HazMap3D

Trusted Compliance

Delivering Project Certainty Through 3D Fire and Gas Modelling

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London Section

8th January 2019

MICROPACK FIRE & GAS

Micropack (Engineering) Ltd.

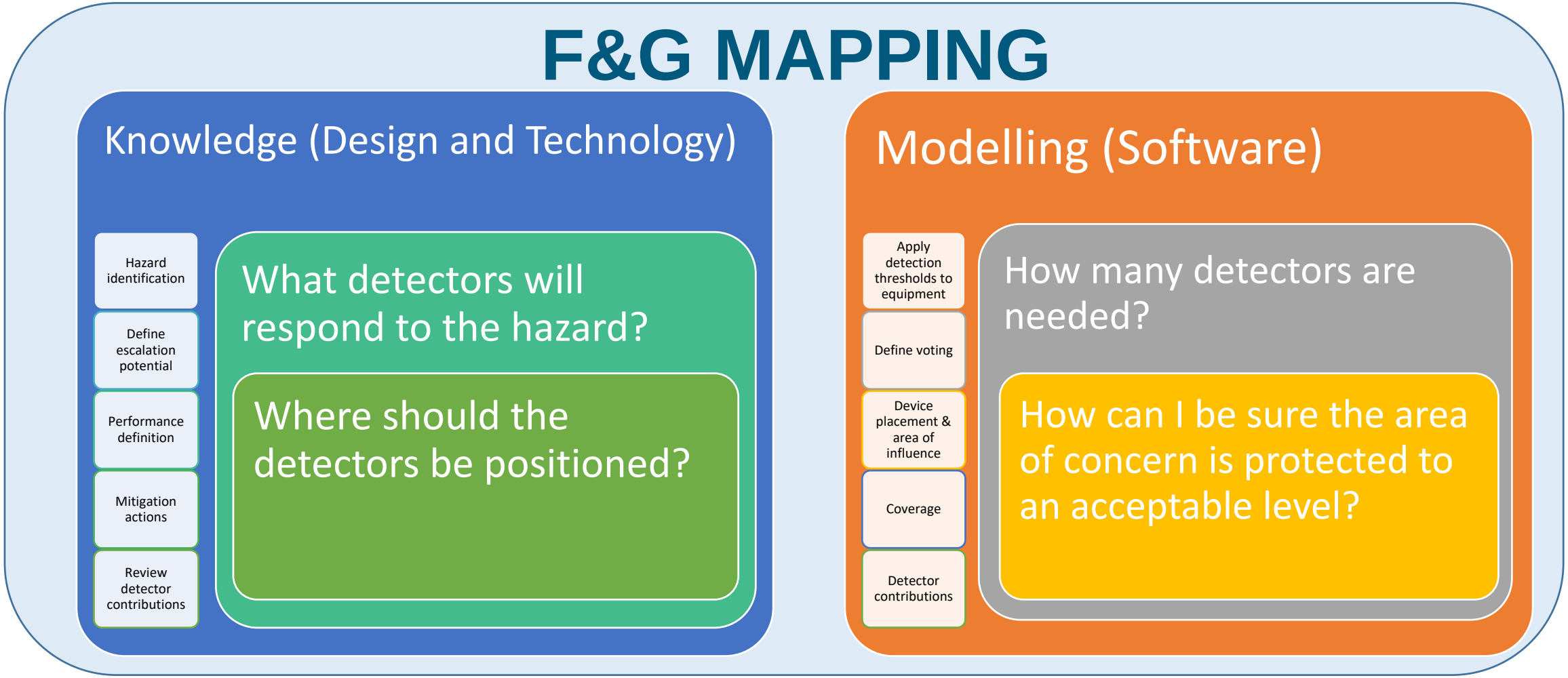
- **Scottish** Hazard Detection Company
- **Joint Inventors** of modern day Fire and Gas Mapping with **Shell Global Solutions 1989**
- Design & manufacture of **flame detectors since 1996**
- World leader in **Intelligent Visual Flame Detection**
- Markets
  - Oil & Gas, Refining, Petrochemical, Waste, Aviation, Tunnels, LNG & Marine

Customers Trust our Expert Knowledge

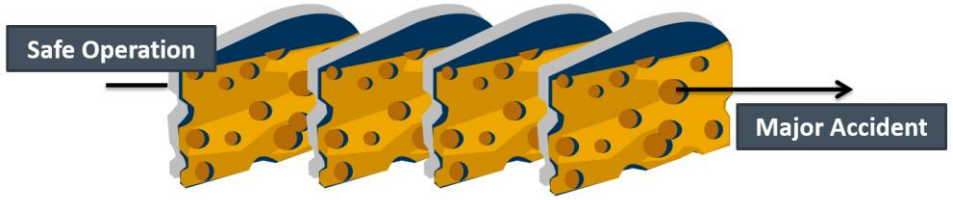
Why Fire and Gas Mapping?

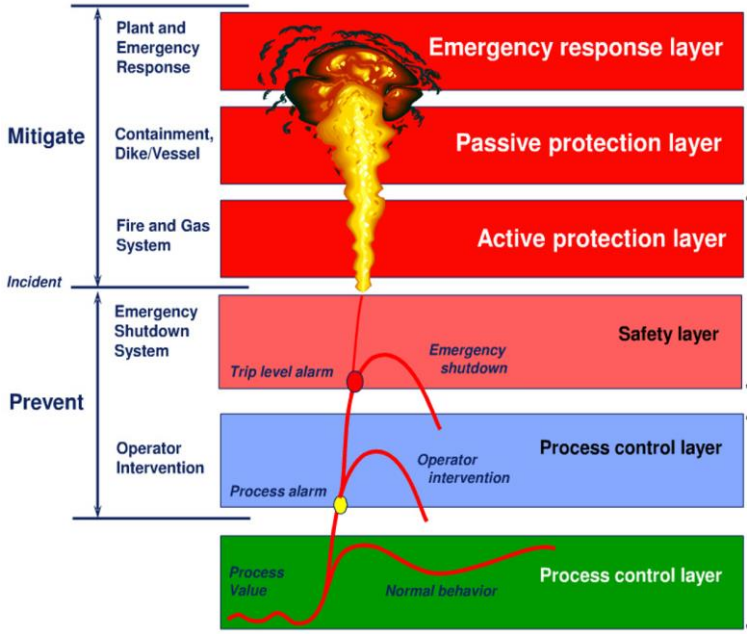
- Fire and Gas mapping answers the following questions:
  - What detectors will respond to the hazard?
  - Where should the detectors be positioned?
  - How many detectors are needed?
  - How can I be sure the area of concern is protected to an acceptable level?
  - How do I address change management?
- This presentation will show how fire and gas mapping **actively contributes to Project Certainty** by;
  - Providing optimised detection coverage
  - Reduced design time

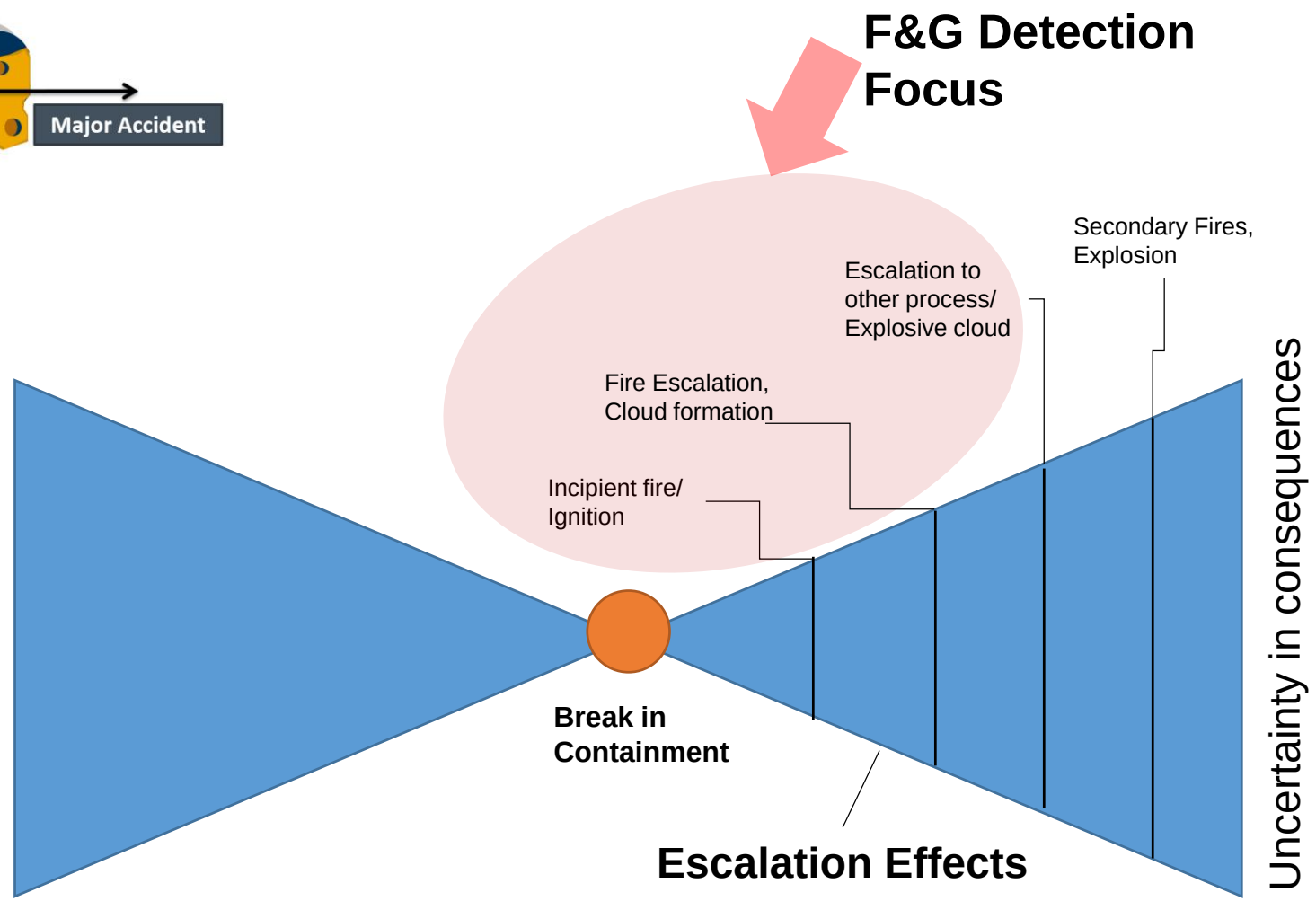
Improving Design Quality and Consistency



What is the Purpose of Detection?

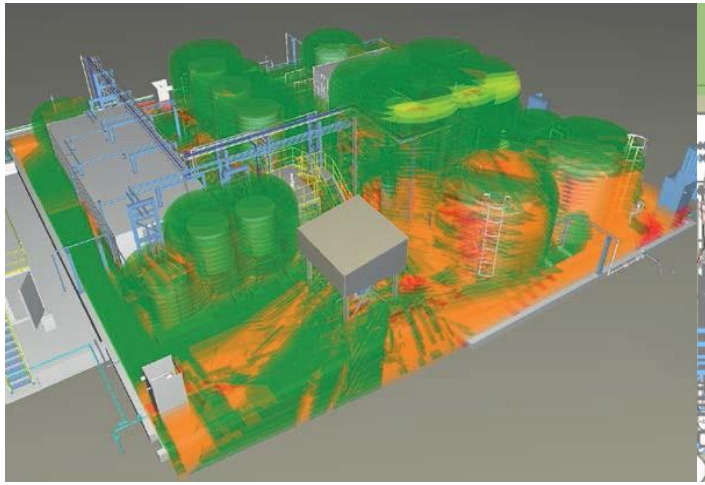


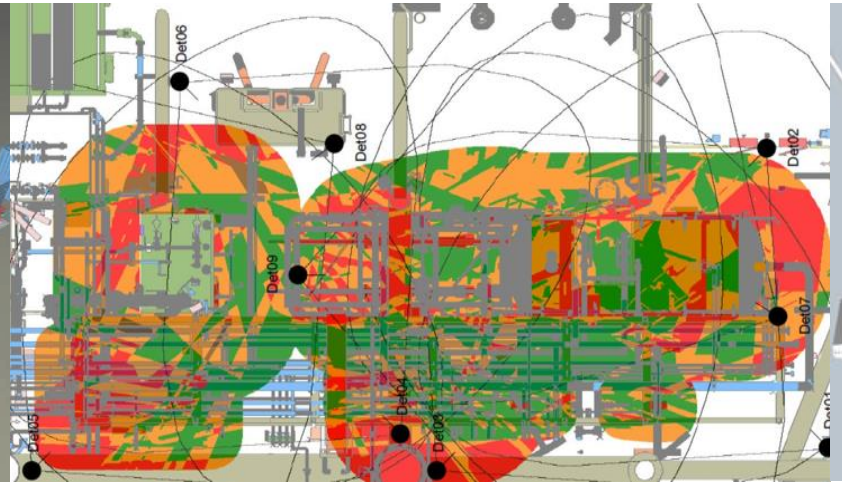




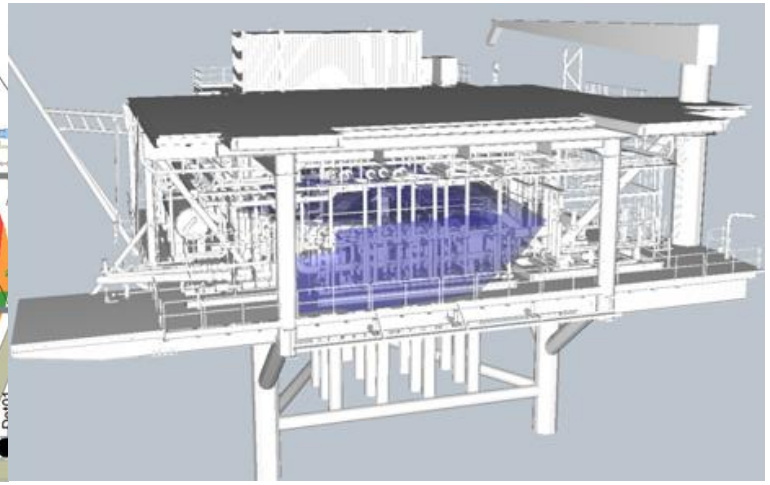
The flame detection problem

- How do we know if we have enough flame detectors?



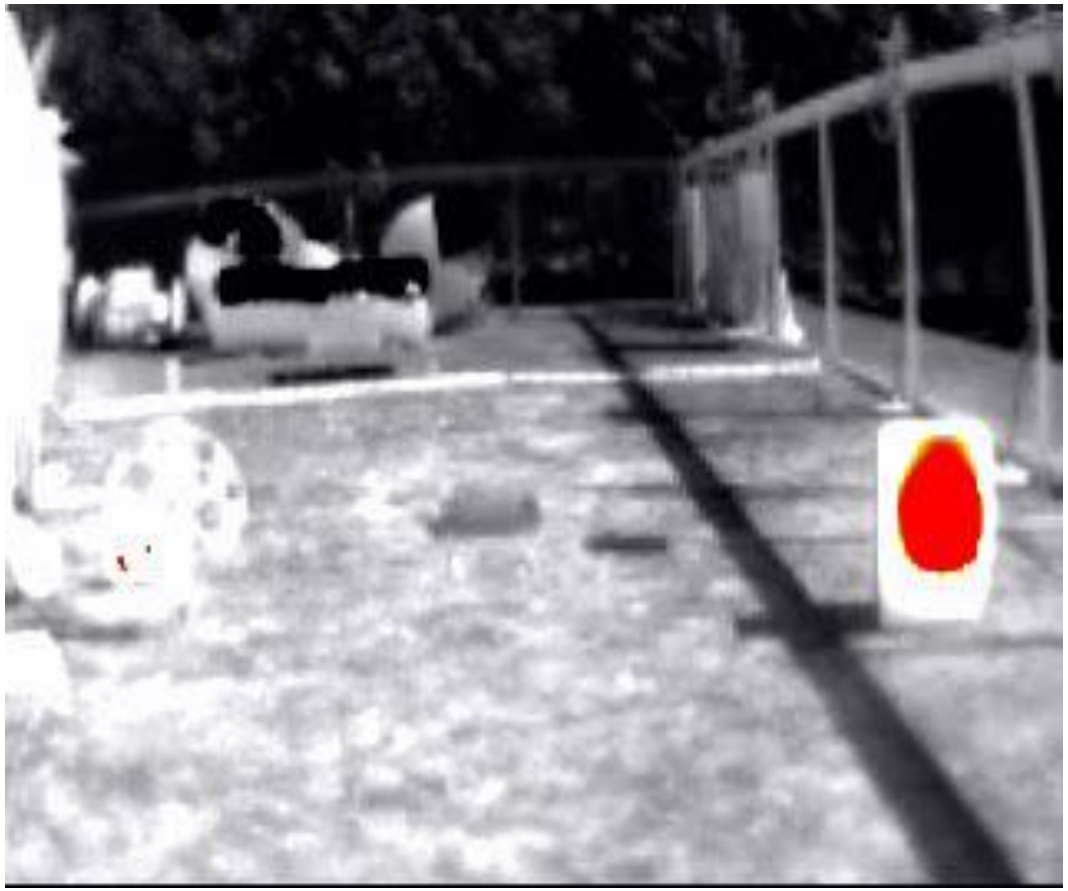


- How do we know where to position our flame detectors?



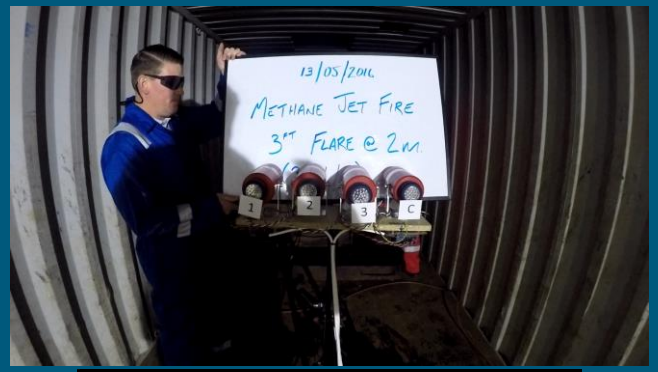
- How do we know our flame detectors are appropriate to detect a specific flame?

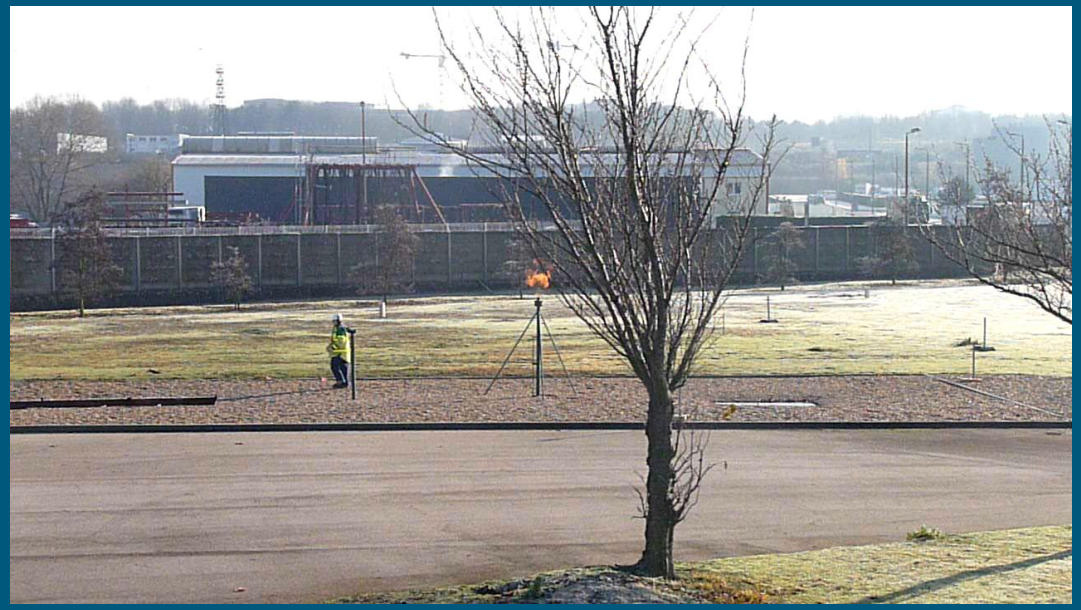
What does a detector see?



Example Consideration: Flame Detector Behaviour to Large Fires

- Flame detectors should have the ability to detect fires which are:
  - Close to the detector
  - Far away from the detector





Flame Detection Modelling – Grading Process
Flame Detection Targets

- Certain practices apply a high risk grade with a surrounding lower risk grade. This is termed a **Nested Fire Grade**. (Zone within a Zone).
- Nested Fire Grade benefits:
  - Ability to account for different fire scenarios
  - Accommodates the limitations of some flame detectors
- Application example, a high pressure vessel
    - Flame detector challenge – the need to detect small fires may mean large fires cannot be detected due to sensor saturation
    - High pressure gas fire (need to detect large fire)
    - Fire from adjacent equipment impinging on high risk equipment (need to detect small fire)

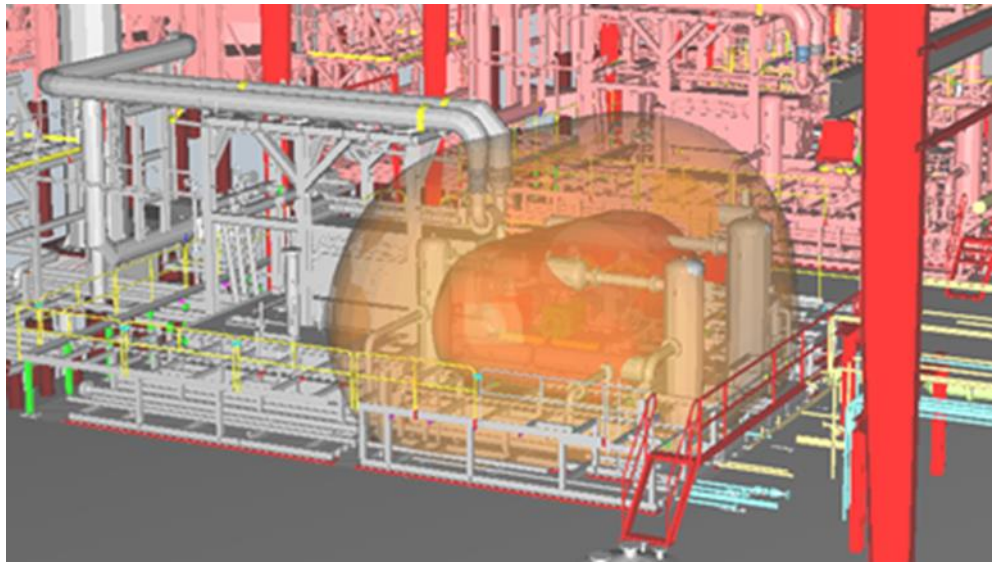
Flame Detection Mapping – Grading Process Performance Based Design

➢ **Red High Risk Immediately Next to Vessel**

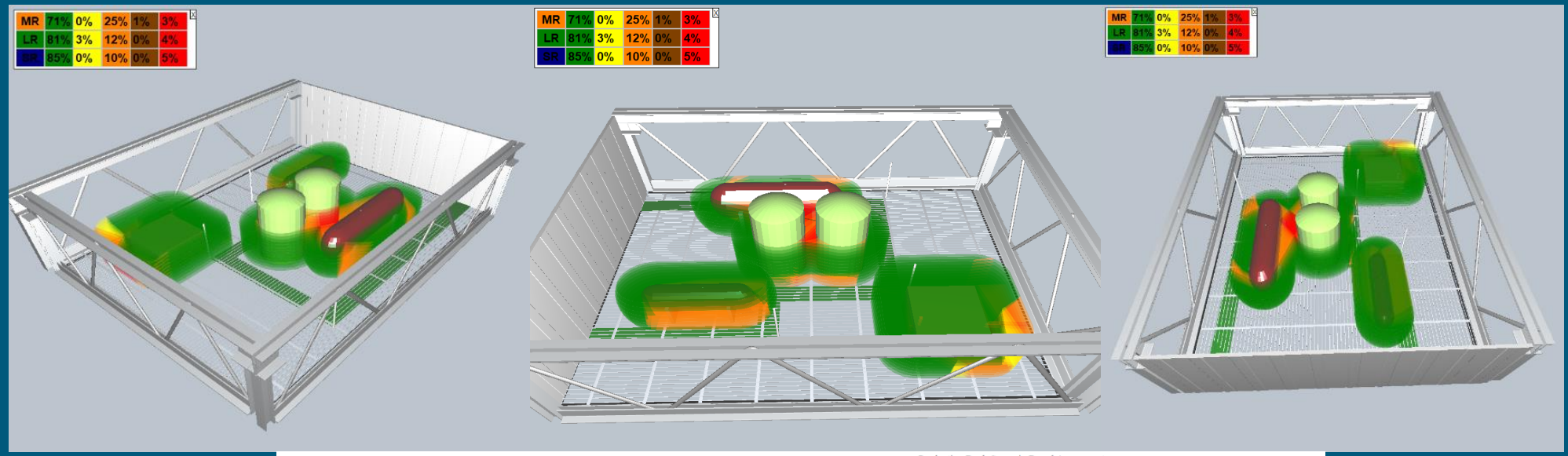
- High Risk 10kW Alarm, 50kW Control Action, 1m extension.
  - ➢ A small independent fire (i.e not from the vessel itself) will be detected and actioned before causing a rupture on the high risk equipment

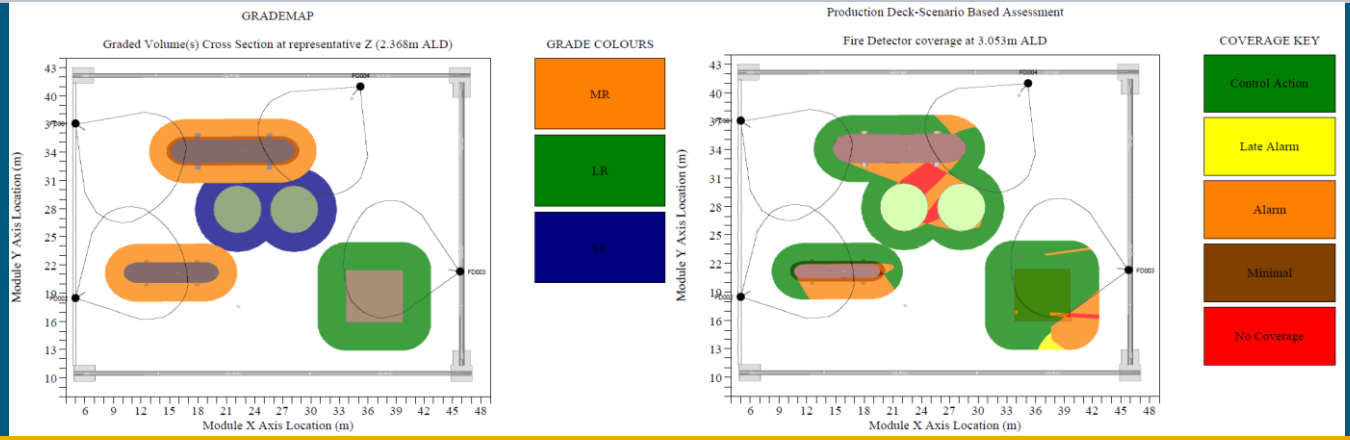
➢ **Orange Medium Risk Surrounding the High Risk Grade**

- Medium Risk 50kW Alarm, 100kW Control Action, 3m extension
  - ➢ Detects potential jet fires when they become more visible to detectors, further from the vessel.
  - ➢ Detectors very close to the vessel may become saturated, but can detect secondary fires which may be the cause of a higher escalation rupture



Flame Detection Assessment





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Reporting Feature: Flame Detection Assessment

FLAME DETECTOR ASSESSMENT
Performed by HazMap3D v2.01
Assessed on 27-Feb-2018 at 09:28

HazMap3D version

Assessment Date

PROJECT INFORMATION

Project name:	**Production Deck**
Assessment title:	**Scenario Based Assessment**
Number of detectors:	4 (4 existing, 0 new, 0 relocated)
Overall coverage:	96% (% graded samples achieving alarm action or better)

Detector Total; Review type: Existing, New, Relocated

Coverage achieved

COVERAGE SUMMARY

MR	72%	0%	24%	1%	3%
LR	74%	1%	20%	0%	5%
SR	85%	0%	10%	0%	5%
Totals	76%	0%	19%	0%	4%

MR/LR/SR	Fire graded equipment
	Selected alarm and control points met (2ooN)
	Fire must grow
	Alarm point met only (1ooN)
	No detection, alarm when fire grows
	No detection point met

Reporting Feature: Flame Detection Assessment

DETECTOR CONTRIBUTIONS

TAG	Individual	1ooN	2ooN	>2ooN
All Detectors		95.5	76.6	29.1
FD001	45.1	93.3	51.6	15.6
FD002	68.0	85.5	45.6	6.5
FD003	44.4	92.8	55.4	13.0
FD004	48.0	91.6	58.9	7.1

Review detector contributions

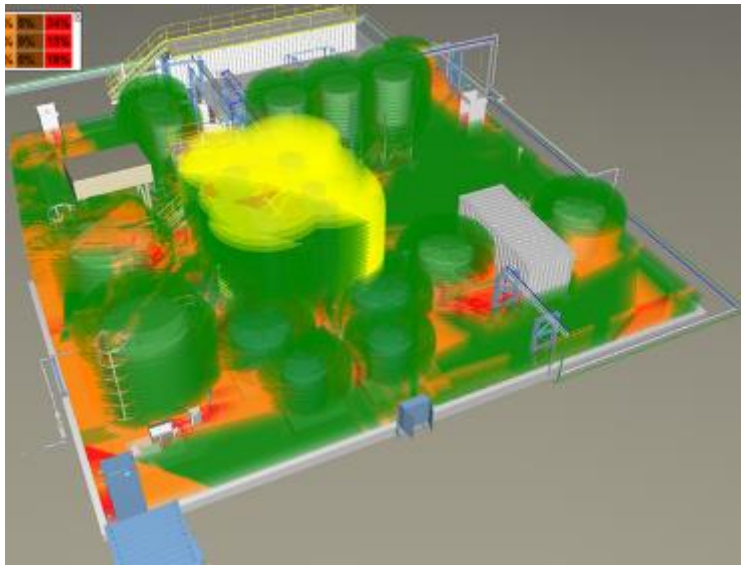
Engineering Judgement determines if the contribution of each detector is sufficient to maintain its place in the model

Tag No	Type	X,Y,ALD(m)			Pan/Tilt(deg)		Comments
Det01	Det-X3301(Med)	29.300	6.340	2.760	+180	+13	
Det02	Generic25m	26.500	0.290	2.860	+142	+13	
Det03	Generic25m	14.321	0.265	2.765	+65	+13	
Det04	Generic25m	26.090	0.010	2.760	+142	+13	

Appropriate device selection can save money

Assessment title: All FDS301

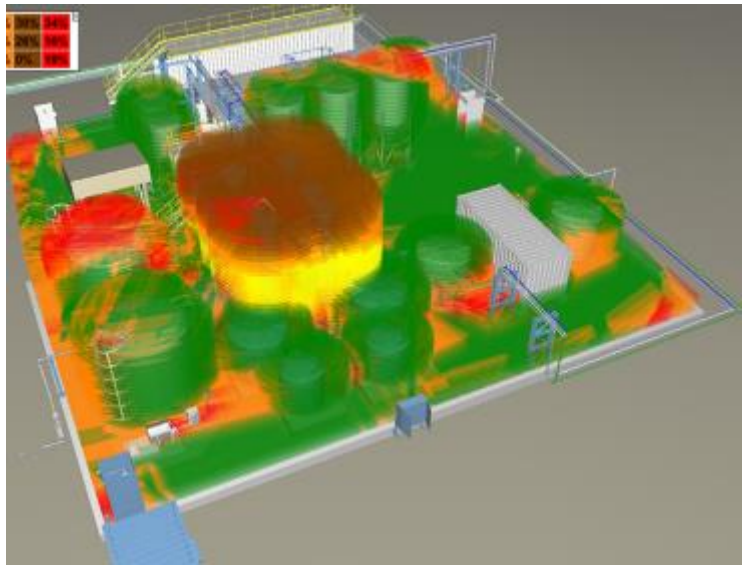
Number of detectors: **10**



HR	31%	0%	29%	5%	34%
MR	36%	32%	19%	0%	13%
LR	56%	0%	26%	0%	17%

Assessment title: Same Layout Triple IR

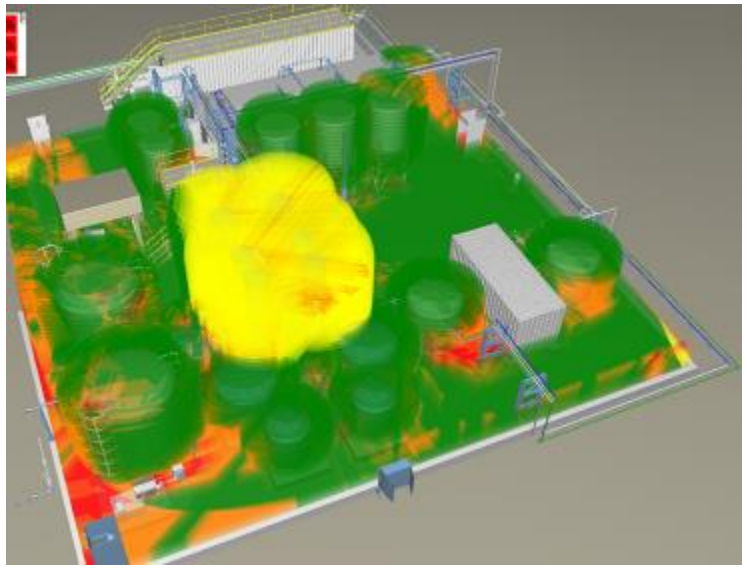
Number of detectors: **10**



HR	1%	0%	35%	30%	34%
MR	11%	15%	32%	26%	16%
LR	54%	0%	28%	0%	19%

Assessment title: Triple IR w/ more devices

Number of detectors: **16** (9 existing, 6 new, 1 relocated)

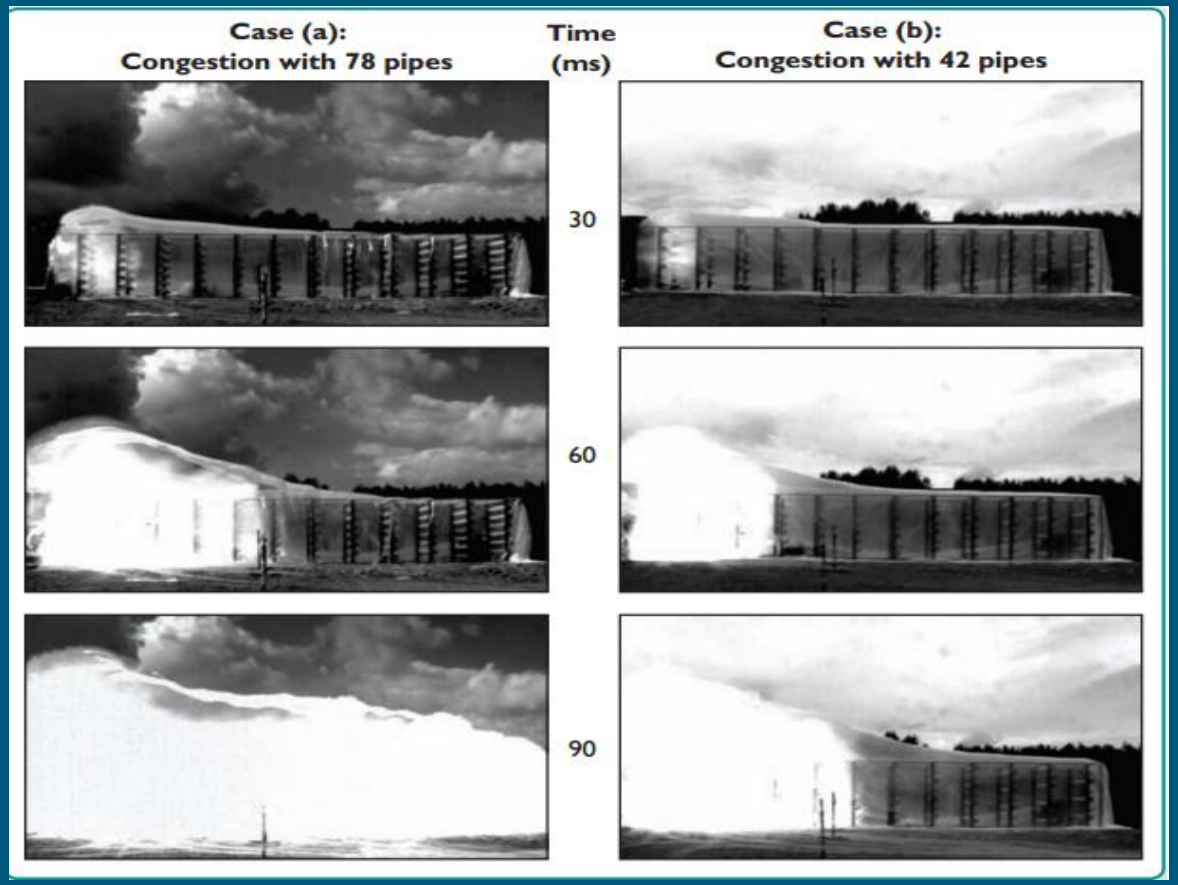


HR	27%	0%	31%	16%	26%
MR	30%	39%	17%	3%	10%
LR	64%	0%	20%	0%	16%

MICROPACK FIRE & GAS

Gas Detection Mapping – Grading Process

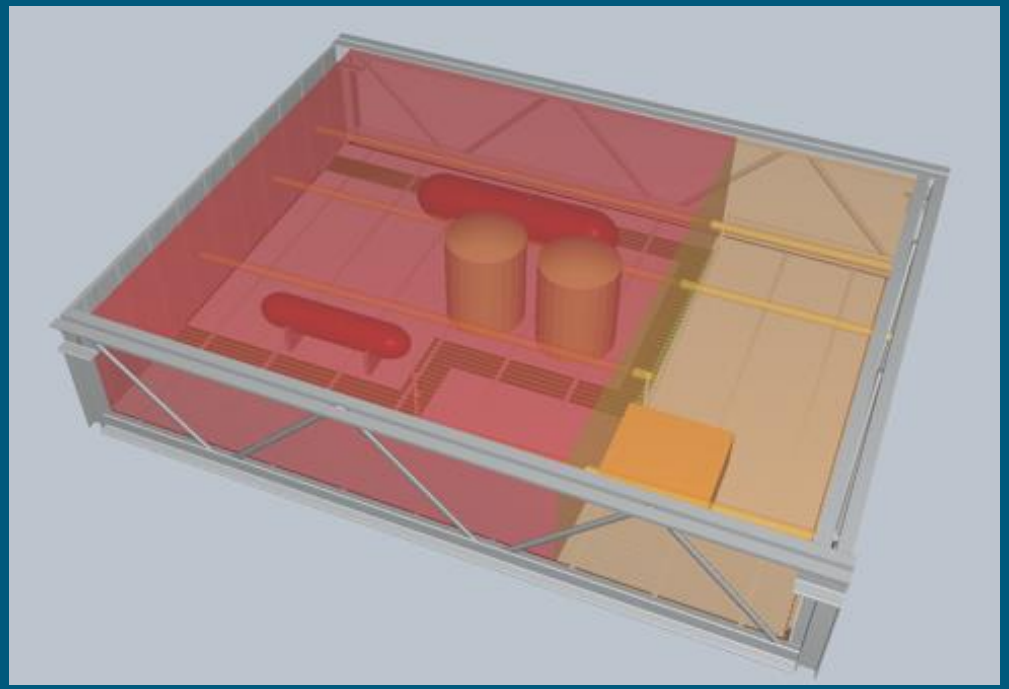
Blockage Ratio – Ignition Behaviour

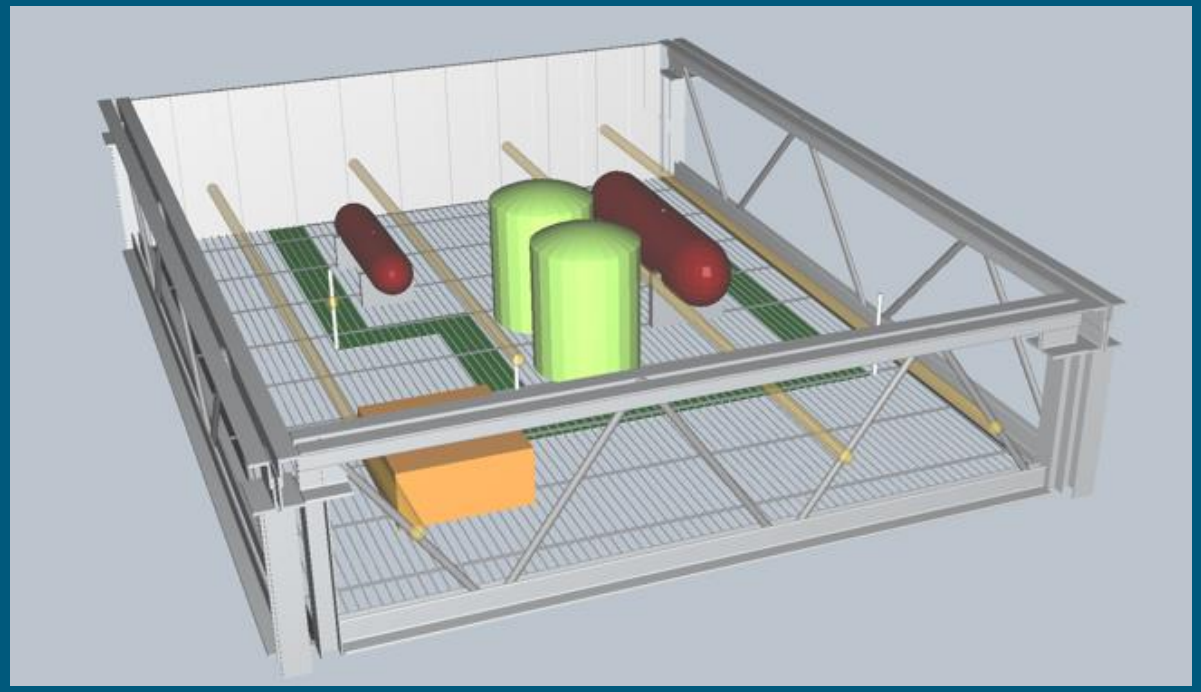


Gas Detection Mapping – Grading Process

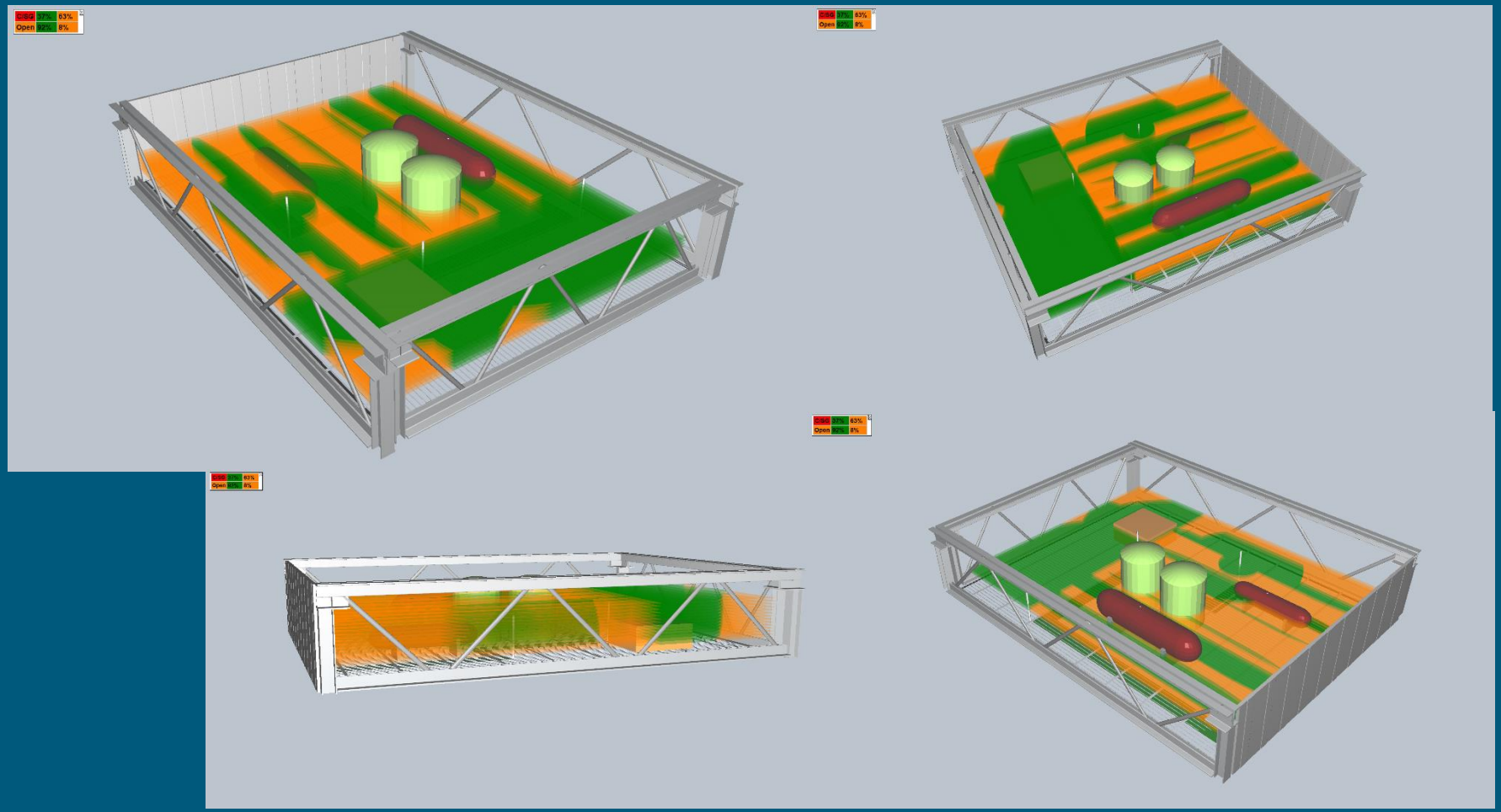
Grade Volume

Add Detectors





Gas Detection Mapping Assessment



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Detector Contributions

GAS DETECTOR DETAILS (Page 1 of 1)										Detector Contributions						
										Individual		Voted				
Tag	Type	Tech	Status	Det X,Y,ALD (m)			Rcv X,Y,ALD (m)			L	H	L	H	2L	HL	2H
OPGD001	DR Pulsar 2 (mr)	OPGD	Exists	4.995	37.800	3.492	46.072	38.116	3.552	39.4%	24.1%	3.7%	10.0%	24.9%	20.0%	12.4%
OPGD002	HW Excel (mr)	OPGD	Exists	4.995	31.737	3.210	46.099	31.559	3.665	54.6%	29.2%	3.1%	10.2%	34.8%	21.1%	15.3%
OPGD003	DR Pulsar 1 (mr)	OPGD	Exists	4.995	22.776	3.330	34.328	22.654	4.085	52.2%	12.4%	5.2%	9.6%	21.4%	15.0%	0.1%
OPGD004	HW Excel (mr)	OPGD	Exists	4.995	14.923	2.906	46.062	15.132	4.127	47.8%	25.9%	9.5%	18.6%	15.7%	8.8%	3.5%
IRPGD001	SIM-GD10P	PGD	Exists	22.381	17.532	2.715				19.4%	1.1%	0.0%	0.6%	7.3%	6.7%	0.5%

GAS DETECTOR ASSESSMENT
Performed by HazMap3D v2.10
Assessed on 05-Sep-2018 at 15:24

PROJECT INFORMATION

Project name: **Production Deck**
Assessment title: **Proposed Gas Detection**
Number of detectors: 5
Calculation model: Simple

ASSESSMENT VOLUME DIMENSIONS

Height: 4.00 m Length: 30.00 m Width: 40.00 m Deck Z: 0.00 m

ASSESSMENT PARAMETERS

Grading Rules (only grades used in assessment are shown)

Grade	Hi Gas Diameter	Lo Gas Diameter	Voting
C/SG	5.00m	15.00m	H+L
Open	10.00m	30.00m	H+L

Assessment performed using 15 slices from 2.00 m to 6.00 m
Increment between 3D assessment slices: 0.29 m

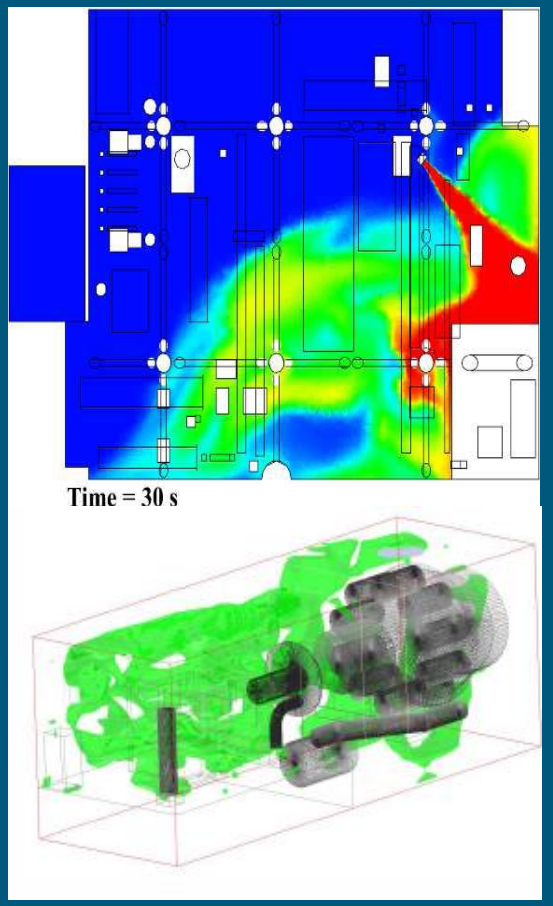
ASSESSMENT SUMMARY

Assessment	Grade C/SG	Grade Open	Overall
Full control action	37%	92%	54%
Some coverage	63%	8%	46%

Gas Detection – Target Gas Cloud vs Dispersion Modelling

Reliability of Approach

- If we determine an 8m cloud can cause an overpressure of >150mBar in a module of a facility, shouldn't we design the system to ensure this is detected?
- If we conduct probabilistic dispersion scenarios, how many scenarios are enough?
  - 50,000 crude scenarios in '2D'?
  - 50 detailed CFD simulation (likely not even that many)?
  - If we run 'enough' simulations (hundreds of millions of scenarios?) we find that gas can **and does** go anywhere – was it worth the time and cost?
  - Are you comfortable placing detection based on such a limited sample?
  - Can the 8m gas cloud remain undetected in certain circumstances?
  - Will designs be inconsistent dependent upon the operator of the simulations and the tool being used?
  - Will it ultimately result in **more** detectors? There is always another scenario to run and more detectors to add…



Gas Detection Effectiveness – The False Narrative

The UK Health and Safety Executive statistics on gas releases:

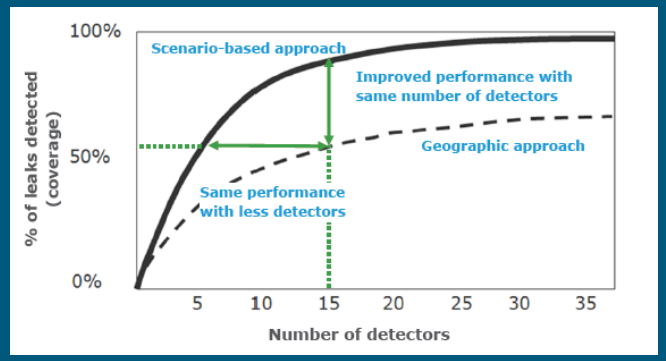
- 1993-2015 approx. half of gas releases were undetected by fixed gas detection systems in the UKCS
- Narrative which has been drawn:
  - Gas detection placement inadequate
  - Methods advised on gas detection design inadequate

- This narrative is not founded on scientific principles:
  - Were the releases large enough to present the explosion hazard in which the detectors are designed to prevent?
  - Was the layout of gas detectors in compliance with the best practice guidance available? Probably not.
  - Were all of the detectors in operation at the time of gas release? Probably not.

When all of these factors are considered, detecting half of the recorded releases could be viewed as impressive!

Scenario vs Geographic – Debunking the Myths

- Using gas dispersion modelling will design a more effective gas detection system… debunked:
  - The following graph is often cited to promote dispersion based mapping… but is flawed in its analysis:



(Scenario-based fire & gas mapping as a way to optimise detection layouts, Presented at FABIG TM94, DNVGL)

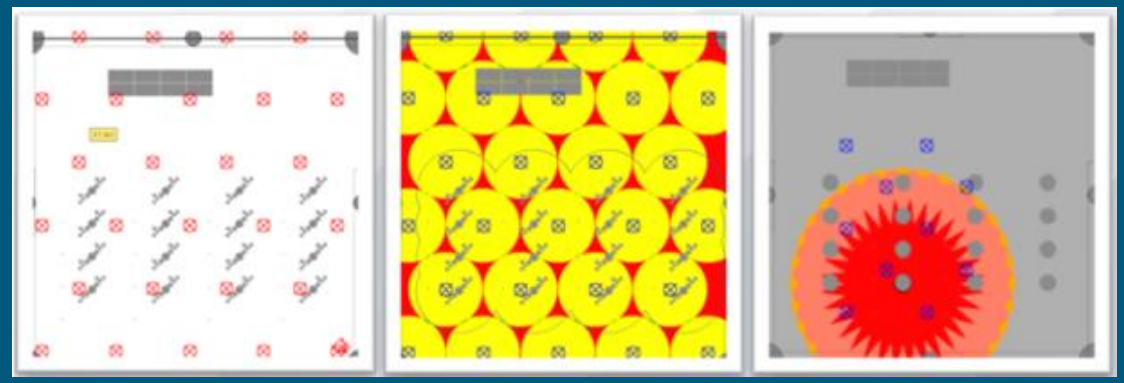
  - Verification runs the same scenarios and assumptions which were used to generate the layout – of course it will show good detection 'effectiveness' for the layout.
  - The performance is also to 'no. of leaks detected'. Ultimately we don't care if the detection system detects 99% of leaks if they are all insignificant – we care about the 1% which will cause an explosion.
  - If we run an alternative analysis of effectiveness as 'how many times will the gas cloud of concern remain undetected' then the **scenario based design will be highly ineffective** but the **geographic layout will be 100% effective**.

Scenario vs Geographic – Debunking the Myths

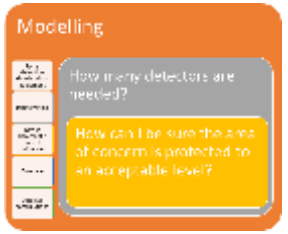
- Gas Dispersion Based Mapping will reduce the number of gas detectors required... debunked:
  - If we run one scenario and place detectors where the gas goes = very few detectors. **Not a suitable design though.**
  - If we run a 'suitable' number of scenarios, gas will go everywhere and we have to **place detectors all over the module, whether an explosion hazard exists or not.**

Case Study (from 'Optimizing Gas Detectors' presentation, ISA UAE Conference, May, 2016):

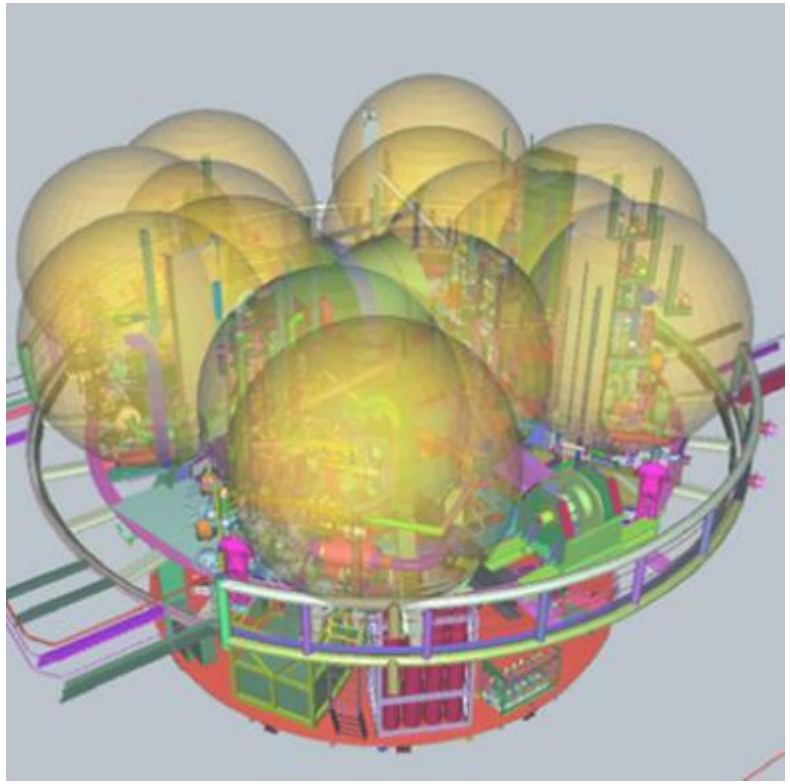
  - Reduced 27 detectors to 17 detectors (using scenario based approach) while only reducing coverage from 91% to 86%
  - In reality, the geographic approach could provide 100% coverage of the module using ~5 line of sight detectors (practicality dependant) – quite a cost saving from the 'optimised' scenario based approach which recommended 17! Think of all that cable and maintenance!
  - Also, the approach which recommended 17 detectors left significant gaps which a substantial gas cloud would remain undetected.



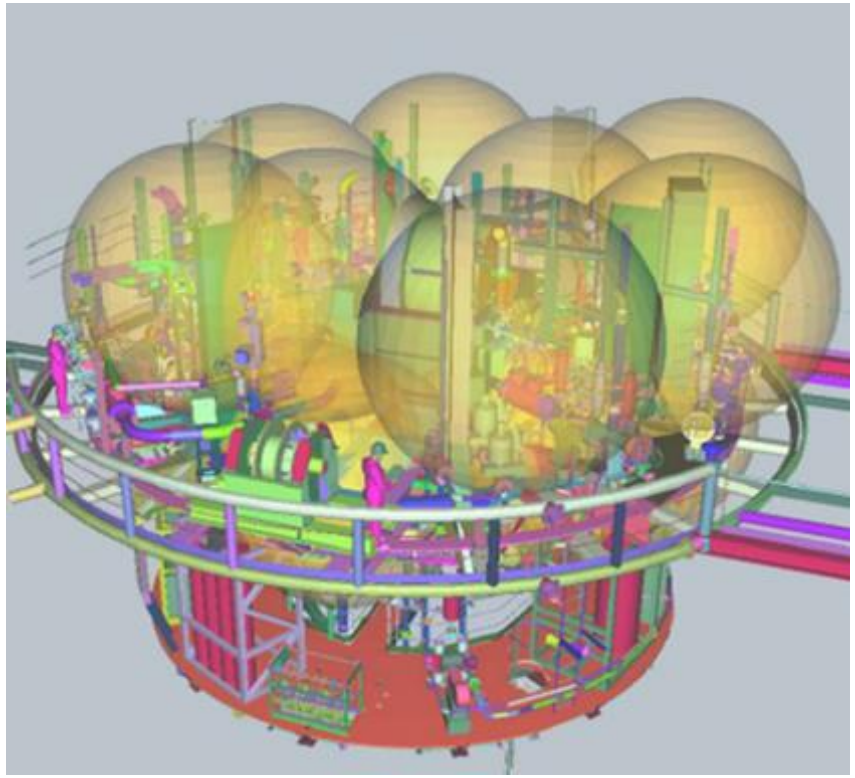
Modelling comparisons
- detecting gas accumulations



Gas Dispersion Layout - 14 detectors



Volumetric Approach – 8 detectors



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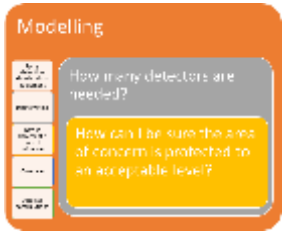

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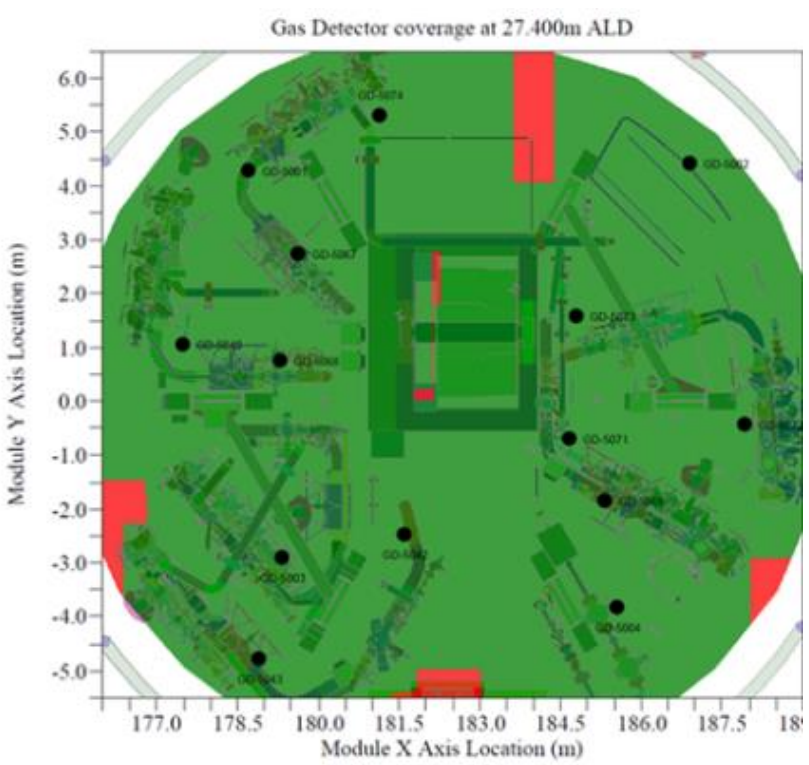

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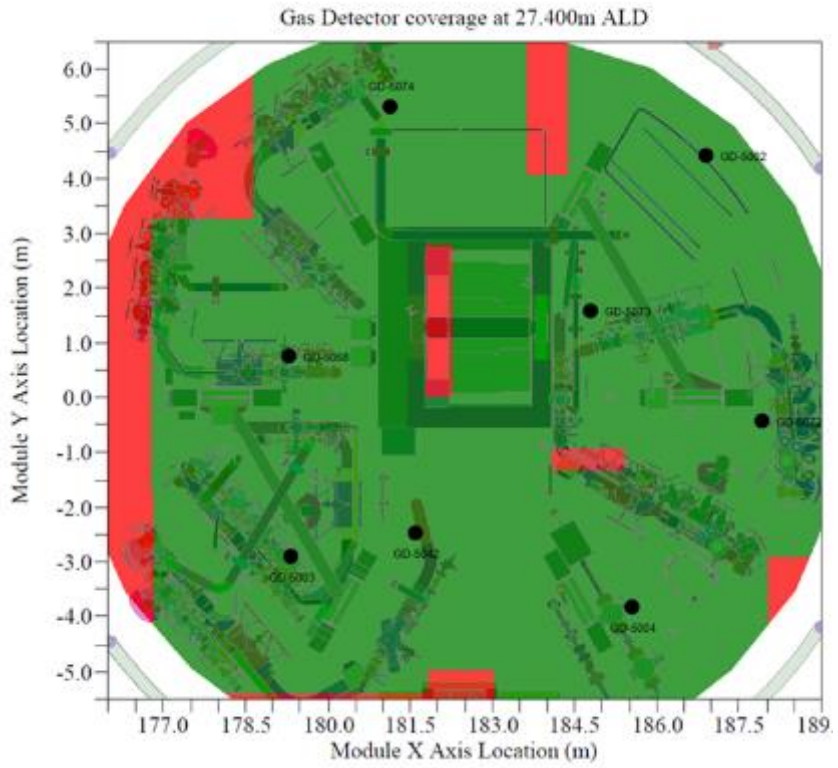

Summary
Fire & Gas Mapping - Improving Design Quality and Consistency

F&G MAPPING

Knowledge

- Hazard identification
- Define escalation potential
- Performance definition
- Mitigation actions
- Review detector contributions

What detectors will respond to the hazard?

Where should the detectors be positioned?

Modelling

HazMap3D
Trusted Compliance

- Apply detection thresholds to equipment
- Define voting
- Device placement & area of influence
- Coverage
- Detector contributions

How many detectors are needed?

How can I be sure the area of concern is protected to an acceptable level?

Thank you very much for your attention

James McNay

Director of Consultancy and Engineering

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