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UNDERSTANDING THE IMPACT ON SPRINKLER SYSTEMS DUE TO REDUCED SUPPLY WATER PRESSURE

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Abstract. *Sprinkler systems are designed and installed to control the spread of fire. They are designed based on information including the supply water flow and pressure availability to meet the hydraulic demand of the system design. One of the challenges facing sprinkler systems currently designed and installed in New Zealand is the trend of mains town supply water pressures being reduced by water supply companies to mitigate leaks in the water supply pipe work caused by ageing infrastructure and continued urban expansion; the main reason being ageing infrastructure. This presents the results from analysis related to the effectiveness of sprinklers on activation in a fire scenario and results from computer modelling of a sprinkler system to determine what the impact of reducing the pressure in a sprinkler system below the original design parameters is.*

1 INTRODUCTION

Sprinkler systems are designed and installed to control the spread of fire. They are designed based on information which includes the supply water flow and pressure availability to meet the hydraul

4 year period [4] for an .ordinary hazard (OH) system as 1,200 l/min operating at a pressure of 240 kPa.

2 METHODOLOGY

2.1 Background

Circa 1990, sprinkler experiments focusing on the interaction of sprinkler systems and smoke vents were conducted by the UK Building Research Establishment at the Multifunctioneel Trainingcentrum in Ghent, Belgium. Subsequent to that work, Frank et al (2012) [9] used this experimental work to further understand the reliability of sprinklers by modelling sprinkler activation times. This paper builds on the further work by Frank (2013) [2] with consideration to sprinkler system configuration type, pipe diamete ( ) -10 (o [(wi (e,)34 72 51

Figure 3: Graph of Flow/Pressure sample data from five New Zealand sites

To simulate a reduction in town main water pressure the ‘Town’s Main Sample 2’ Curve was reduced at intervals of 10% for each simulation run within HYENA and BRISK until a noticeable change in the sprinkler system performance to suppress the fire was observed form the output results. The supply water flow/pressure curves used for modelling are shown in Figure 4. The reduction in pressure is denoted by the 10% increment reductions.

Figure 4: Graph of an incrementally reduced Flow/Pressure design curves used in the HYENA modelling component of the analysis.

2.3 Sprinkler system enclosure

Investigating a component of the work completed by Frank (2013) and also using the Ghent sprinkler test layout design as discussed in Frank’s research. The sprinkler set up and enclosure design comprised of a 55-sprinkler head grid spaced at 3.35 m by 2.45 m within an enclosure

2.4 Sprinkler system selection

Three types of sprinkler layout systems were considered as representative of a sprinkler system installed in commercial buildings in New Zealand today. They are the end-type; loop-type used circa post1970's and an older version of the loop-type used circa pre 1970's in saw tooth roof profile buildings.

Based on the resources and timeframe available for the project, the end-type and loop-type (post circa 1970's) sprinkler systems were selected to be modelled in HYENA and BRISK using the same sprinkler grid layout similar to the Ghent sprinkler experiment as used by

2.5 Areas of Operation for an OH3 sprinkler system

The areas of operation, as shown by the shaded regions in Figure 5 and Figure 6, comprise of 18 sprinklers per zone as defined by NZS4541. The guidance of NZS4541 requires that the hydraulic demand for all 18 heads operating simultaneous

**Although this sprinkler head is a quick response sprinkler [10], the RTI is set at 200 $(m.s)^{1/2}$ for the B-RISK models.

2.8 Design Fire Selection

The design fire that was selected for use in the modelling was a fast growth 5.3 MW fire as it was considered, from the Society of Fire Protection Engineering (SFPE) handbook, to be representative of the fuel load for type for a commercial premises [11], [12]. Furthermore, the 5.3 MW design fire was initially confirmed to activate a number of sprinkler heads exceeding the 18 sprinklers within the area of operation. Frank et al work (2012) used a larger fire (up to 14MW).

2.9 Design Fire Location

The End-Type and Loop sprinkler configurations were modelled with the design fire located in one of two locations; Within t

In Figure 7, the ‘no suppression’ curve shows a sharp reduction just before 1800 seconds; this is due to the fire becoming ventilation controlled. If the width or height of the opening to the enclosure was increased, this effect would occur later, depending on the vent area increase.

Figure 7: HRR rate results for End-

Loop	Hydraulically Least Demanding	0%	0%	29
		20%	36%	21
		30%	47%	6
		40% to 100%	63% to 157%	4
	Hydraulically Most Demanding	0%	0%	23
		20%	37%	17
		30%	47%	6
		40% to 100%	63% to 157%	4

4 DISCUSSION

The town's main sample pressure

A development of the BRISK tool could be to incorporate a ‘dynamic sprinkler activation’ function into BRISK which could potentially improve the resolution of the model output results especially the HRR graphs by showing a staggered curve that would be expected from the successive activation of the sprinkler heads.

Although the models used in this analysis only varied the supply water pressure, system configuration and fire location; the model matrix as shown in Table 3 should be considered to include variables such as change in Response Time Index (RTI) of the sprinkler heads used in the model, alternative design fires (to include; different growth curves, different peak HRR value/size and adjust location relative to the sprinkler head i.e. reduce the radial distance of the nearest sprinkler head to the centre of the fire), alternative system configurations, alternative ceiling heights, sprinkler head spacing.

Suggested further work would include 1) Expanding the model matrix in Table 3 to include additional variables as previously discussed; 2) Expand the modelling analysis to work towards developing a Framework/Process; 3) To consider developing a -328 (a) (w) -4 (-2 (;R -2 (;I-16