BRANZ

ISSUE 692

BULLETIN

DESIGNING FOR FIRE SAFETY AND PASSIVE FIRE SAFETY SYSTEMS IN HOUSING

July 2024

- This bulletin outlines key design and specification requirements for passive fire safety in new homes. In some areas, it goes beyond the minimum requirements in the Building Code.
- It does not cover active fire safety systems such as alarms and sprinklers.
- This bulletin replaces Bulletin 606 *Residential fire safety*.

1 INTRODUCTION

1.0.1 New Zealand Building Code clauses C1–C6 *Protection from fire* set minimum requirements for new building work to reduce the likelihood of a fire starting and spreading, to reduce the risk of harm by fire to people and other property and to facilitate firefighting and rescue operations if a fire does start.

1.0.2 Gaps have been identified in Building Code requirements and some are very limited compared to those in other countries, which suggests the need to think beyond just designing and specifying the minimum to comply with the Building Code.

1.0.3 This bulletin focuses on design and specification of passive fire protection in housing, including:

- the construction elements and materials designed to prevent or delay the spread of fire and/or smoke
- building location on site
- access for firefighting
- particular issues for infill and densified housing
- building change of use.

1.0.4 This bulletin does not cover care or detention facilities such as rest homes or prisons.

1.0.5 BRANZ has extensive resources around fire safety:

- The fire safety design section of the BRANZ website [www.branz.co.nz/fire-safety-design].
- BRANZ Appraisals and CodeMark certificates for fire-tested or assessed fire ratings of systems or materials.
- The B-RISK fire modelling tool (most useful for fire engineers).
- A large new fire laboratory for testing building elements.

1.0.6 This bulletin should be read in conjunction with its companion bulletin, BU693 *Designing active fire safety systems in housing*.

2 HOW A FIRE DEVELOPS

2.0.1 Understanding in general terms how a fire develops helps explain the importance of passive fire protection systems (Figure 1):

- Initial ignition – a fire almost always has small beginnings.
- Fire growth and spread – this is initially upwards and then outwards from the point of origin. Radiation may ignite adjacent combustible materials such as chairs or curtains.
- Possible ignition at ceiling level.
- Possible flashover depending on the conditions – when the whole room or space suddenly catches fire. Oxygen levels in the room begin to drop and levels of toxic gases such as carbon monoxide increase rapidly. If the walls fail to contain the fire and break down, there will be less chance of a flashover.

2.0.2 Smoke generated by a fire can move through the

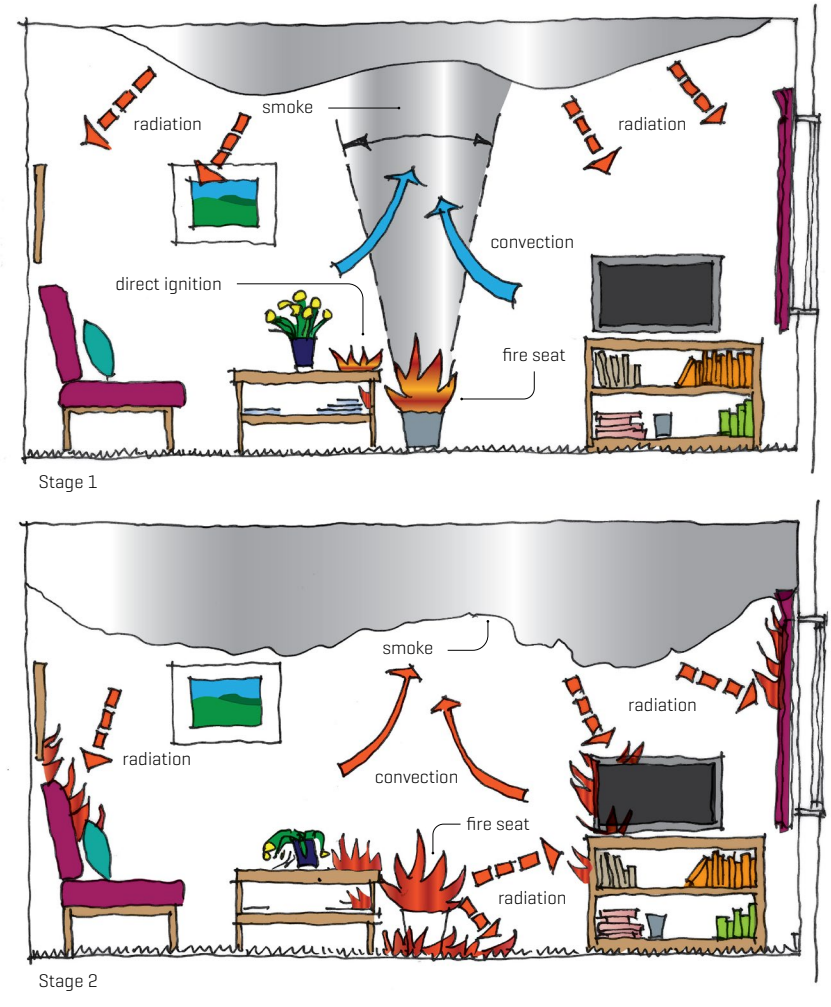

Figure 1. Development of a fire in a home.

smallest of gaps in construction (which is why fire-rated sealants are used). Hot smoke moves naturally to the upper levels of a building and will continue rising until one of these situations occurs:

- It is halted by an obstruction such as a ceiling. As further smoke is generated, it spreads horizontally across the ceiling until it reaches the walls. It then begins to fill the room from the ceiling down and will escape through openings and gaps.
- It cools down enough to stop rising as it mixes with ambient air and begins to fall.
- It is cooled by water from sprinklers or firefighting operations.

2.0.3 Initially, fire can spread as a result of flames impacting on and igniting adjacent materials in the space where the fire is first ignited (although this is not the case with a smouldering fire). It then may spread through larger gaps (including open doors) or by burning through or breaking building elements such as windows to other spaces in the building. Further spread occurs, often rapidly, as a result of hot unburnt gases in the smoke where sufficient air or oxygen is present or is introduced. This radiant heat can ignite ceiling linings, curtains or adjacent furniture. Subsequent spread occurs after the fire has burnt through elements such as the walls and ceilings containing it or radiated heat has ignited combustible materials on the other side of a wall. There is also the possibility of external fire spread to adjacent buildings where there is radiant heat from external flames (such as a façade fire or glazing element failure).

3 BUILDING CODE REQUIREMENTS

3.0.1 Building Code clauses C1–C6 *Protection from fire* give the minimum fire safety requirements for building work. The Building Code objectives are to:

- safeguard people from fire
- limit fire spread to protect other property
- facilitate firefighting and rescue operations.

3.0.2 The Building Code fire clauses have two Acceptable Solutions and two Verification Methods that housing designers can use to demonstrate compliance. (Note that C/VM1 is only for solid fuel-burning appliances and that using C/VM2 requires proficiency in the use of fire engineering modelling methods so is more suitable for use by professional fire engineers and has limited application for architects and designers.)

3.0.3 The Building Code fire clauses categorise buildings by seven different risk groups (see Table 1.1.1.1 of C/AS1). Each risk group has different requirements in the Acceptable Solutions. Generally, the requirements apply to:

- firecells, fire safety systems and fire resistance ratings
- means of escape
- control of internal fire and smoke spread
- control of external fire spread
- firefighting
- prevention of fire occurring.

3.0.4 Two risk groups cover permanent accommodation:

- SH Buildings with sleeping (residential) and outbuildings.
- SM Sleeping (non-institutional).

3.0.5 C/AS1 applies only to risk group SH – detached dwellings and low-rise multi-unit dwellings where each dwelling has an independent escape route and no more than one dwelling unit above another such as detached houses, townhouses and terraced housing. It includes detached dwellings where fewer than six people (not including members of the residing family) pay for accommodation such as Airbnbs and boarding houses. Simple outbuildings such as garden sheds and garages as defined in section 7 of the Building Regulations 1992 are also included in C/AS1.

3.0.6 C/AS2 applies to other buildings. For risk group SM, this includes permanent accommodation (such as apartment buildings), transient accommodation (such as hotels, motels, backpackers or any other buildings where six or more people pay for accommodation, wharenui and other community sleeping spaces, even if they are used only occasionally) and educational accommodation (such as university halls of residence or school boarding hostels). C/AS2 has more onerous requirements than C/AS1.

3.0.7 There may be factors that move a building out of scope of either C/AS1 or C/AS2. For example, there are certain building features that are considered too complex to be adequately addressed within the C/AS2 provisions. Atriums, proportionally large intermediate floors and heights exceeding 20 storeys are considered complex features. The list included in C/AS2 paragraph 1.1.2 is not necessarily exclusive, particularly as new building design features are developed. New construction methods such as mass timber may be considered complex and therefore out of the scope of C/AS2 in some instances.

3.0.8 Other Building Code clauses also apply to fire protection features. For example, passive fire protection elements and materials must meet requirements under B2 *Durability* and continue to perform for 5, 15 or 50 years depending on their function, difficulty of access and the ease of detecting their failure.

3.0.9 There are other Building Code compliance methods that can be applied for specific compliance aspects related to products, systems or subassemblies. For example, products and methods that are certified under the Ministry of Business, Innovation and Employment (MBIE) CodeMark scheme must be accepted as complying with the Building Code as long as they are used according to CodeMark instructions. MultiProof (for standardised designs) and BuiltReady (for modular components built off site) are two other certification schemes.

3.0.10 With the exception of MultiProof, these pathways are generally complementary to C/AS1, C/AS2 or C/VM2, covering different aspects of compliance related to the specific product, system or assembly, and do not cover holistic aspects of compliance such as the means of escape and firefighting provisions. As such, other than MultiProof, they cannot be used in isolation to establish compliance with the Building Code provisions for protection from fire without also considering one of C/AS1, C/AS2, C/VM2 or a specific engineering

design-based Alternative Solution. MultiProof does cover the entire design of a building, but it is more of an alternative to the standard consenting process. Attaining approval for a MultiProof design would generally still require demonstration of compliance to C/AS1, C/AS2, C/VM2 or a specific engineering design-based Alternative Solution.

4 USING C/AS1 TO DEMONSTRATE COMPLIANCE

4.0.1 Fire safety requirements under C/AS1 include number and length of escape routes, distances to boundaries, fire prevention, internal surface finishes and firefighting access.

4.0.2 There are limits on the length of escape route given in Table 3.3.1.1 *Travel distances on escape routes*. Installing an automatic sprinkler system allows a longer escape route.

4.0.3 Joined household units (such as in multi-unit buildings, terraced housing or townhouses) must have 30-minute fire separations between them. The separation, if loadbearing, must have a fire resistance rating (FRR) of no less than 30/30/30. The three numbers in the FRR represent time to failure in minutes for:

- structural stability (how long the element can retain its loadbearing capacity)
- integrity (how long the element can maintain its fire-separation capability)
- insulation (how long the element can shield heat from its far side).

4.0.4 The 30/30/30 durations are measured for a construction when subjected to a given fire condition in a test furnace as specified in a test standard. FRRs only indicate comparative performance among different products. A particular FRR does not ensure that building elements can survive for the listed time in actual fire conditions, which will almost always be different from the standard fire resistance test conditions.

4.0.5 It is important that the entire fire separation is constructed to provide the required fire-resisting performance. In particular, details such as junctions and penetrations must not compromise the fire performance of the fire separation. Designing to minimise detailing requirements in fire separations such as by routing services so they will not penetrate fire separations is recommended to reduce such problems.

4.0.6 The only surface finish requirements/restrictions in risk group SH apply to foamed plastic building materials or combustible insulating materials. With a few exceptions, if these materials form part of a wall or ceiling system, the completed system must achieve a Group Number of 3 or less. The foamed plastics must comply with the flame propagation criteria in AS 1366 *Rigid cellular plastics sheets for thermal insulation* Parts 1–4 for the material being used.

4.1 KEY C/AS1 REQUIREMENTS FOR EXTERNAL WALLS AND ROOFS

4.1.1 While houses are usually built at least 1 m from a boundary, sometimes a tight section, alterations or the need for garages or other outbuildings means that a building is set out less than 1 m from the boundary. Where part of an external wall of a single household unit or attached side-by-side multi-unit dwellings is less than 1 m and angled less than 90° from the boundary (Figure 2), the boundary walls must meet an FRR of 30/30/30 from both sides (C/AS1 5.1.1). This requirement does not apply if an automatic sprinkler system is installed.

4.1.2 With multi-unit housing where there is one unit above another, any part of an external wall less than 5 m from the boundary must have an FRR of no less than 30/30/30. If a wall that requires this fire rating includes windows less than 1 m from the boundary, they must be fire rated too.

4.1.3 If the external walls need to be fire rated, the eaves require protection too. The options are to construct the underside of eaves with an FRR of 30/30/30 or to extend

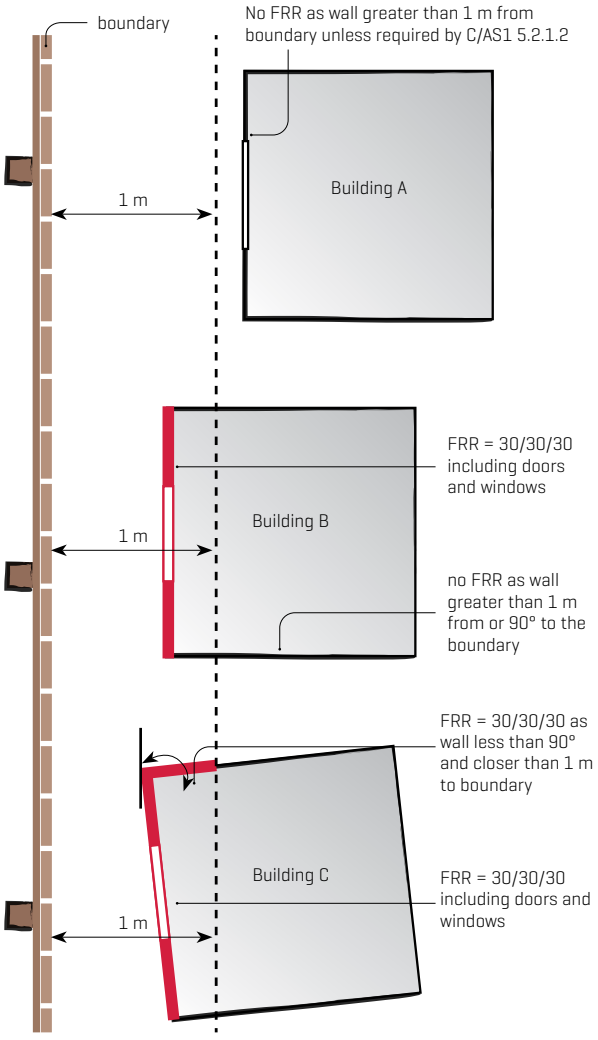

Figure 2. Fire ratings for single-storey SH buildings in C/AS1 close to the boundary.

the fire-rated wall through inside the roof space to the underside of the roof.

4.1.4 Where the eaves are within 650 mm of the boundary, the eaves and wall must have an FRR of 30/30/30 even if the wall is greater than 1 m from the boundary and would otherwise not require an FRR.

4.1.5 There are concessions available for some of the passive fire protection requirements for housing where automatic sprinkler systems are installed (see Bulletin BU693 *Designing active fire safety systems in housing*).

4.1.6 Where a building is more than 1 m from the boundary and less than 10 m high, there are no specific fire spread requirements around the combustibility of cladding materials.

4.1.7 There are specific requirements where the building height exceeds 10 m and the building is less than 1 m from the boundary (where the angle between the building and the boundary is less than 90°). External wall cladding materials must be non-combustible or limited combustible materials or tested in accordance with the relevant test in Appendix E in C/AS1 and achieve at least the required fire performance stated in Table 5.3.1.1.

4.1.8 As with all areas of construction, installation of elements and materials providing fire protection in homes should strictly follow the consented plans. Where any variations are being considered, the designer should always be consulted and the building consent authority approached for approval.

4.1.9 The requirements around means of escape are set out in Part 3 of C/AS1. An escape route can include open paths, exitways and final exits. The final exit, where the escape route enters a safe place, might be beyond the exit door from the building.

4.1.10 This bulletin does not cover all of the elements of C/AS1 and only covers some exceptions such as fire spread from lower roofs. Refer to C/AS1 for full requirements.

4.2 FIREFIGHTING REQUIREMENTS

4.2.1 There are specific requirements in C/AS1 section 6.1 around Fire and Emergency New Zealand (FENZ) vehicular access for multi-unit dwellings with more than two units that are located remotely from the street boundaries of a property.

4.2.2 Firefighting facilities often require greater consideration in higher-density housing developments. This can include aspects such as:

- fire appliance access and attendance points
- fire hydrant locations (both internal and external) and occupant vehicle parking considerations
- fire alarm panel location and information provided
- firefighting hose runs.

4.2.3 FENZ has published a designers' guide to firefighting operations, which is a good resource to better understand firefighting needs in buildings (see section 10).

4.3 C/AS1 AND PREVENTION OF FIRE OCCURRING

4.3.1 Part 7 of C/AS1 sets out requirements for installation of solid-fuel, gas-burning and oil-fired heating appliances and out design and construction requirements for chimneys for open fires. Clauses G9 *Electricity* and G11 *Gas as an energy source* provide the requirements for fire safety around electricity and gas.

5 USING C/AS2 TO DEMONSTRATE COMPLIANCE

5.0.1 C/AS2 is used for all risk groups other than SH and includes risk group SM Sleeping (non-institutional). Because of the breadth of its scope, some areas of C/AS2 do not apply to housing. The comments in this bulletin refer only to the requirements for risk group SM.

5.0.2 The factors that determine the minimum requirements in C/AS2 include:

- number of occupants – for residential occupancies, these can be counted as bedspaces
- type of occupancy – for risk group SM, this could be permanent, transient or educational
- floor area
- escape height
- number of escape routes
- height and width of escape routes
- length of escape routes
- the circumstances where specific fire safety systems are required, which can include automatic sprinklers.

5.0.3 C/AS2 Part 4 covers control of internal fire and smoke spread and covers specific requirements for sleeping areas. The requirements for fire separation and fire resistance ratings are given in C/AS2 4.6.

5.0.4 C/AS2 Part 5 covers control of external fire spread, which includes FRRs of external walls, vertical fire spread and external cladding systems.

5.0.5 C/AS2 Part 6 covers firefighting, which includes FENZ vehicular access and firefighting facilities.

5.0.6 C/AS2 design requirements are much more complex than C/AS1 and cannot be fully outlined in this bulletin. Refer to C/AS2 for the full requirements. Construction techniques that are acceptable for C/AS1 buildings may be challenging or not suitable for C/AS2 buildings. For example, completing all framing before lining may cause problems with junctions involving fire-rated floors/ceilings and walls.

6 WEAKNESSES IN CURRENT BUILDING CODE REQUIREMENTS

6.0.1 Designers of new housing would be prudent to consider more than just the minimum requirements for compliance. For example, this could be through decisions such as specifying non-combustible wall claddings where they are not specifically a Building Code requirement. Emerging methods of construction such as mass timber may not be well covered by the current compliance documents. There may be additional

guidance that may be useful for such methods such as the Timber Unlimited document in section 10.

6.0.2 In its 2022 consultation on changes to improve the safety of people from fire, MBIE identified fire risks that are not adequately captured in C/AS1:

- Unreasonable delay moving to a place of safety.
- Interior spread through the building to adjacent household units.
- External vertical fire spread to upper floors in the building containing sleeping uses or other property.
- External spread to other properties across a boundary.
- Structural systems designed adequately to prevent injury to occupants and firefighters and protect other property during and after fire.

6.0.3 Past BRANZ research has found that Building Code documents have not kept pace with housing intensification, including the growing demand for apartments. Work is being undertaken across the area of fire safety, and BRANZ expects to see these issues addressed in future Building Code amendment proposals.

7 OTHER ASPECTS OF FIRE SAFE DESIGN

7.0.1 There is a wide range of simple design and specification considerations that are not specifically mentioned in Building Code clauses but can be used by designers to reduce fire risk:

- Consider installing a (residential) sprinkler even if not required.
- Consider how kitchens and living rooms (where fires are most likely to start) can be closed off from the rest of the dwelling (particularly the sleeping areas).
- Ensure bedrooms have more than one means of escape so that occupants do not have to pass through living rooms and kitchens on their way out of the house.
- If possible, provide two means of escape from upper floors – windows may be a means of emergency escape provided the occupants can readily and safely use them.
- Choose finishes that will be less likely to ignite or to generate smoke if ignited.
- Locate cooktops where they would not block the kitchen exit if they were to catch fire.
- Line walls next to cooktops with a fire-resistant material.
- In kitchen design, consider where a 1.8 kg or bigger multi-purpose dry powder type fire extinguisher could be located where it is easily accessible.
- Specify solid core doors (that resist fire better than hollow core doors) between bedrooms and the higher fire risk areas of the home.
- Provide night or emergency lights near the floor or at stair-tread level in corridors and stairwells to provide better light for escape routes.
- Make the exit door a different colour to the surrounding wall.
- Avoid keyed or electronic door egress that makes exiting difficult in an emergency or power cut.
- Provide additional protection for proposed or future alternative energy systems such as fire resistance-rated and/or non-combustible surface finishes around potential battery, solar panel or electric vehicle charging locations and additional interconnected detection in spaces containing these systems.
- Consider what can be done to reduce the risk to rural housing from wildfires (see the FENZ document in section 10).

8 DESIGN CONSIDERATIONS FOR FIREFIGHTING

8.1 INFILL HOUSING

8.1.1 One area where designers need to think beyond minimum requirements for compliance is with infill housing. The construction of new homes on back sections requires consideration of how firefighters can access a house fire.

8.1.2 Some new infill housing is being constructed with driveways to back sections around 2.9 m wide (Figure 3). This may be wide enough for cars but is not wide enough for a fire appliance. The typical hose on a fire truck is 25 m long, so where there is a long driveway, firefighters who are forced to operate their vehicles from the road will need to connect multiple hoses together to reach the house. A longer hose run reduces the pressure of the water supply and makes it more difficult to extinguish the fire. In extreme cases, there is a risk that there is not enough hose to reach the fire.

8.1.3 FENZ recommends that driveways (which may or may not be sealed) should have a minimum width of 4 m. This can be reduced to a minimum width of 3.5 m at entrances provided tight turns are not required. Also consider the height clearance across the length of the driveway as fire trucks are taller than cars.

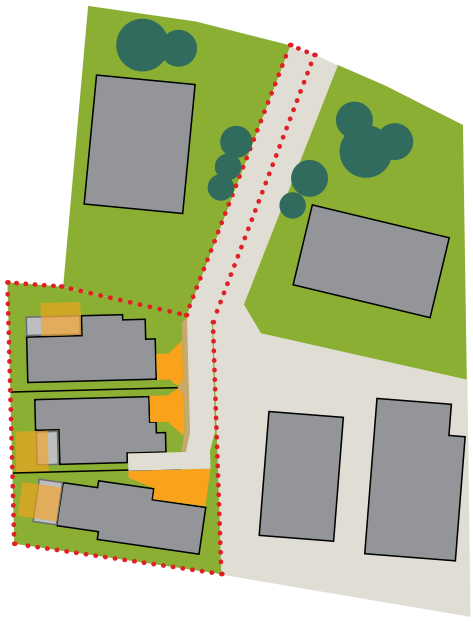

Figure 3. Infill housing down a long narrow driveway can provide difficulties and dangers for firefighting.

8.1.4 Consider separation distances to the boundary and other buildings that are greater than Building Code minimums. Where houses are very close together – they are just 2 m apart in some new developments – there is a greater risk of fire spreading to neighbouring buildings. Firefighters will need to use more water jets to protect nearby buildings, which stretches the capacity of equipment and personnel as well as the water supply.

8.2 TALLER BUILDINGS

8.2.1 The growth of multi-storey accommodation buildings in recent years will continue with district plan changes under way allowing taller buildings, including 6-storey buildings in areas close to city and metropolitan centres. Building designers should make specific provision for fire appliance access to a building and consider where it could safely and effectively be set up to operate from. Where possible, provide space at the corner of buildings, especially with multi-storey buildings, where it is safer for fire trucks to operate from rather than immediately in front where the building façade may collapse.

8.2.2 Many mid-sized towns where densified housing is being currently implemented don't have aerial appliances. The fire appliances available in these towns have ground-based ladders that can reach approximately 10 m high, enough for rescue in most 3-storey buildings. However, buildings should be designed in such a way that all occupants will have evacuated by the time the fire service arrives. Ground-based water jets can be directed to reach to the top windows of an approximately 3-storey building.

8.2.3 Larger cities have more capable aerial appliances with ladders that have an effective reach of 22 m. These can reach most buildings of 5–6 storeys. These are only found in larger urban centres such as Auckland, Hamilton, Wellington, Christchurch and Dunedin.

8.3 EVACUATION PROCEDURES

8.3.1 The Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures, and Evacuation Schemes) Regulations 2018 include requirements for owners, tenants and occupants of buildings. Consideration of these requirements during the design stage is important to prevent problems during the use of the building.

8.3.2 Among these requirements, the owner must have evacuation procedures in place for the safe, prompt and efficient evacuation of building occupants in the event of a fire emergency. Consideration can also be given to how the building will be safely reoccupied. Thought into how this will be implemented at the design phase (for example, where an assembly point will be located) can contribute to an overall safer and more occupant-friendly building.

9 CHANGE OF USE OF EXISTING BUILDINGS

9.0.1 When the use of a building changes, the fire protection requirements may change.

9.0.2 What constitutes a change of use depends on whether the old and new uses are in the same use category in Schedule 2 of the Building (Specified Systems, Change the Use, and Earthquake-prone Buildings) Regulations 2005. If old and new uses are in the same category, there is no change of use. If they are in different use categories and Building Code requirements for the new use are higher, there is a change of use.

9.0.3 For example, a large 3-storey character home that houses a single family is being converted to three separate dwelling units one above another. This is a category change from SH (sleeping single home) to SR (sleeping residential). It is a change of use because there are more onerous fire safety requirements with the new use.

9.0.4 Existing buildings with a change of use often present difficulties in passive fire protection. Fire-rated materials or elements may be difficult to retrofit and identifying what existing building materials have been used might be challenging. The full extent of any non-compliance may only become apparent during the course of construction. An existing building that is subject to a building consent is required under Building Act sections 112 (alterations) and 115 (change of use) to be demonstrated to comply with some Building Code requirements on an "as nearly as is reasonably practicable" (ANARP) basis. Section 112 requires ANARP compliance only for the means of escape, while section 115 requires ANARP compliance for means of escape, protection of other property, structural performance and fire rating performance.

10 MORE INFORMATION

BRANZ

BU693 *Designing active fire safety systems in housing* (BRANZ bulletin)

Guide to passive fire protection in buildings

Closer housing and construction site fire safety risk (*Build* article)

Firefighting capability and building height (*Build* article)

Fire safety in multi-storey apartments (*Build* article)

Medium-density housing #7: Fire safety (*fact sheet*)

FENZ

Designers' guide to firefighting operations: Emergency vehicle access

Wildfire safer housing guide

TIMBER UNLIMITED

Fire safety in multi-storey mass timber structures

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