



Reconciling Mental Health Anti-ligature & Fire Engineering Requirements

(A New Zealand Case Study)

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 **BECA**

Background – New Zealand Mental Health / Fire Engineering

Mental health focus

Developing anti-ligature expectations

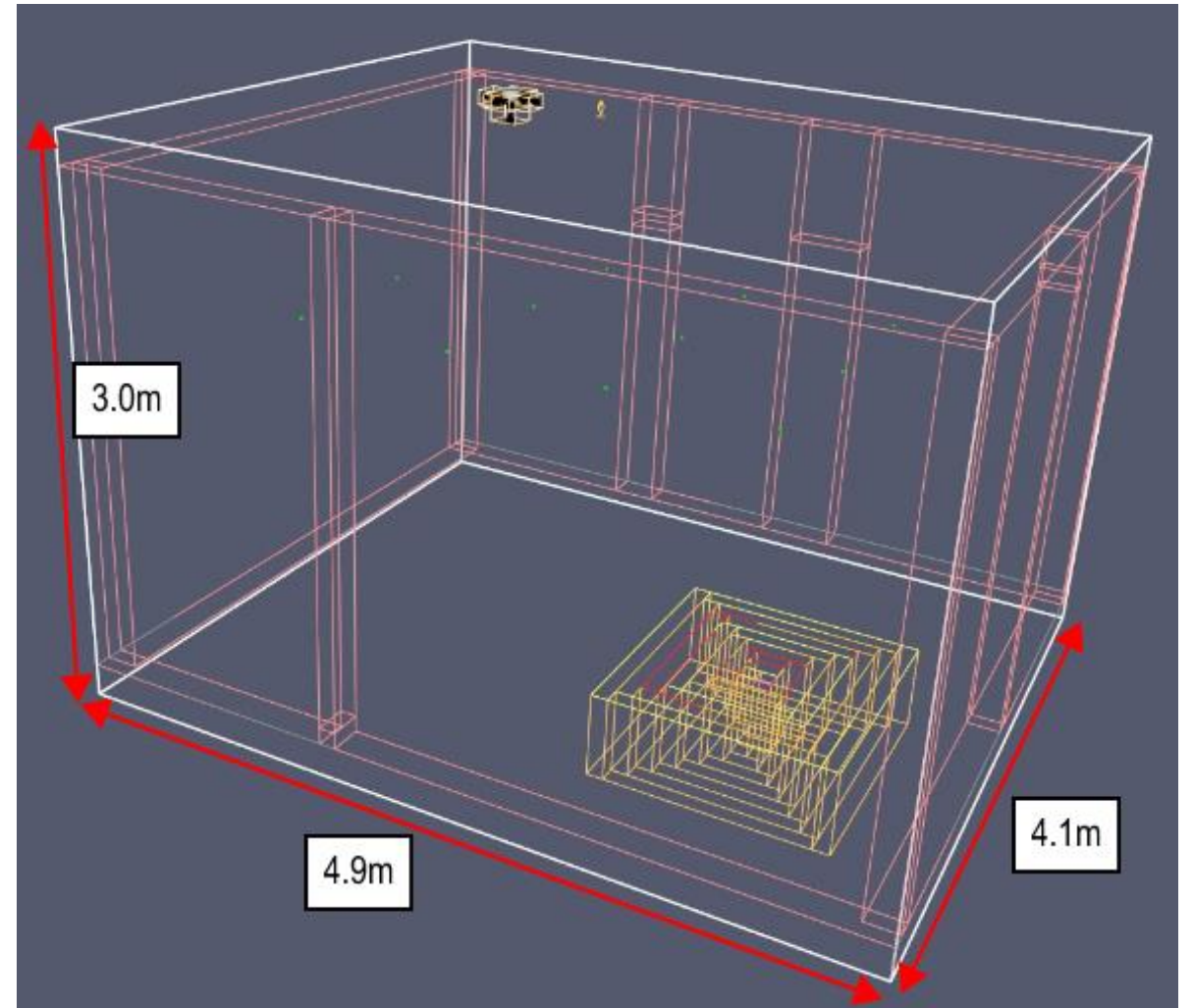
Risk zoning approach

Smoke detection challenges



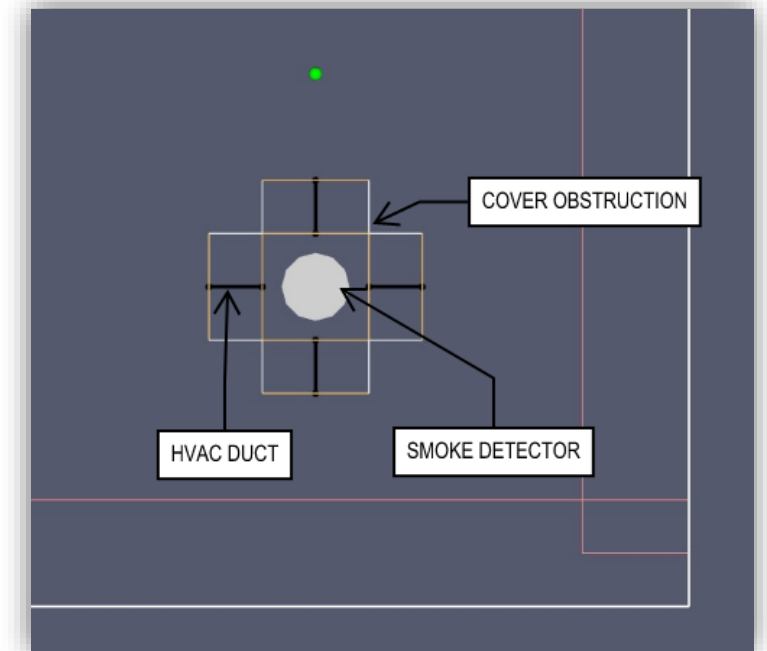
Methodology – Building Geometry

- Based on review of several new & existing facilities
- Identified average bedroom size & configuration



Methodology – General Assumptions / Parameters

Model Parameter	Value
Wall Leakage	0.1% Area
Door Leakage	10mm Gap Around Door
Cover Leakage	HVAC Model
Smoke Detector Characteristics	Optical Density at Alarm - 0.097m^{-1} (20% OBS) Radial Distance - 3.8m Distance Below Ceiling - 25mm Type - Heskestad Ionization (L=1.8m)
Materials	Walls & Ceiling - Plasterboard Floor - Concrete Detector Cover - Steel (1mm)
Mesh Dimension	0.1m
Fire	Heat of Combustion (ΔH_c) - 20 MJ/kg Medium Growth Rate HRRPUA - $1000\text{kW}/\text{m}^2$ Discretized Rectangular Burner
Species Yield	CO - 0.04 kg/kg Soot - 0.07 kg/kg
Simulation Mode	Large Eddy Simulation (LES)



Methodology – Scenarios

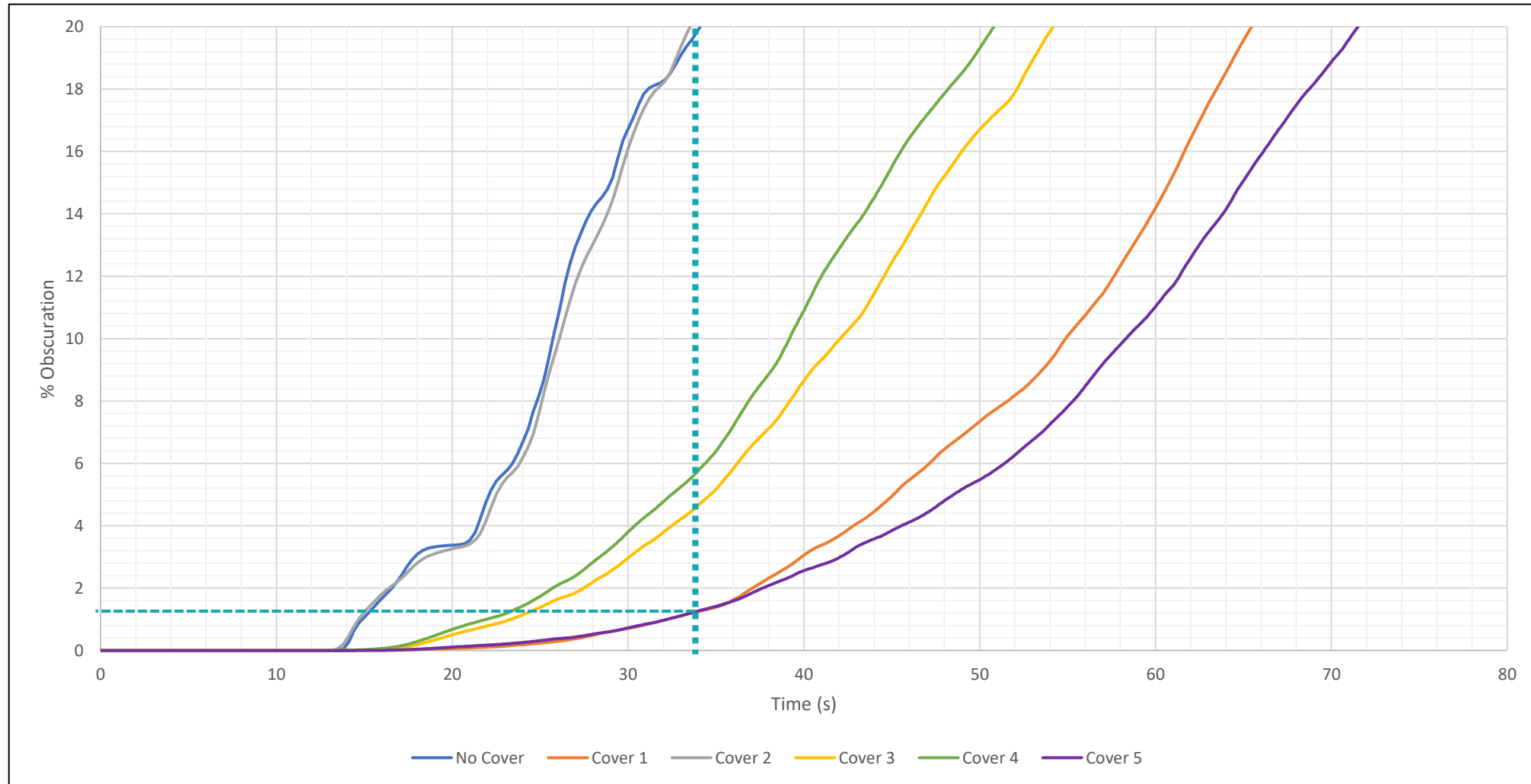
Model Scenario	Cover Configuration (total free area)	t² Fire Growth Rate
Scenario 1	No Cover	Medium (0.0117kW/s ²)
Scenario 2	Cover 1 (0.0090m ²)	
Scenario 3	Cover 2 (0.0500m ²)	
Scenario 4	Cover 3 (0.0125m ²)	
Scenario 5	Cover 4 (0.0180m ²)	
Scenario 6	Cover 5 (0.0045m ²)	Fast (0.0469 kW/s ²)
Scenario 7	No Cover	
Scenario 8	Cover 1 (0.0090m ²)	Slow (0.00293 kW/s ²)
Scenario 9	No Cover	
Scenario 10	Cover 1 (0.0090m ²)	



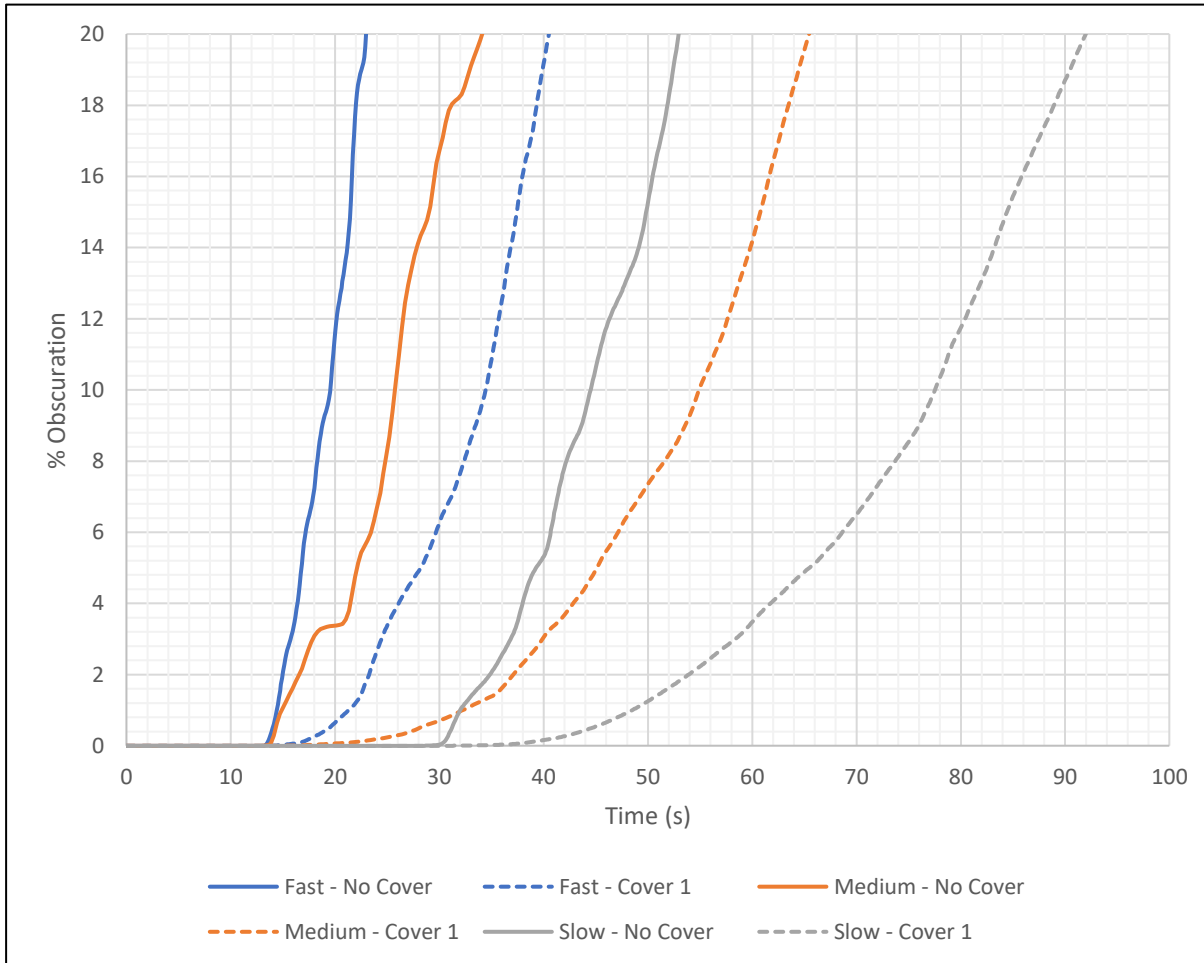
Results – Cover Configurations

Model Scenario	Cover Configuration (total free area)	Detector Activation Time (20% OBS)	Delay (s)	Multiplier
Scenario 1	No Cover	33.96	-	-
Scenario 2	Cover 1 (0.0090m ²)	65.30	31.34	1.92
Scenario 3	Cover 2 (0.0500m ²)	33.40	-	-
Scenario 4	Cover 3 (0.0125m ²)	54.14	20.18	1.59
Scenario 5	Cover 4 (0.0180m ²)	50.76	16.80	1.49
Scenario 6	Cover 5 (0.0045m ²)	71.48	37.52	2.10

Results – Cover Configurations



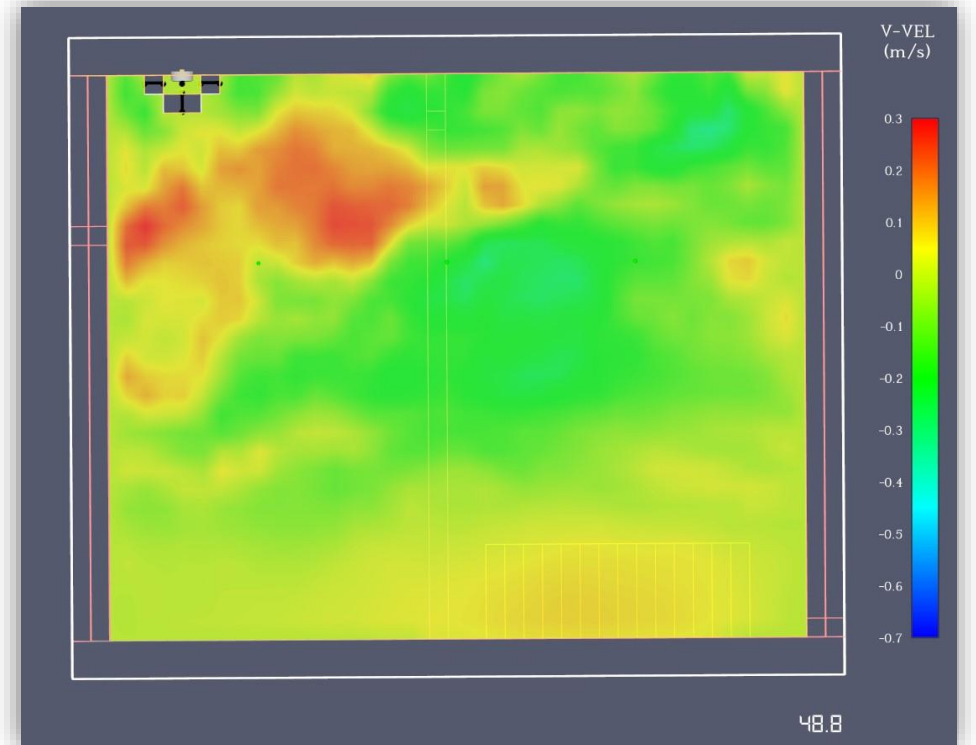
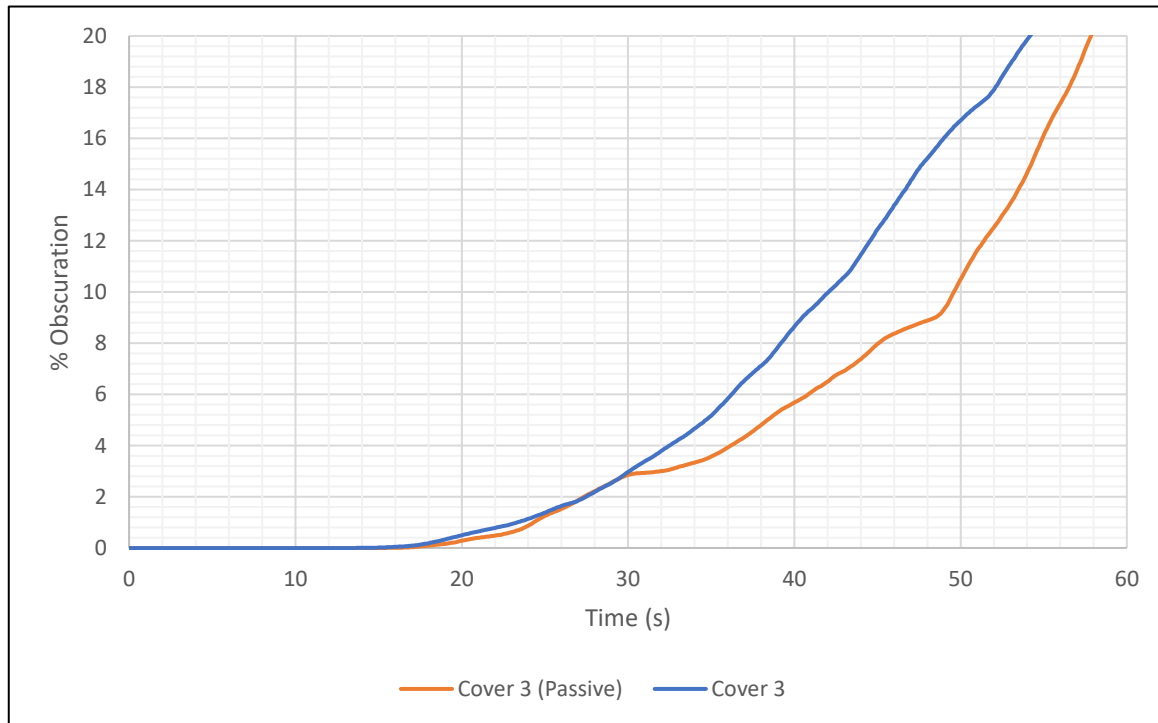
Results – Fire Growth Rate



Model Scenario	Cover Configuration (total free area)	t ² Fire Growth Rate	Detector Activation Time (20% OBS)	Delay (s)	Multiplier
Scenario 1	No Cover	Medium (0.0117 kW/s ²)	33.96	-	-
Scenario 2	Cover 1 (0.0090m ²)		65.30	31.34	1.92
Scenario 7	No Cover	Fast (0.0469 kW/s ²)	22.94	-	-
Scenario 8	Cover 1 (0.0090m ²)		40.46	17.52	1.76
Scenario 9	No Cover	Slow (0.00293 kW/s ²)	52.92	-	-
Scenario 10	Cover 1 (0.0090m ²)		92.00	37.08	1.74

Results – HVAC Model Sensitivity

- 20% difference
- Time delay multiplier could be up to 2.3x accounting for 'error'
- Detector lag time influence



Conclusions

- Current anti-ligature smoke detector solutions are not fit for purpose
- FDS HVAC model can quantify smoke detector cover impact
- Initial results identified up to 2.3x time delay
- Increasing smoke detector sensitivity alone is not the answer
- This study provides a framework and is not to be used directly in design

The background is a solid teal color. It features several thick, bright yellow lines that create abstract, geometric shapes. One line starts at the top left, goes down and right, then up and right, then down and right, forming a jagged path. Another line starts at the bottom left, goes up and right, then curves upwards and right, then down and right, forming a curved path. A third line is a vertical segment on the right side of the image.

Thank You