was designed based on phased evacuation and the entry door to the stairwell on the fire floor had to shut upon completion of evacuation of that floor.

1. INTRODUCTION

As per the New Zealand legislation (New Zealand Building Code Clause C4), a functional requirement of a building is that occupants must be provided with a means of escape without being unreasonably delayed from going to a place of safety. In doing so the occupants will not suffer any illnesses or injuries. There are also performance criteria to fulfil, such as the evacuation time, not exposing occupants to certain levels of carbon monoxide, heat and ensuring visibility remains at a certain distance throughout evacuation.

Due to the increase in height and number of multi-storey

The overall objective of the research is to determine the effectiveness of designing a pressurized stairwell in a software called Fire Dynamic Simulator (FDS) using AS/NZS 1668.1:2015.

A literature review was done to generate a list of design scenarios based AS/NZS 1668. As the standard has different design scenarios depending on the classification of the building, the applicable scenarios were selected.

2. METHODOLOGY

2.1. Design Scenarios

A list of design scenarios was generated based on AS/NZS 1668.1:2015/Section 10.3 and can be found in Table 1. An office occupancy was chosen as it is one of the most common types of occupancies in a multistorey building.

The types of automatic fire alarm systems that were used in the model were the smoke detection system (SD) and sprinkler system (SPK). These typical fire alarm systems are based on the New Zealand Building Code (NZBC) Clause F7.

As per Section 10.3 of AS/NZS 1668.1:2015, the performance criteria for the system stairwell pressurization system was evaluated based on stair entry doors being open during the operation of the system.

Phased evacuation refers to when the door to the stairwell at each floor was closed after the floor evacuation time. This represented a staged evacuation where only the fire floor (FF), the floor above and below (FAB) the fire floor were evacuated before other floors. An all-out evacuation was when the doors remained open throughout the entire model run. This represented every floor evacuating simultaneously which would result in queueing in the

times and travel time from the most remote point on the floor to the entry door. Door gaps were modelled as 0.2m by 0.2m as the 10mm door gap in C/VM2 would not show up in the model due to the mesh size.
The pressurization system was modelled as an inlet measuring 1m by 1m located at the top of each stairwell. The fan was ramped up linearly over 30 seconds from the time the detector or sprinkler was activated. This was the method that adopted by BRISK when modelling pressurization fans.

The building was modelled in CONTAM (Version 3.2) to determine the fan flow rate which was used in the FDS model. CONTAM was chosen as it was an iterative software that could provide the fan flow rate quickly and was the recommended software by Klote in the Handbook of Smoke Control Engineering.

An additional relief vent of $4m^2$

3.2.

Figure 9 shows the velocities through the doors for the SD case with an all-out evacuation with relief vents activating. When an all-out evacuation strategy was employed, the stairwell was compromised (as shown by the blue line in Figure 3) due to the decrease flow rate through the doors (as shown in Figure 9) on the fire floor as shown by the red line, and increase in smoke production.

3.6. Fifth Floor Door Velocities for the SPK Cases

Figure 10 shows the velocities through the doors for the SPK case with no relief venting and phased evacuation. The velocity through the fourth and fifth floor doors were below the minimum of 1m/s and the system also failed to perform as shown by the red line in Figure 4.

Figure 11 shows the velocities through the doors for the SPK case with relief vents activating and phased evacuation. The velocities through the fourth and fifth floor doors were below the minimum of 1m/s (as shown by the red and black lines).

Figure 12 shows the velocities through the doors for a SPK case with an all-out evacuation and relief vents activating. The velocities through all the doors were

This was not the case for the sprinkler-controlled fire as shown in Figure 24. With 1 or 3 relief vents activating, the pressurization system was able to control the smoke from entering the stairwell and flowing into the floors below.

4. ISSUES ENCOUNTERED

The first issue encountered was the lack of symmetry of smoke flow on the fire floor when the floor was divided into three meshes along the x-axis. There appeared to be a barrier even though there was a full height and length opening between the meshes of the room as shown in Figure 25.

Another view of the discontinuity can be seen in the uneven smoke filling of the room as shown in Figure 26. This barrier or discontinuity did not appear once the orientation was changed to divide the fire floor along the y-axis.

There was also uneven smoke flow into the stairs as observed in Figure 23. The front stair had more smoke filling than the rear stairs. This could be due to the pressurization system pushing air into the floor and affecting the smoke flow from the fire floor due to the uncontrolled smoke production. The relief vent had a certain area that would allow a maximum flow through so smoke had to escape from the fire floor from the stair entry doors.

Lastly smoke was flowing back into the sixth floor from the relief vents as shown in Figure 17. This was due to the relief vents being located vertically above each other.

5. CONCLUSION

A stairwell pressurization system design according to the design scenarios in AS/NZS 1668.1:2015 will only function as intended

6. RECOMMENDATIONS

Errors occurred in the models when the fire floor was divided into three meshes along the Y-axis. This error combined with long run times per model and number of