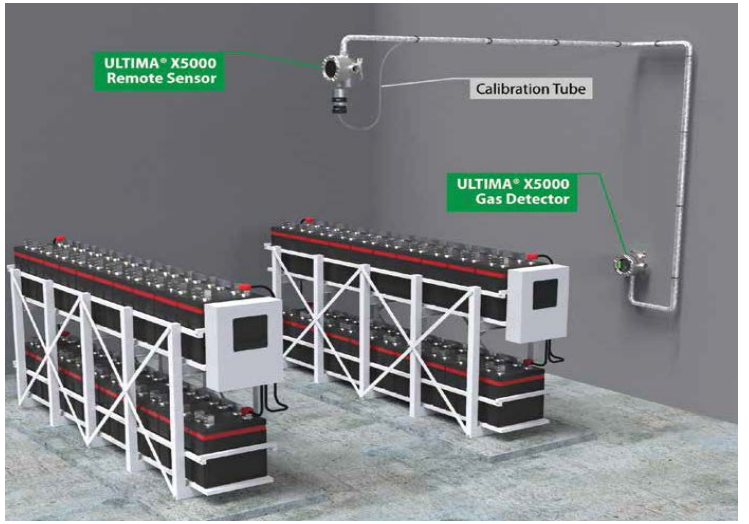
- Leaks in piping/ turbine
- Hydrogen removed / stored during maintenance
- Good potential for H_2 to pool at ceiling surface
- Stations are often remote with very few workers

Lead Acid Battery Room Application

- Common application found in telecommunications stations, data storage centers and any industry that uses battery power equipment such as forklifts

Safety Issues

- By product of charging process is H_2
- Batteries are sealed, but tend to leak
- Battery back up rooms typically small with very little ventilation
- Good potential for H_2 to pool at ceiling surface



Transportation

- Emerging application for use of Hydrogen in public and private transportation

Safety Issues

- Leaks while H_2 is compressed
- Leaks during delivery and filling operations
- Piping/storage corrosion
- Stations are located in public places increasing the risk to surrounding area

Protection Layers for Hydrogen Hazard

- Detection layers reduce the incidence of hazard propagation, preventing hazards from escalating into catastrophic consequences
- Three detection techniques are effective for hydrogen leak response:
  - *Leak detection*
  - *Gas detection*
  - *Flame detection*
- This combination increases the odds that hydrogen gas dispersal or fire is identified early on, either before ignition or an explosion occurs

Layers of Protection Philosophy

- Combine technologies that mimic the senses of seeing, hearing, smelling to detect gas leaks, flames, and other hazardous conditions

SEEING

FL500 H2 Flame Detector

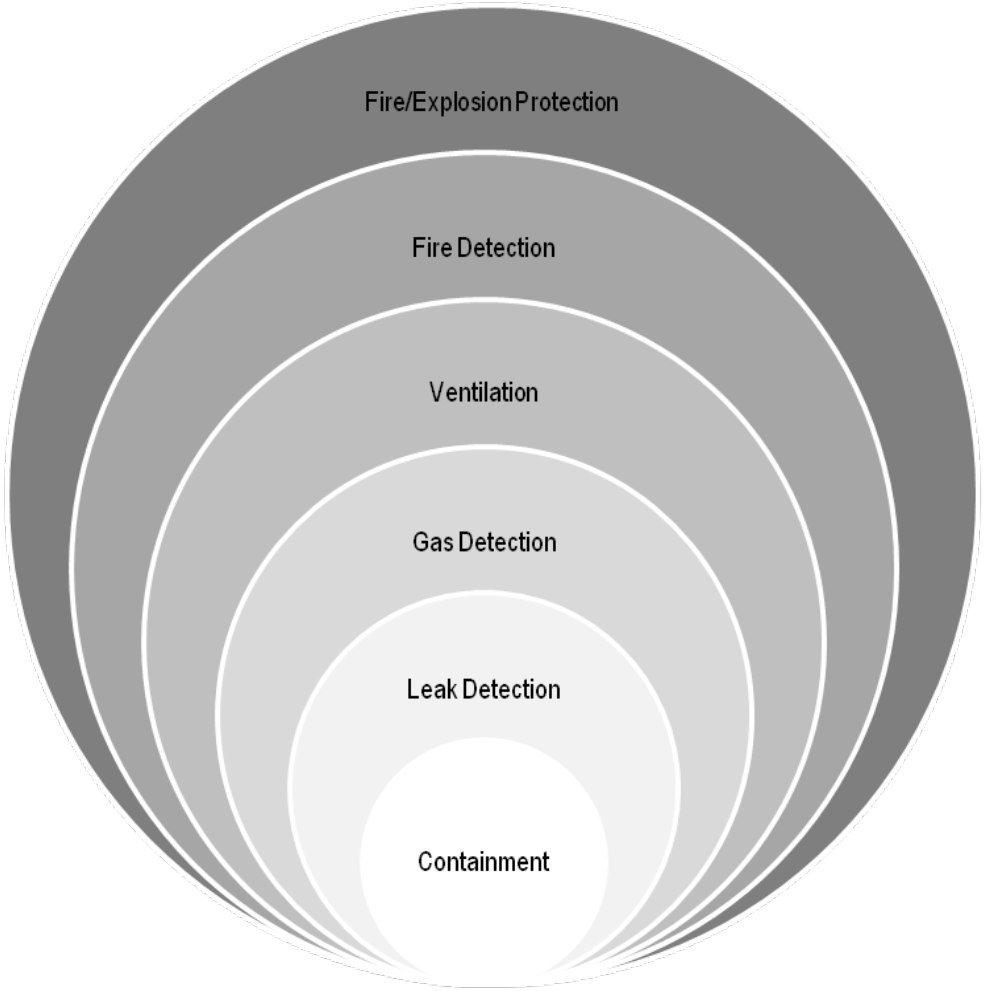
HEARING

Observer-i Ultrasonic Gas Leak Detector

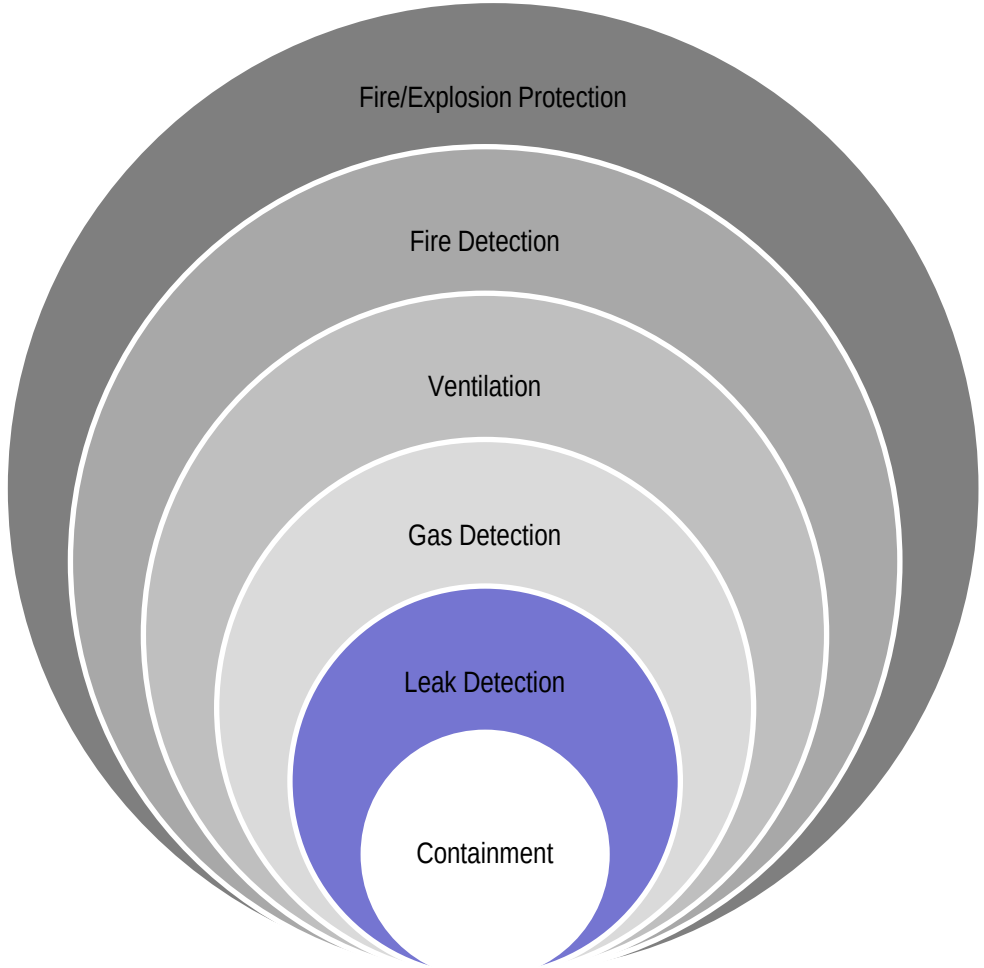
SMELLING

ULTIMA X5000 Cat Bead Point Detection

Protection Layers for Hydrogen Hazard



Protection Layers for Hydrogen Hazard



Ultrasonic Detection

Protection Layer: Leak Detection

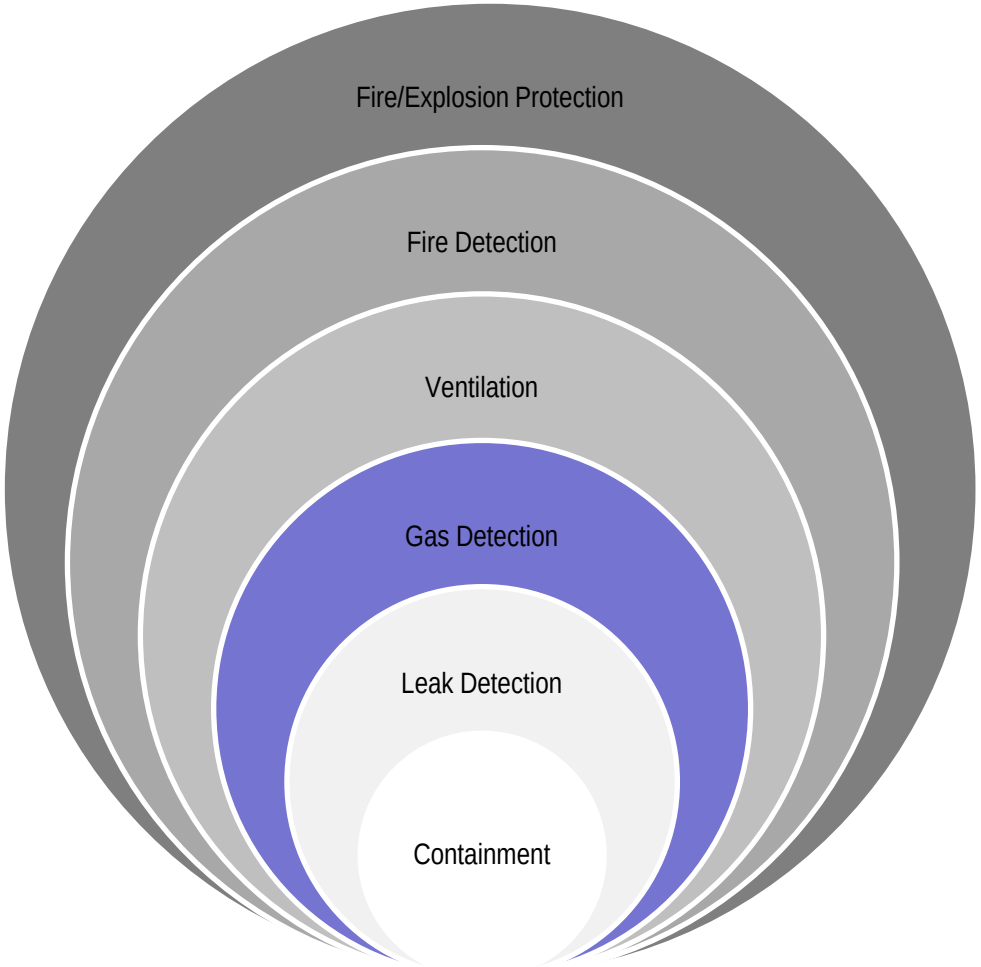
Advantages

- Fast detection of pressurized gas leaks
- Not sensitive to gas dilution, orientation of leak, or wind direction
- Versatile – detects pressurized leaks regardless of type of gas
- Not influenced by heavy rain or other ambient conditions
- Minimal maintenance, no consumable parts
- Robust, fail safe operation

Limitations

- Not suitable for low pressure leaks
- Under certain conditions affected by man-made or natural ultrasonic sources
- Background noise levels need to be estimated prior to installation
- Unable to determine concentration of gas

Protection Layers for Hydrogen Hazard



Catalytic Bead Detection

Protection Layer: Gas Detection

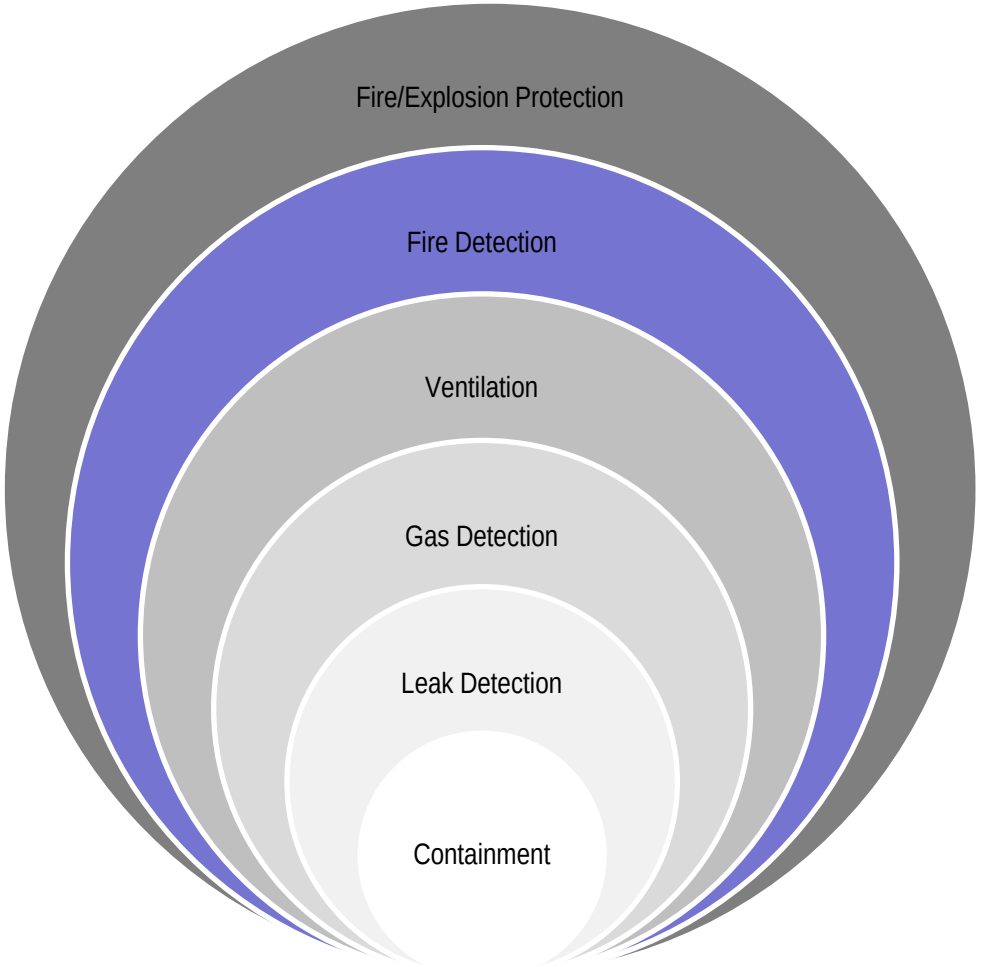
Advantages

- Robust
- Simple to operate - easy to install, calibrate, and use
- Long lived with a low life-cycle cost
- Can detect a variety of gases
- Wide operating temperature range
- Easily calibrated to gasses such as hydrogen which cannot be detected by infrared absorption

Limitations

- Passive detection – not fail to safe
- Gas must diffuse into catalytic sensor in order to be detected
- Catalyst may become poisoned or inactive due to contamination (requires regular inspection)
- Requires oxygen for detection
- Prolonged exposure to high concentrations of combustible gas may degrade sensor performance

Protection Layers for Hydrogen Hazard



Hydrogen–Specific Flame Detection

Protection Layer: Fire Detection

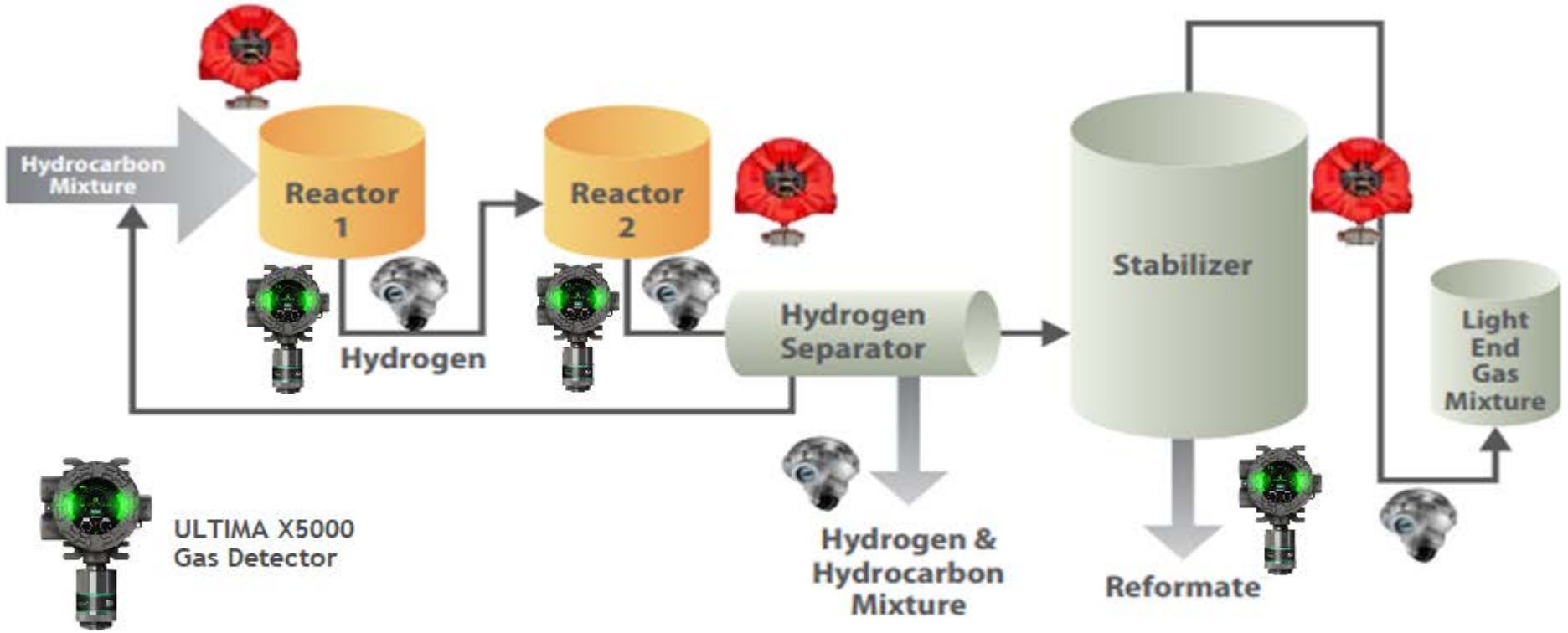
Advantages

- Fast response to hydrogen fires
- Fail-to-Safe: Continuous Optical Path Monitoring (COPM)
- Ultraviolet and IR technology reduces possibility of false alarms
- Wide field-of-view
- Compatible with flame test lamp

Limitations

- Unable to detect heavy, smoky fires
- Unable to detect smoldering fire without a flame
- Affected by strong sources of UV radiation (ex. arc welding) or certain combinations of UV and IR radiation

Application Example



ULTIMA X5000
Gas Detector

Observer-i Ultrasonic
Gas Leak Detector

General Monitors FL500 - Hydrogen
Flame Detector

Detector Allocation Across Catalytic Reforming Unit

Summary

- Because of its properties, hydrogen poses severe physiological, physical, and chemical hazards
- In a worst case, a gas leak can form a flammable mixture, which when ignited, produces a detonation
- A combination of catalytic bead and ultrasonic gas leak monitors and fire detectors increase the chances that hazards are addressed while they can be contained
- Diverse safety systems, combined with a design that prevents leakage and eliminates possible ignition sources, offer a sound approach for managing hydrogen processes

Please contact

PARALOS Expert Safety Team for additional details and guidance

info@paralos-tech.gr