Fire spread from lower roofs

It's important with higher-density housing in urban areas to ensure fire doesn't spread from a lower roof to an adjacent, taller wall. BRANZ fire researchers are delving into the validity of the current 9 to 5 rule.

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THE NEW ZEALAND protection from fire Acceptable Solutions have had a requirement to prevent fire spread to a building from an adjacent lower roof since their introduction in 1992.

9 to 5 rule to prevent fire spread

The requirement has been that either the:

- adjacent roof must be fire-rated anywhere within a distance of 5 m of a taller wall, or
- 9 m of the wall above the adjacent roof has to be fire-rated with no unprotected openings (see Figure 1).

This combination of fire-rating requirements has come to be known as the 9 to 5 rule. The required amount of fire resistance and sprinkler concessions have varied as the Acceptable Solutions have evolved.

The 9 to 5 rule comes into effect if:

- firecells behind the wall contain other property
- there are sleeping spaces or exitways behind the wall and the wall is in the same building as the adjacent lower roof or in an adjacent building on the same title.

Two local fires spread this way

Two New Zealand examples where this type of fire spread occurred were the 1978 Bryce Street Market fire in Hamilton and the 2005 Bracken Court fire in Dunedin.

In the Bryce Street Market fire, the fire originated in a flea market. In the Bracken Court fire, the fire originated in a converted warehouse with commercial and sleeping occupancies.

Both fires caused substantial damage to next door taller commercial buildings on several levels above the lower adjacent roof. The fire spread into the adjacent taller buildings through windows.

Table 1

NFPA 80A minimum separation distances

NO. OF STOREYS LIKELY TO CONTRIBUTE TO FLAMING THROUGH ROOF	HORIZONTAL SEPARATION DISTANCE OR HEIGHT OF PROTECTION ABOVE EXPOSURE	
	m	ft
1	7.5	25
2	10	33
3	12.5	41
4	15	49

Table 2

NFPA 80A maximum flame heights

NO. OF STOREYS BURNING	FLAME HEIGHT ABOVE ROOF (IN STOREYS)
1	1.4
2	1.8
3	2.2
4	2.6
5	2.9
6	3.1

Looking back for 9 to 5 basis

The original basis for the 9 to 5 rule was unclear, so BRANZ undertook a research project to investigate.

The 1992 Acceptable Solution does not provide many clues on where the rule came from. Preceding editions of NZS 1900 Chapter 5 (which were replaced with the Acceptable Solutions in 1992) did not include a similar requirement.

Draft standard DZ 4226, an intended replacement for NZS 1900 Chapter 5 but never implemented, included a 10 to 6 rule. The requirement would have been to fire-rate 10 m of the wall above the roof or the roof within 6 m of the wall. It is possible that this was used as the approximate basis for the 1992 Acceptable Solution requirements.

DZ 4226 is quite explicit in describing the basis for the 10 to 6 rule, citing NFPA 80A as the source. However, the NFPA 80A requirements are actually slightly different and are linked to the number of storeys on fire contributing to the flames from the roof.

Rather than requiring a greater wall protection height than the roof protection, the NFPA 80A distances are equal (see Table 1). The rationale given for this is that a moderate wind could be expected to tilt flames and extend them a horizontal distance about the same distance as they would extend vertically with no wind.

The NFPA 80A requirements were based on a study of maximum flame heights from fully involved building fires.

The maximum flame heights listed in Table 2 were found to be the same for different building occupancies.

Potential heat impact from roof fire

The next step of the project was to use engineering analysis to evaluate the potential heat impact from a roof fire on a higher adjacent wall. Using the NFPA 80A flame height data, heat transfer modelling was used to estimate the envelope where ignition of combustible items in an unprotected area, for example through non-fire-rated windows, could occur.

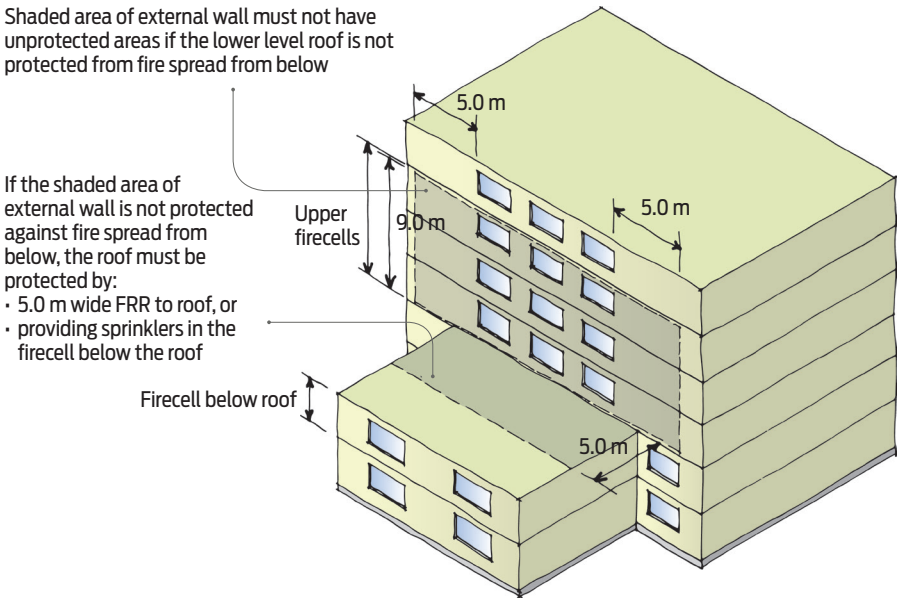


Figure 1: Acceptable Solution to prevent fire spread from lower roof (from C/AS2 Figure 5.6).

2005 Bracken Court fire in Dunedin.

PHOTO – TED DANIELS

Some ordinary combustibles will ignite at a minimum radiant heat intensity of 12.5 kW/m², but New Zealand Building Code clause C3.6 allows a maximum received radiation of 16 kW/m² based on assistance from the Fire Service to prevent fire spread. For comparison, the heat intensity reaching the atmosphere from the sun is about 1.4 kW/m². Contours where the radiant heat intensity drops to the maximum allowed for a range of fire venting through square roof openings are shown in Figure 2.

Modelling results varied with configuration

For vertical flames (no wind effects), the envelope where the heat intensity is above 16 kW/m² for a 15 m × 15 m roof opening was 9.2 m vertical and 4.6 m horizontal or approximately equivalent to the 9 to 5 criteria.

Adding the effect of wind tilting the flame to 45° increased the horizontal envelope to 6.1 m.

Increasing the number of storeys contributing to the fire to four resulted in the envelope reaching 12.9 m vertically and 9.9 m horizontally.

Reducing the size of the roof vent with a single storey contributing reduced the envelope to 5.4 m vertically above the fire and 4.9 m horizontally from the roof opening.

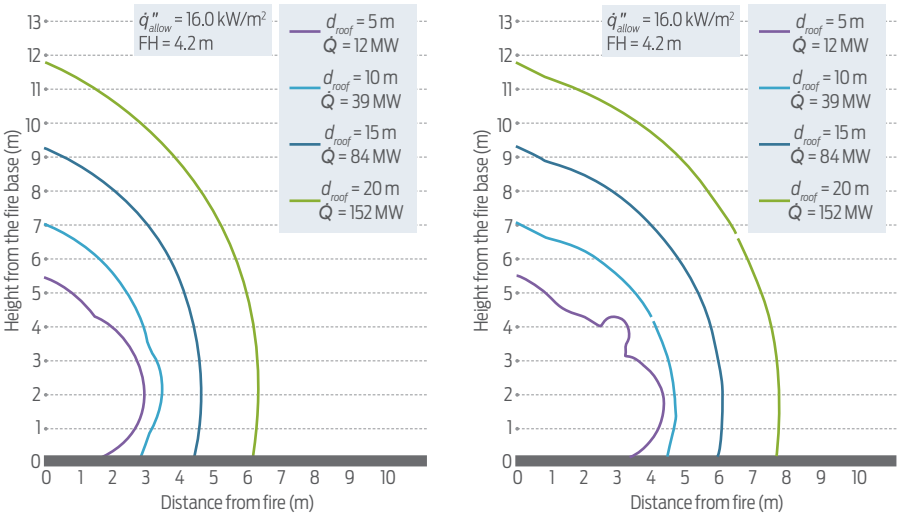
Future work will validate these model results using new experimental data.

One rule may not be suitable for all

This research has uncovered the likely basis for the 9 to 5 rule for fire spread from lower roofs. Modelling has supported this requirement, although it has also shown that the current one-size-fits-all approach may not be suitable for all lower roof configurations.

A BRANZ study report providing details on the modelling methods used, validation experiments and regulatory requirements in other jurisdictions will be made available shortly.

Note For the report, see www.branz.co.nz/study_reports. This research was funded by the Building Research Levy.



(a) vertical flames

(b) flames tilted at 45º+ vertical flames.

Figure 2: Allowable heat intensity contour for flames from a venting roof ranging from 5 m to 20 m square openings (single-storey contributing).