Hydrogen Risk Mitigation Through Fire and Gas Mapping

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The Safety Company

SAFEGUARDING
PEOPLE, PLACES & THE PLANET

Agenda

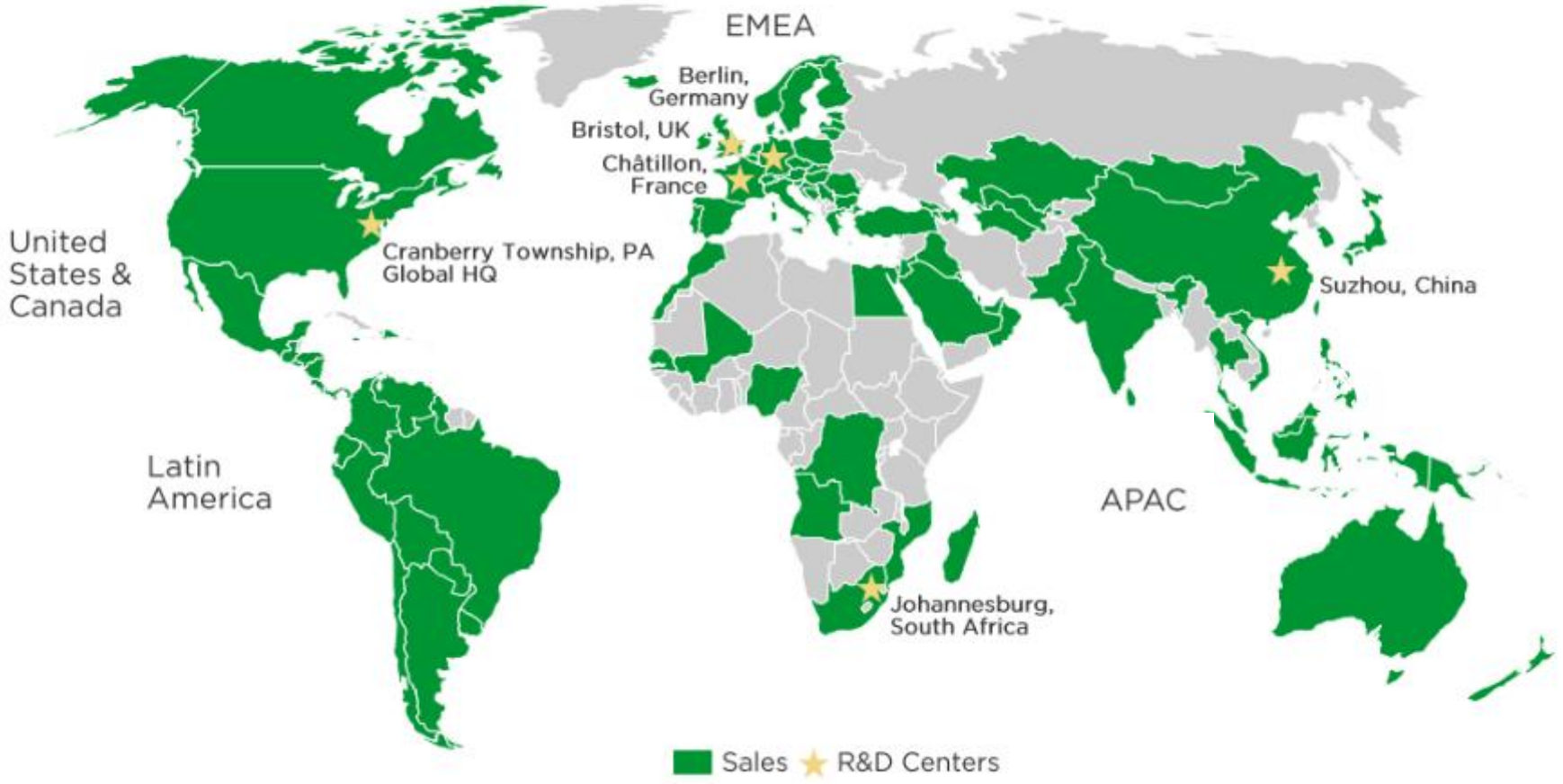
1. MSA Safety – Protecting Lives for 110 Years
2. Hydrogen Properties and Challenges
3. Fire and Gas Mapping – support for Hydrogen applications
4. Fire and Gas Detection – technology summary

Protecting Lives for 110 Years

MSA The Safety Company

SAFEGUARDING PEOPLE, PLACES & THE PLANET

Delivering innovative safety solutions globally



Sales in 100+ Countries

5,000+ Associates

Leading positions in many areas of safety

DETECTION

Connected instrumentation to protect workers, enhance site safety, and increase operational efficiency

Fixed Gas & Flame Detection

Portable Gas Detection

FIRE SERVICES

Innovative products and solutions to help protect firefighters

SCBA & Connected Firefighter

Protective Apparel & Helmets

INDUSTRIAL PPE AND OTHER

Sophisticated solutions to enhance worker safety

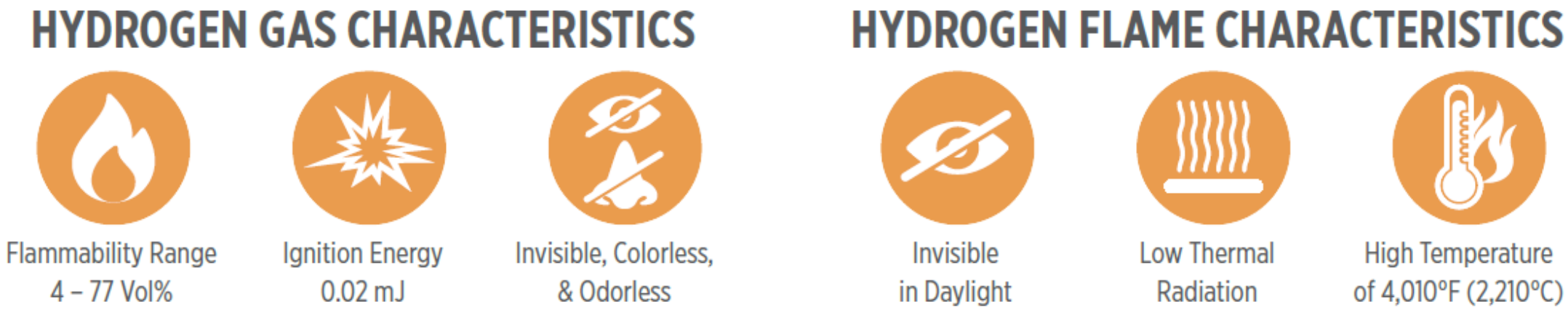
Industrial Head Protection

Fall Protection

Hydrogen Challenges

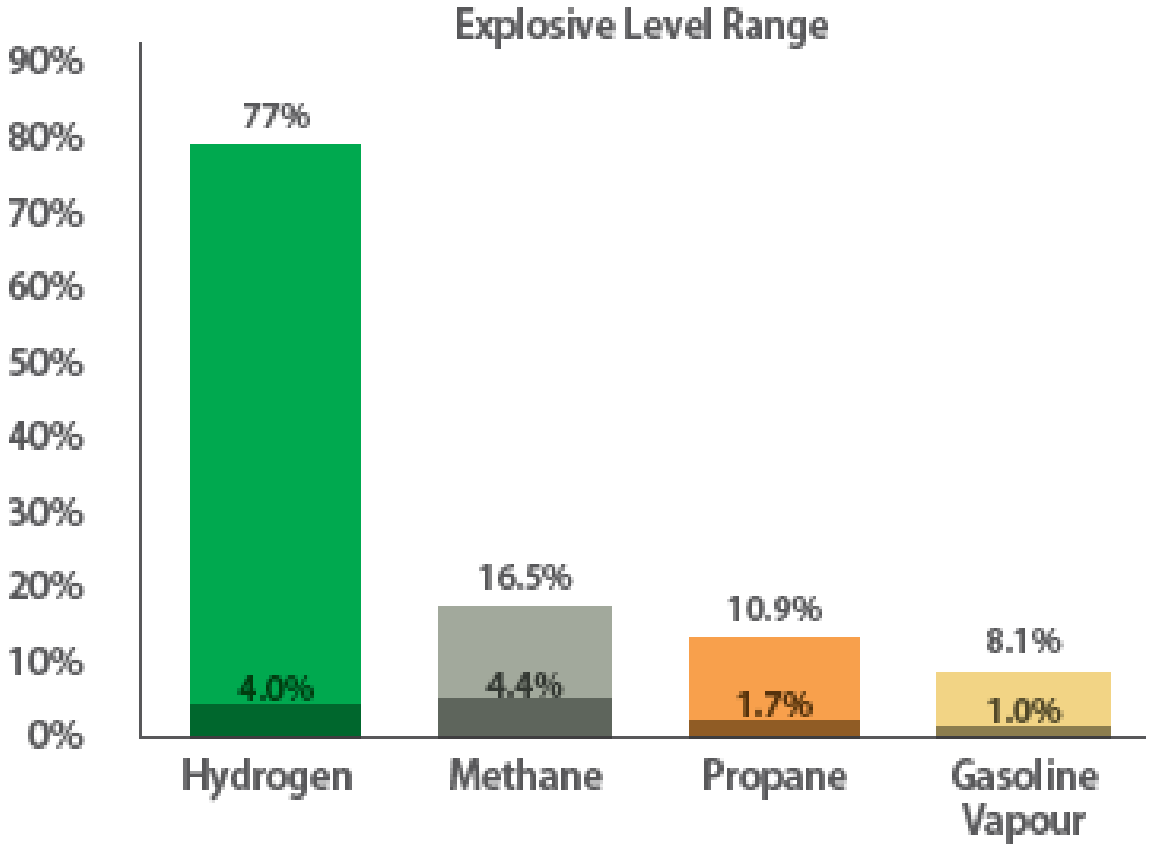
What can help in managing the risk?

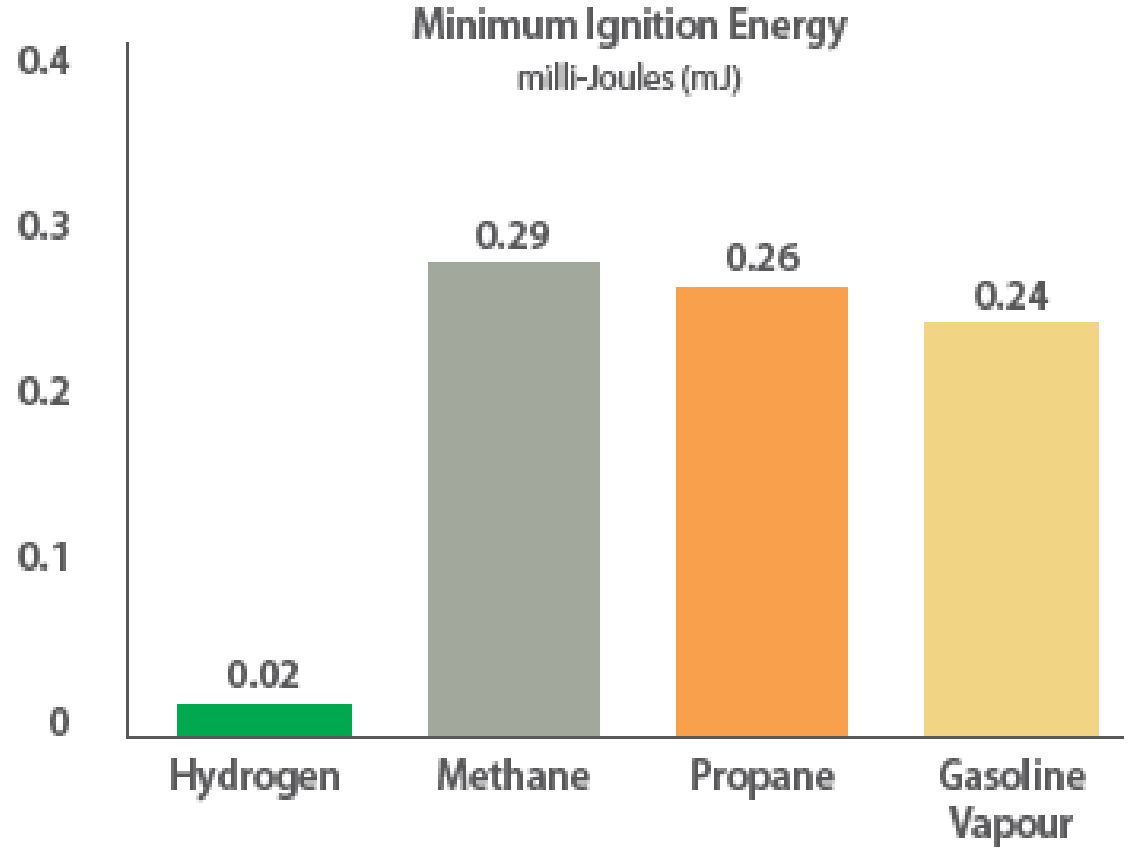
Hydrogen Properties and Challenges



- Challenging H2 gas and flame properties require careful risks evaluation and reduction of those risks towards an acceptable risk profile.
- **Fire & Gas Mapping is a solution that assist in evaluations, considering the application, sensor technologies, detector placement, zoning, probability of alarming and voting.**

Hydrogen comparison to common fuels





Why we are emphasizing on Fire & Gas Mapping

Available standards on H_2 do not give enough guidance

Some of Existing Standard and Information About Fire And Gas Detection System / Instruments			
Standard	**Description**	**Available information**	**Gap**
ISO 22734-2019	H2 Generator using water electrolysis - Industrial/Commercial and Residential	• **ISO 22734-2019**: Ventilation activates at 25% LEL (1% H_2 by volume). • **IEC 60079-29-1**: Defines detector performance, including response behaviour and vibration testing. • **IEC 60079-29-2**: Guidelines for detector maintenance.	These standards do not provide guidance on where to install fire and gas detectors or on improving leak detection ratios, nor do they address emerging technologies for analysis and detection.
ISO/TR 15916	Basic Consideration for the safety of H2 System	General guidance of use of gas and flame detector in probable place of leak accumulation and ventilation duct	
ISO 26142-2010	H2 Detection Apparatus Stationery Application	Advises to refer to **IEC 60079-29-1**	
ISO 19880-1-2020	Gaseous H2 Fueling Stations - General requirements	• Refer to **IEC 60079** for area classification. • Highlight **IEC 61508's** role in safety. • Focus on mechanical protection, referencing **ISO 22734** and **ISO 26142.** • Emphasise setting appropriate alarm thresholds.	

Fire and Gas Mapping

Support for Hydrogen applications

Performance Target –> Improving leak detection

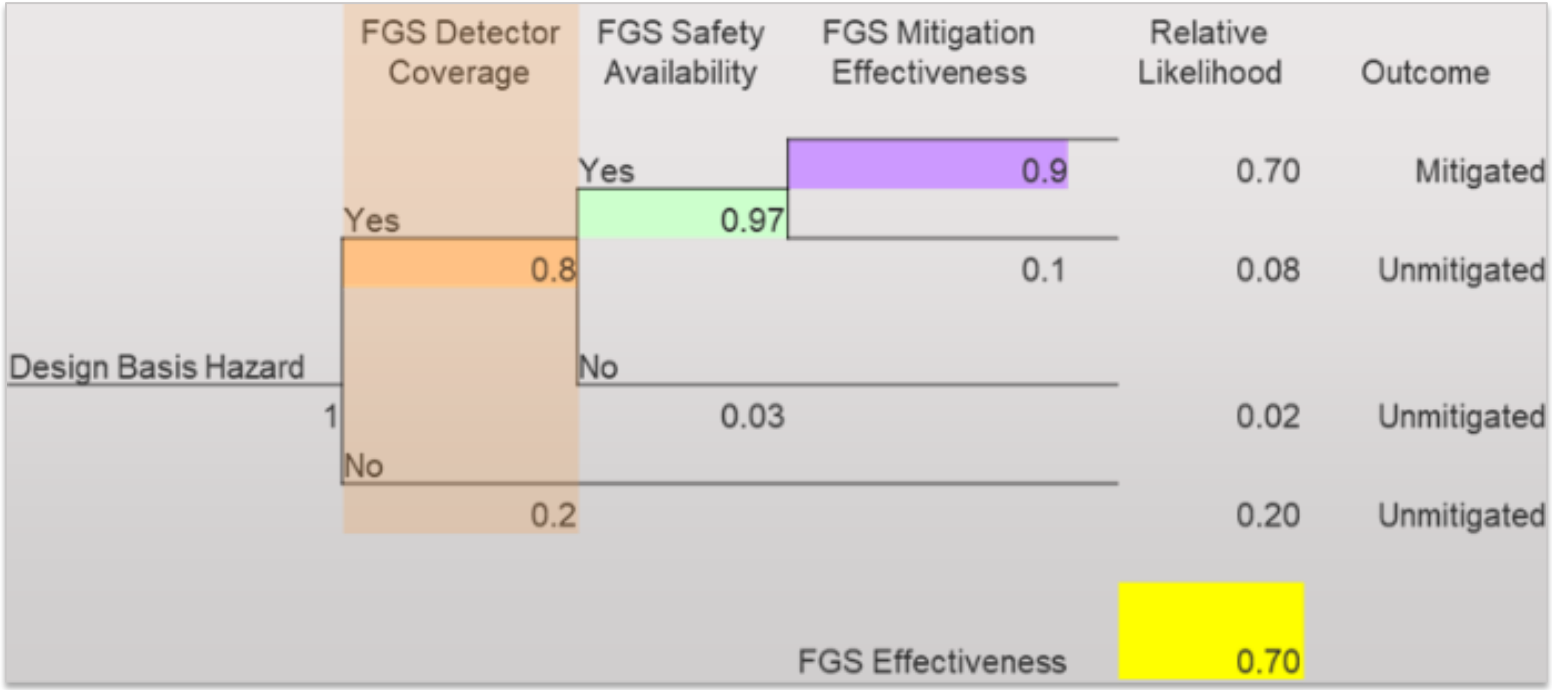
- **Detection Coverage**
  - Fraction of hydrogen gas release scenarios detected
- **Safety Availability (PFDavg)**
  - Probability that a system will fail, and not be able to perform its safety function
- **Mitigation Effectiveness**
  - Degree to which consequence is mitigated after successful activation

- Safety availability and mitigation effectiveness can be improved by selecting right kind of control system and field devices which will actuate the mitigation process.
- **However, the detection coverage is the main contributing factor for effectiveness of the entire system.**

Step 1: FGS Effectiveness Parameters

Event tree representation of fire and gas safety systems (FGS) effectiveness parameters

The ISA 84.00.07 approach employs a simplified category-based event tree analysis with a scoring system that will pick a gas detection "grade" as a function of the parameters that define risk, which include:



- Equipment type – proxy for leak rate
- Degree of occupancy of area
- Likelihood of ignition of release
- Likelihood of early or immediate ignition
- Released material type – proxy for consequence magnitude
- Process pressure – modifier to consequence magnitude
- Degree of confinement – modifier to consequence magnitude

Step 2: Selection of Performance Grade

Zone ID	Equipment Items								Hazards				
	Tag	Base Likelihood Score	Occupancy Factor	Environment Factor	Early Ignition Factor	Base Consequence Factor	Process Pressure Factor	Flammable Environment Factor	Hazard Code	Likelihood Factor	Cons. Factor	Hazard Rank	Selected Grade
Area 144	ET-01/02/03	Piping Manifold	High (Near Continuous Occupancy) >30%	Low Ignition Probability (3%)	Very Unlikely (No Credible Sources of Immediate Ignition)	Gas [T(process) > NBP or Cryogenic Liquids T(ambient) > BP]	Atmospheric to 50 psig (atm. To 3 bar)	Confinement / High Congestion (2D High)	Comb. Gas	0.5	4.5	4	B

- Parameters are categorised, not numerically quantified.
- Categories are assigned scores, leading to an overall score.
- The overall score correlates to a performance target (e.g., gas detection grade).
- In the electrolyser case study, categories were selected for a closed facility housing

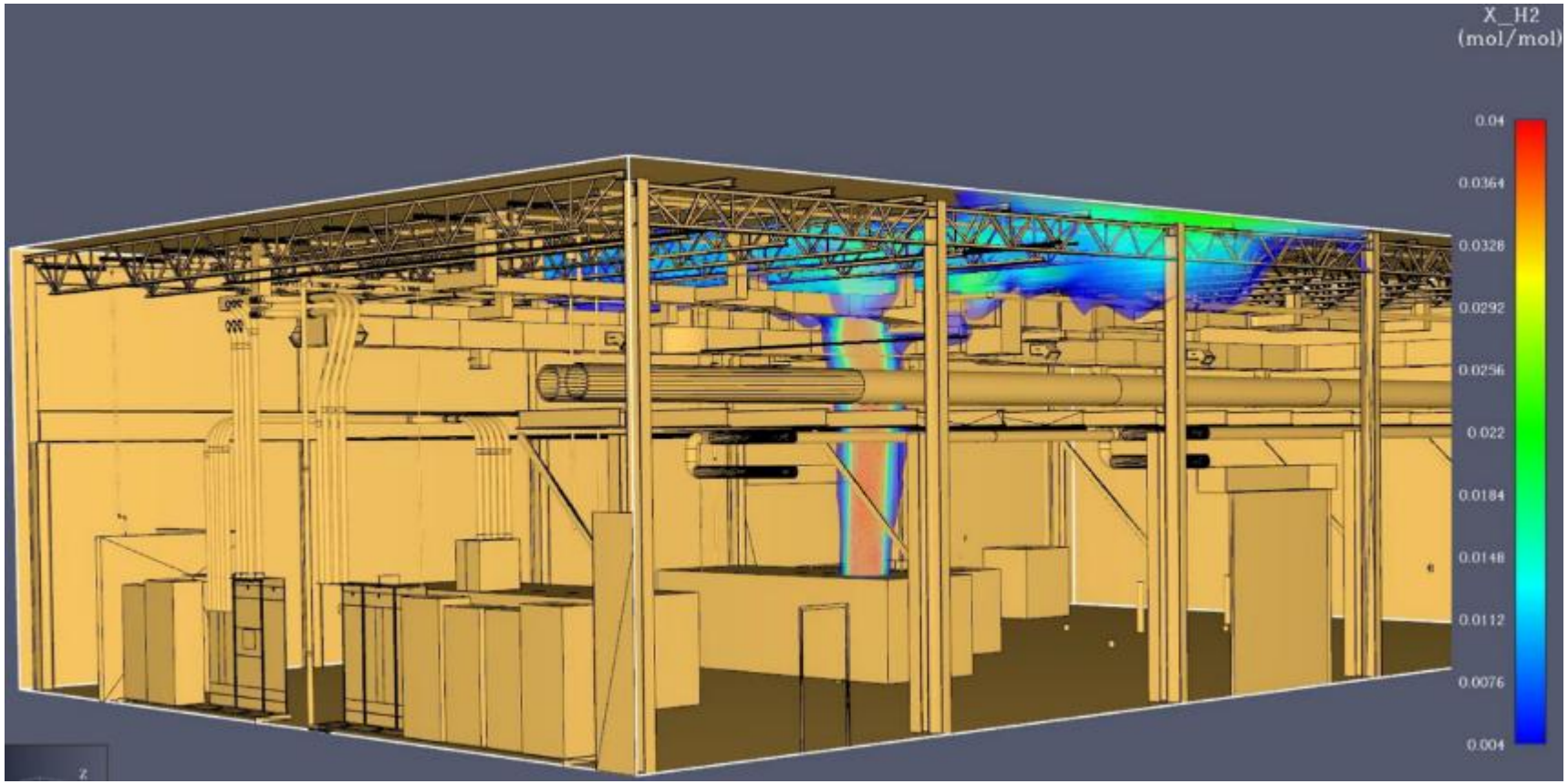
Step 3: Category Grade Definition

An example of grade as per ISA TR 84.00.07 for electrolyzer

Hazard	Adjusted Hazard Rank	Grade	Detector Coverage	Safety Availability	Response Time
Fire Hazard	>=7	A*	0.90	99.9%	N/A
	5 to <7	A	0.90	99%	N/A
	2 to <5	B	0.80	99%	N/A
	0.5 to < 2	C	0.60	90%	N/A
	<0.5	N/A	No Detection Required	N/A	N/A
Combustible Gas Hazard	>=7.5	A*	0.90	99.9%	Rapid (10-30 sec)
	5 to <7.5	A	0.90	99%	Rapid (10-30 sec)
	2 to <5	B	0.80	99%	Early Detection (<60-90 sec)
	0.5 to < 2	C	0.60	90%	Moderate (60-90 sec)
	<0.5	N/A	No Detection Required	N/A	N/A

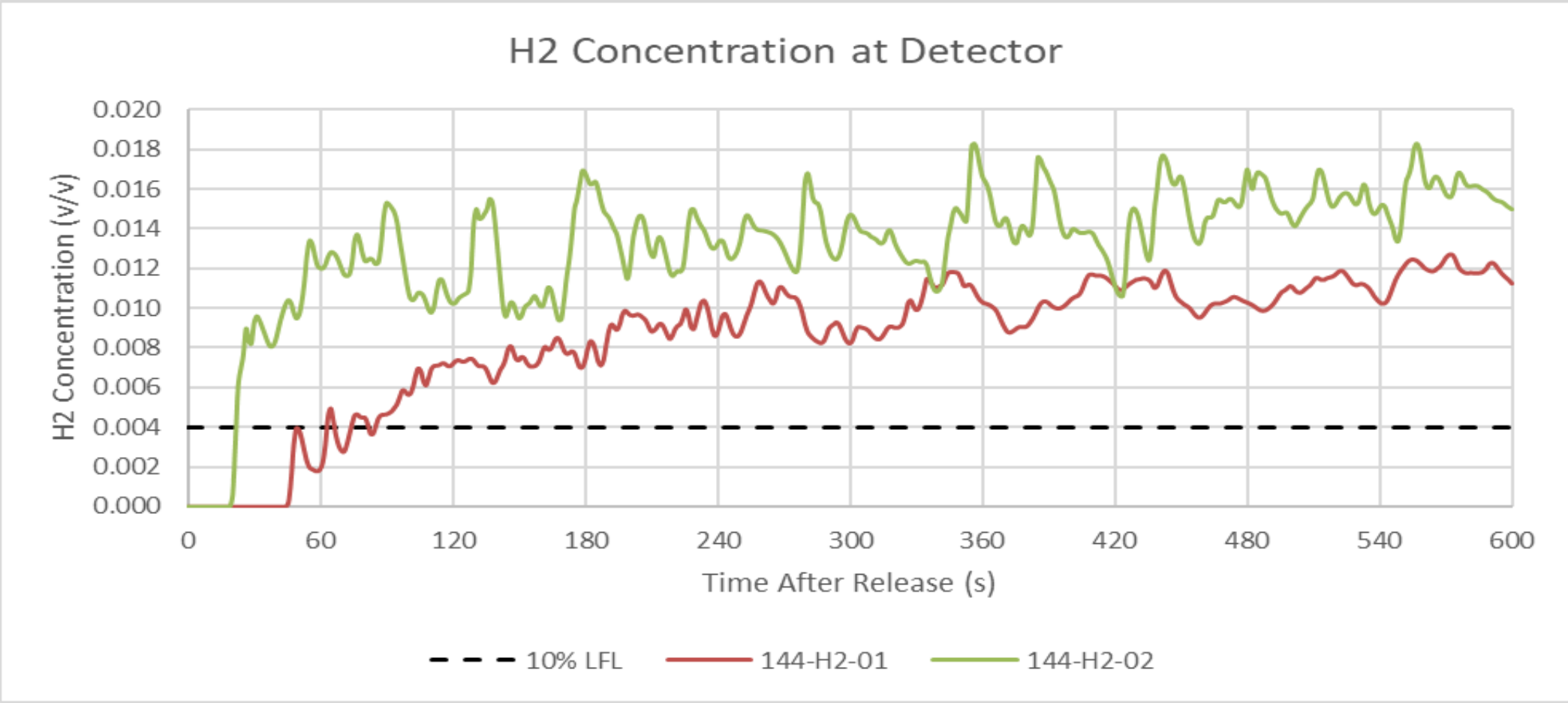
Step 4: Dispersion Modeling/Concentration profile

CFD Model of Concentration Profile of Electrolyzer Hydrogen Release

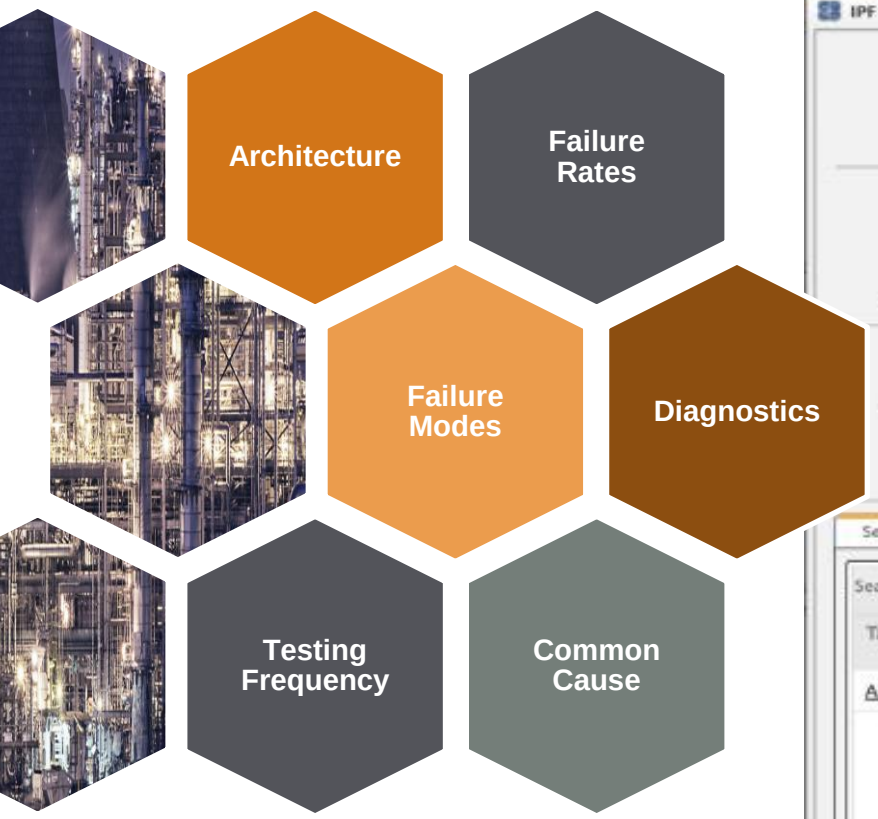


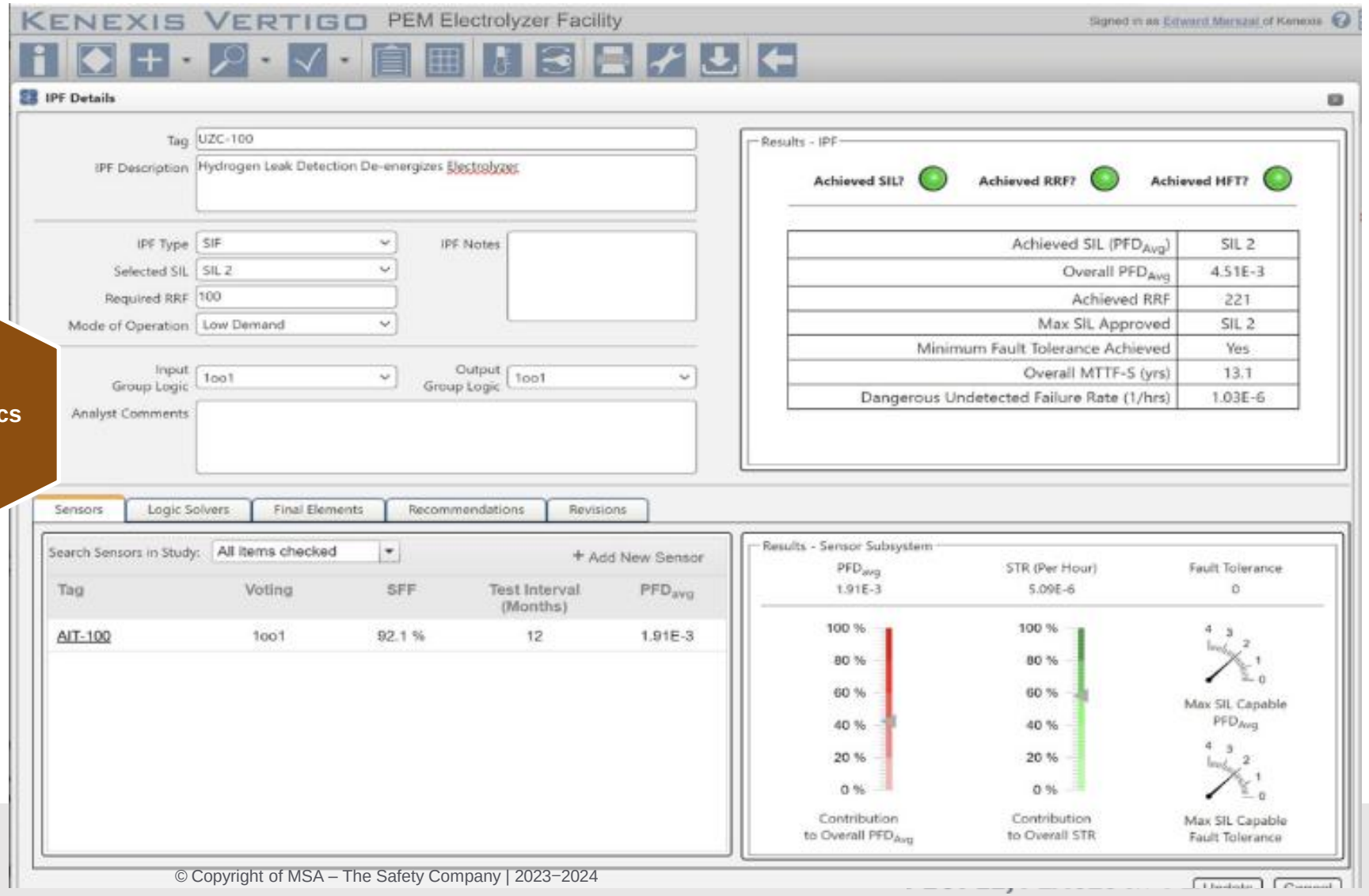
Step 5: Dispersion Modeling – Time to detect

Time to Detect Trends (CFD) – Confirm Response Time

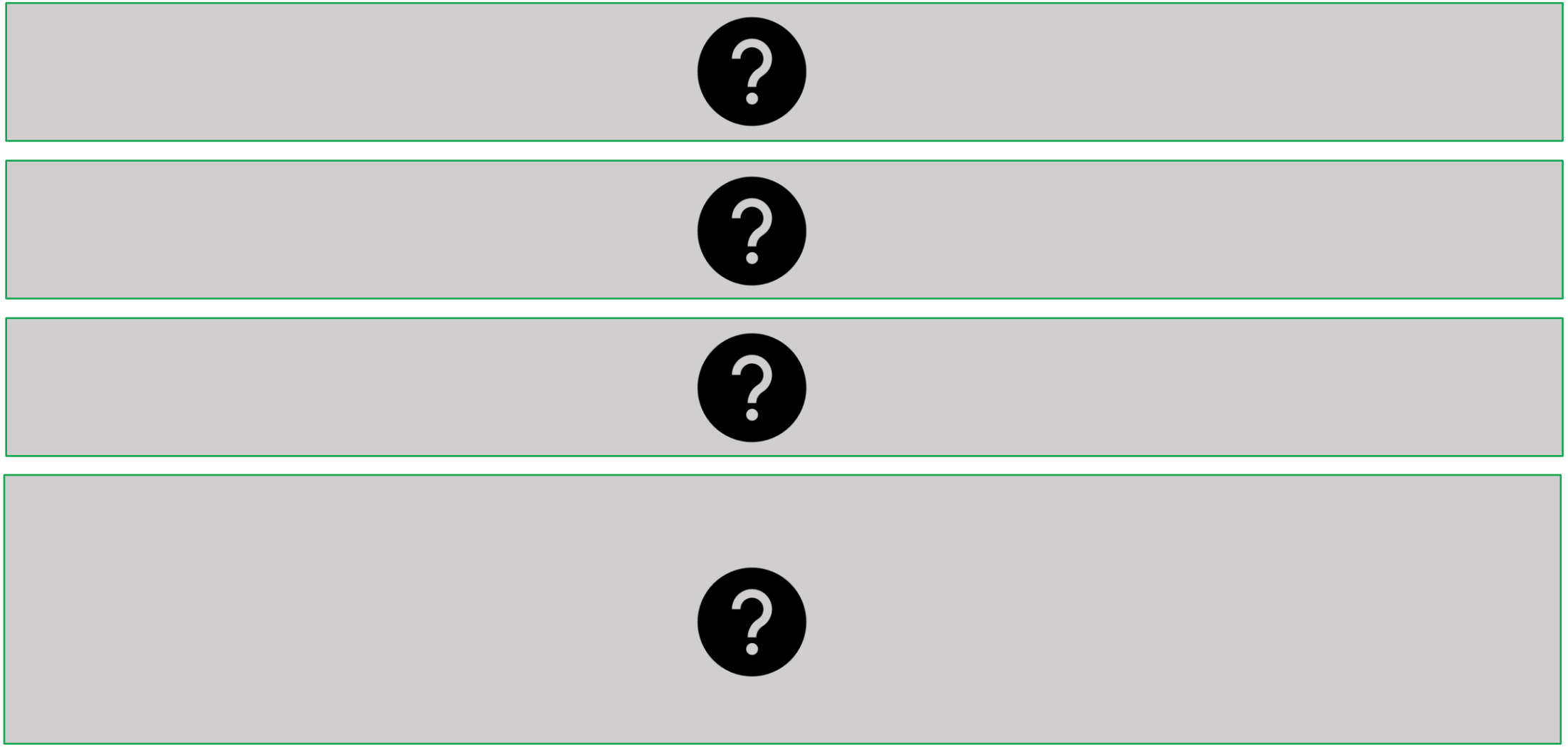


Step 6: Confirm safety availability - PFD





What can we conclude?



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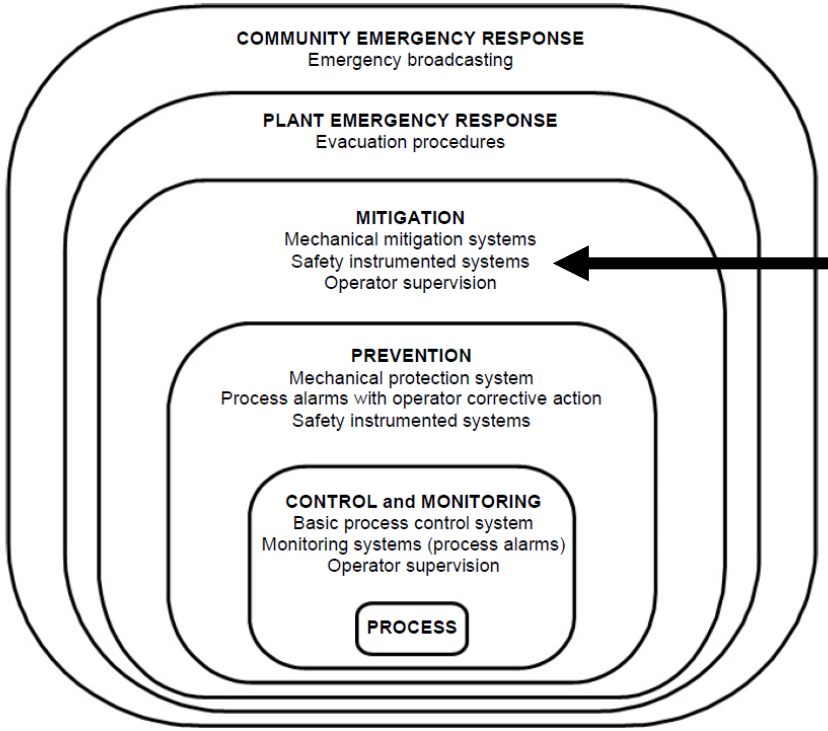
- As hydrogen fuel technology advances, risk analysis will require gas and fire detectors to safeguard hydrogen generating and containing equipment. To ensure tolerable risk, these systems should comply with **IEC/ISA 61511** and be supplemented by **ISA TR 84.00.07** for guidance on detector quantity and placement.

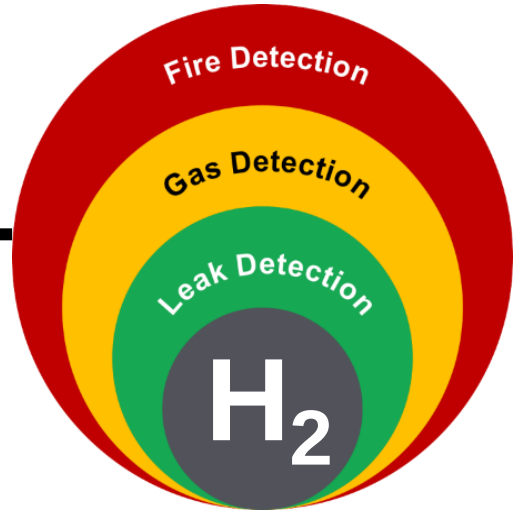
Gas and flame detection technologies

Quick review of layered protection

Protection layers and MSA approach

Gas and flame detection following the human sensory model





Fire Detection Layer
Undetected hydrogen leak can result in fire and explosions

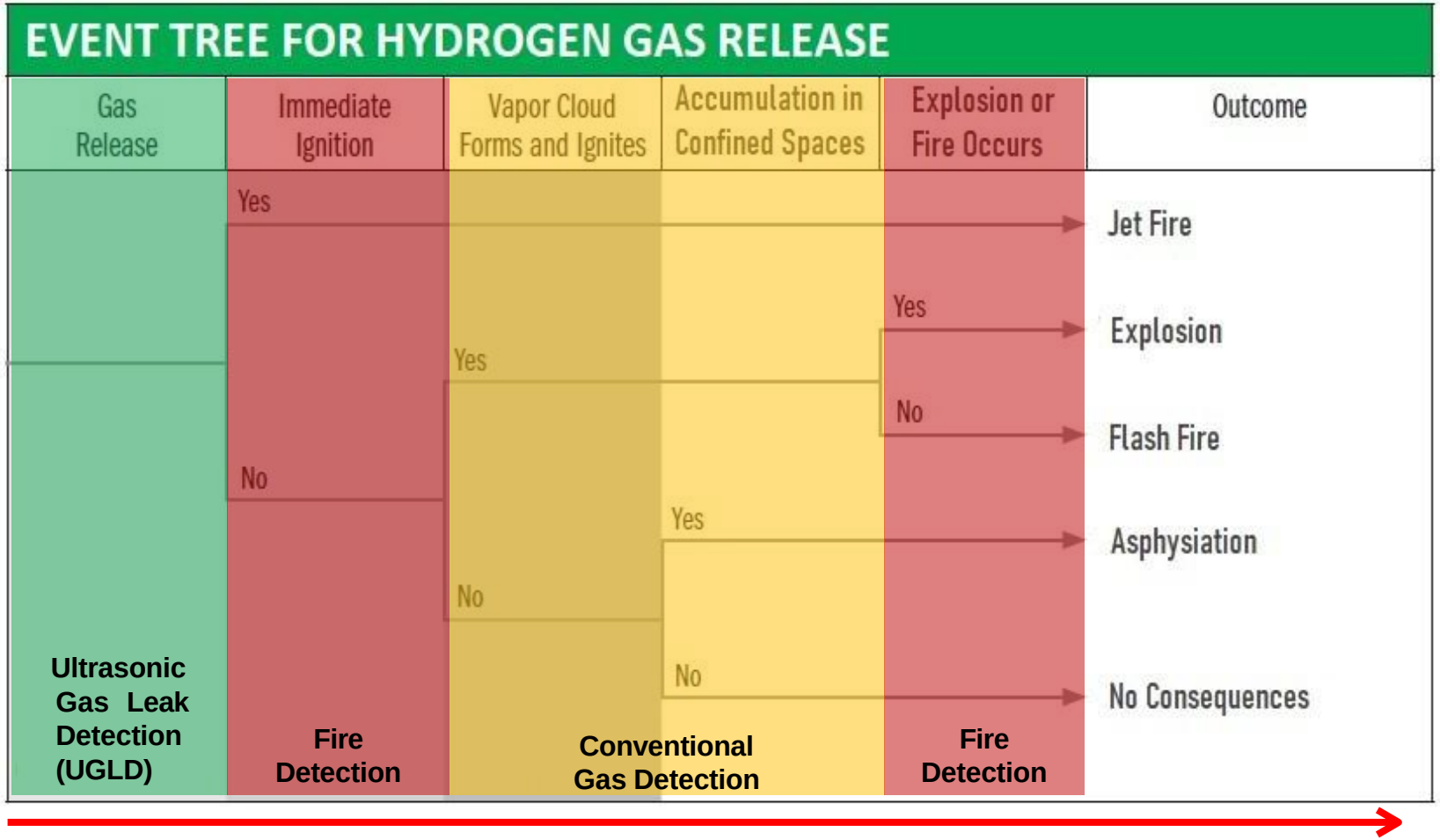
Gas Detection Layer
Conventional gas detection technologies help mitigating risks

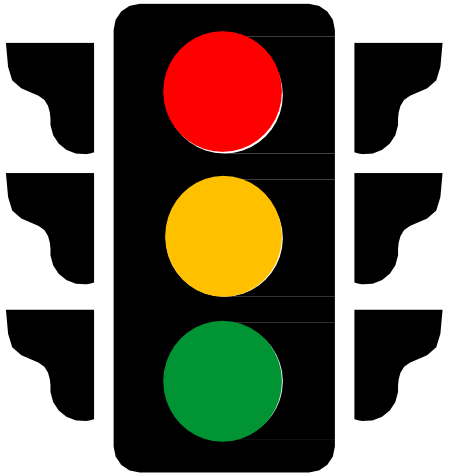
Leak Detection Layer
Ultrasonic gas detection provides the earliest possible response

IEC 61511-1

Gas and flame detection layers applied

Event scenarios following a Hydrogen release





Gas and flame detection layers

Technology implementation

Ultrasonic detection

- 360° coverage
- 28m range
- ANN technology

Observer® i

Point detection

- 0-100% LEL range
- 0-1000 ppm range
- CatBead & EChem

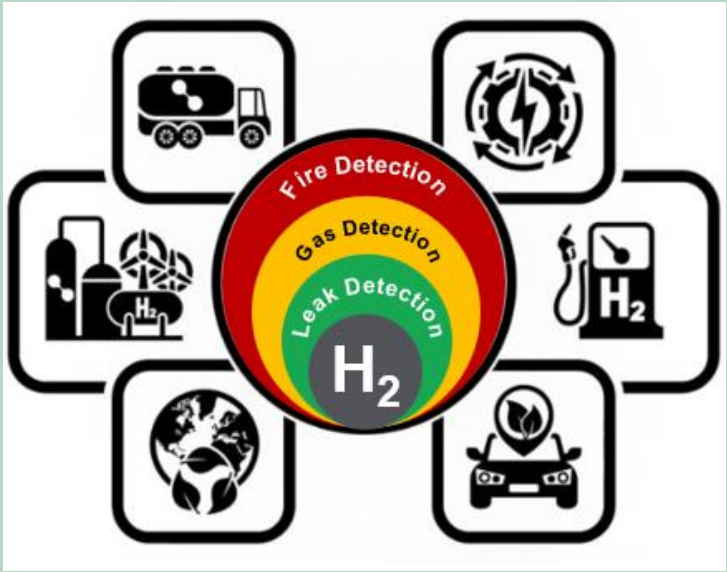
ULTIMA® X5000

Flame detection

- 125° field of view
- 3sec response time
- UV/IR technology

FL500-H2

Visit to learn more:
MSAsafety.com/hydrogen-detection-solutions



Thank You!
Any Questions?

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