Fire safety

Moving from low-density to medium-density housing (MDH) involves people living in closer proximity. This has a number of implications for fire safety design.

The fire requirements of external wall cladding systems are currently under review. BRANZ recommends that designers discuss the requirements with the BCA at an early stage, especially for buildings with more than three floor levels.

Protection from fire requirements

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

- safeguard people from an unacceptable risk of injury or illness caused by fire
- protect other property from damage caused by fire
- facilitate fire-fighting and rescue operations.

A building can be shown to meet the fire safety requirements of the Building Code by following an Acceptable Solution, by using Verification Method C/VM2 *Framework for fire safety design* or by using specific design for consenting as an Alternative Solution.

Acceptable Solutions

Acceptable Solutions provide a prescriptive option to demonstrate that the fire safety objectives have been met and typically apply to simple buildings. They do not require any modelling or other engineering analysis beyond simple calculations. There are seven Acceptable Solutions covering a range of common building uses.

MDH falls under either:

- C/AS1 *Houses, small multi-unit dwellings and outbuildings* or
- C/AS2 *Buildings with sleeping (non-institutional, multi-unit dwellings).*

C/AS1 applies 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. C/AS2 applies to buildings that are more than two dwelling units high or have shared escape routes.

For mixed-use scenarios, other Acceptable Solutions such as C/AS5 *Buildings for business, commercial or low-level storage* or C/AS7 *Vehicle parking* may need to be considered.

BRANZ's *Guide to the Acceptable Solutions: Protection from Fire* describes each Acceptable Solution in more detail.

Verification Method and specific design

C/VM2 *Framework for fire safety design* is a Verification Method for showing compliance with the fire safety requirements of the Building Code using engineering analysis.

If any other methodology is used to show compliance, the design becomes an Alternative Solution. There are some scope limitations for applying C/VM2 although they are not likely to apply to MDH. Alternative Solutions can apply to any building.

Passive fire protection in MDH

Passive fire protection is the design of building elements to prevent the spread of fire and smoke. Generally, passive fire protection considers two things – fire resistance and reaction to fire.

Fire resistance

Fire resistance is the ability of a building element to prevent fire or smoke moving from one side of the element to the other or to resist collapse due to the effects of fire. Fire-resistive construction can be used to separate individual dwellings, escape routes and other hazards and to reduce the amount of radiant heat at the property boundary to prevent fire spreading across the boundary

to neighbouring properties.

Smaller separation distances between buildings or between adjacent household units in the same building increases the risk of fire spreading to a neighbouring property, affecting common escape routes or making fire-fighting more dangerous.

Examples of building elements that may need to be fire-resistance rated are doors, ducts and windows in fire-rated construction. Unprotected areas such as non-fire-rated windows may be acceptable on the exterior of the building depending on the distance to potentially vulnerable targets.

However, unprotected areas may not be allowed or may be more restricted on walls and roofs near property boundaries or other sleeping occupancies. Also, vertical separation between unprotected areas may need to be established using either spandrels or aprons.

Reaction to fire

Reaction to fire is the measure of the spread of flames on the surface of a building element and the speed and degree to which the element contributes heat to the fire.

Reaction-to-fire requirements may apply to external surfaces and internal surfaces of areas of a building (see *External walls* and *Internal surfaces* below for more detail).

Passive fire protection compliance

In order to comply with an Acceptable Solution, passive fire protection construction must be either:

- tested to AS 1530.4:2005 *Methods for fire tests on building materials, components and structures. Part 4: Fire-resistance test of elements of construction* or
- have a formal opinion issued based on AS 4072.1:2005 (R2016) *Components for the protection of openings in fire-resistant separating elements. Part 1: Service penetrations and control joints*.

BRANZ's *Guide to Passive Fire Protection in Buildings* provides additional guidance on the design, construction and testing of passive fire protection systems.

Passive fire ratings

The passive fire rating of building elements consists of three numbers, which represent the time to failure 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).

Building elements may also have rated smoke-stopping capabilities.

Manufacturers publish data sheets and technical guides that provide the rating information for specific assemblies. These details should be identified prior to construction because, for some situations, there may not be any compliant solutions.

Details such as fastener type and spacing, sealant thickness, application and support location and detailing are critical to assure fire-resistance performance. Substituting alternative products may reduce costs but can compromise the passive fire protection performance.

It is important to label passive fire protection on building plans and actual building assemblies to ensure the intended fire-resistance is maintained throughout the life of the building. MDH developments should label all fire-stopped penetrations during construction and provide an up-to-date penetration schedule that can be maintained once the building is occupied.

Penetrations and service installations

To ensure passive fire protection is effective, the entire inter-tenancy structure – common walls, ceiling and floor and walls separating the dwelling from an escape route – of each dwelling unit must be fire-resistant. This is particularly important to remember when installing services, as a boundary is no longer fire-resistant if a penetration is made and not adequately fire-stopped.

A common scenario is that a wall is properly constructed to a tested, fire-resistant specification, but subsequent running of services compromises that fire-resistance by cutting a hole in the wall. The fire-resistant construction needs to extend and meet at each junction between walls, ceilings and floors.

External walls

> The fire requirements of external wall cladding systems are currently under review. BRANZ recommends that designers discuss the requirements with the BCA at an early stage, especially for buildings with more than three floor levels.

Taller MDH buildings and buildings with reduced horizontal separation may require greater control of flame spread on the external surfaces.

Clause 3.2 of the Building Code requires MDH buildings higher than 10 m to be designed and constructed so that there is a low probability of external vertical fire spread to upper floors in the building.

In addition, clause 3.5 requires that buildings must be designed and constructed so that fire does not spread more than 3.5 m vertically from the fire source over the external cladding of a multi-level building. This can be taken to indicate that fire spread to the floor above is tolerated but not higher up the building.

The MDH design should consider three potential vertical fire spread mechanisms for external walls:

- Fire spread through wall openings.
- Combustibility of the cladding system.
- Fire spread from lower roofs.

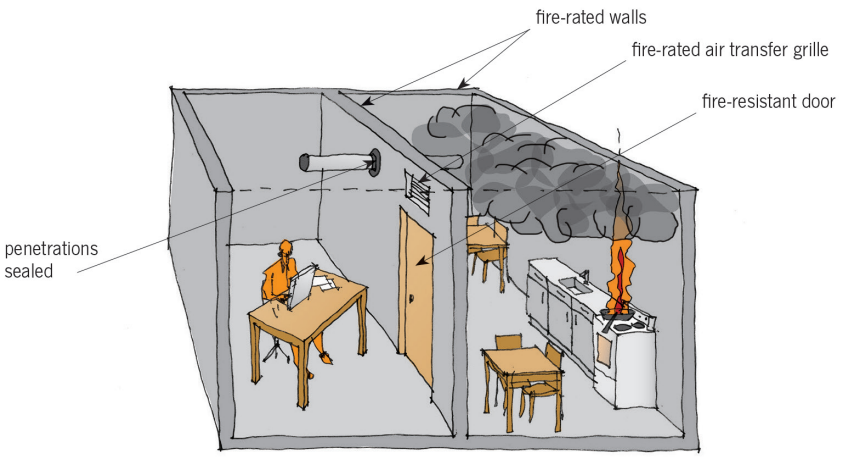

Figure 1. Passive fire protection controls the spread of fire from one location to another.

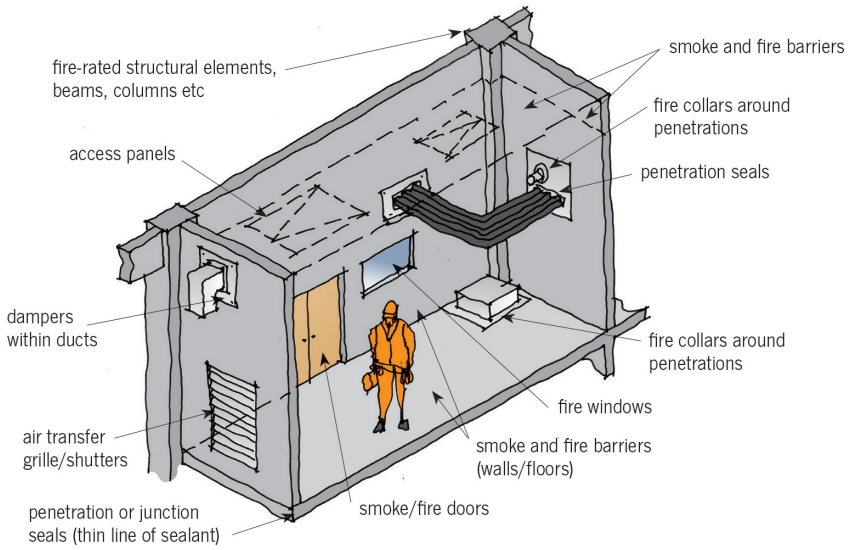

Figure 2. Fire-rated building elements in a typical MDH development.

Fire spread through wall openings

Fire spread through wall openings could be a concern in multi-storey MDH where there are openings in the external wall (such as windows) where flames could project from a lower level, through the opening and spread fire to the floor above.

This issue is usually addressed by including fire-resistant spandrels or horizontal projections beyond the face of the external wall (sometimes called an apron). Minimum dimensions for spandrels and aprons are given in C/AS2 clause 5.7.12. Alternatively, this form of vertical fire spread can be addressed by installing fire sprinklers in the building.

Combustibility of the wall cladding system

The combustibility performance requirements of the external wall cladding system apply to MDH if the distance to the relevant boundary is less than 1 m or the height of the building is greater than 7 m.

Various options are available to satisfy these requirements:

- Full-scale fire testing to NFPA 285 *Standard fire test method for evaluation of fire propagation characteristics of exterior non-load-bearing wall assemblies containing combustible components*. An alternative full-scale test method, such as BS 8414 *Fire performance of external cladding systems*, may also be acceptable to the BCA. Regardless of the test method used, it is important that the construction of the wall cladding system matches the test configuration.
- Using materials that comply with NZS/AS 1530.1:1994 *Methods for fire tests on building materials, components and structures – Combustibility test for materials*. Materials that have a Euroclass A1 or A2 rating are also likely to be accepted.
- Using materials that have been tested to ISO 5660-1 *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)* following the procedure and meeting the criteria given by C/AS2 clause 5.8. Designers should seek guidance from the BCA or other experts on whether other building elements within the external wall must meet these requirements in addition to the outer cladding system.

Designers should seek to avoid using highly combustible materials and cavity insulants within the external wall assembly due to their potential contribution to fire spread. Manufacturers and suppliers of external wall systems should provide evidence of compliance with the fire requirements.

Fire spread from lower roofs

Fire spread from lower roofs can occur in a section of a building or adjacent buildings where there is a lower roof adjacent to a higher external wall. Building Code clause C3 provides the functional requirements relevant to this fire spread mechanism, while the following compliance options are provided in the Acceptable Solutions.

C/AS1

C/AS1 provides a means for MDH that consists of multi-unit dwellings (with no more than one unit above another and where each has an escape route independent of all other units) to comply. Clause 5.3.1 requires that fire spread from a roof close to and lower than an external wall of an attached sleeping unit or building on other property shall be prevented by providing a fire resistance rating of 30/30/30 to either:

- the part of the roof within 5 m horizontally of the wall or
- any part of the wall within 9 m vertically of the roof.

If the household unit below the roof is protected with a sprinkler system complying with NZS 4515:2009 *Fire sprinkler systems for life safety in sleeping occupancies (up to 2000 square metres)*, fire rating of the roof is not required.

C/AS2

For MDH at a scale larger than that covered by C/AS1 or where household units share escape routes, C/AS2 clause 5.7.6 requires that fire spread from a lower roof to an adjacent higher external wall shall be avoided where firecells behind the wall contain:

- other property
- sleeping risk groups SI or SM in the same building (as the lower roof) or in an adjacent building on the same title
- exitways in the same building (as the lower roof) or in an adjacent building on the same title.

Where the distance between any part of the external wall and lower roof is less than 9 m vertically or 5 m horizontally, protective measures shall be applied to either the roof or the external wall.

Roof protection shall be achieved by doing the following:

- providing sprinklers throughout the building or
- constructing the part of the roof within 5 m horizontally of the wall with a fire resistance rating.

External wall protection above an adjacent lower roof shall be provided by constructing the part of the wall closer than 9 m vertically or 5 m horizontally to the roof with a fire resistance rating. If the roof is not protected, there shall be no unprotected areas in this section of the external wall.

For both roof and external wall protection, the designer will need to assess various criteria to determine the required fire resistance rating. Generally, this will be a minimum of 60/60/60, but some exceptions apply.

Internal surfaces

MDH buildings must also control flame

spread on the internal surfaces, exitways and escape routes and other public spaces.

The degree to which internal surface lining (walls and ceilings) and floor surface materials combust and produce smoke can have a major impact on an MDH building's ability to protect people from the effects of fire. Building Code clause 3.4 therefore stipulates performance requirements for both internal surface lining materials and floor surface materials based on a number of risk factors.

Fire performance of internal surfaces

Internal surface lining materials are assigned a Group Number based on the rate the material releases heat and smoke under standard test conditions. As the material becomes more combustible, so the Group Number increases. Materials with Group Number 1 are the best performers, while those with Group Number 4 are the worst performers. Group Numbers 1 and 2 can also have an S suffix, where an additional limit is put on the smoke production rate over the duration of the test.

C/VM2 Table A1 (reproduced below) lists some deemed-to-comply combinations of substrates and coatings that achieve a specified Group Number.

Lining materials classified by EN 13501-1:2007+A1:2009 *Fire classification of construction products and building elements. Classification using test data from reaction to fire tests* can also be used with an assigned Group Number using the guidance given in C/AS2 Table C1.

BRANZ Study Report SR302 *Reaction to fire of interior wall and ceiling linings* provides further details of paint coatings on substrates.

Floor surface materials

For small MDH buildings designed to C/AS1, there are no fire requirements for the floor surface materials. In other MDH, flooring (including timber, carpets and vinyl) must be either non-combustible or have a CRF of not less than that specified in C/AS2 Table 4.2. The CRF value is determined by testing to ISO 9239-1 *Reaction to fire tests for floorings – Part 1: Determination of the burning behaviour using a radiant heat source*.

The threshold levels of CRF for classifying floor surface materials are 4.5, 2.2 or 1.2 kW/m^2, with the highest number being the best-performing material and vice versa. C/VM2 Table B1 allows some timber products that are at least 12 mm thick to be assigned a CRF of 2.2 kW/m^2 without providing evidence of testing.

Surface finishes

For MDH buildings designed to C/AS1, where multi-unit dwellings have no more than one unit above another and where each unit has an escape route independent of all other units, there are no surface finish requirements.

Any wall and ceiling lining and flooring material can be used. The only exception is where exposed foamed plastics or combustible insulating materials form part of a wall or ceiling system.

In large, multi-dwelling MDH buildings or where escape routes are shared, various surface finish requirements apply:

- In exitways, lining materials must achieve Group Number 1-S (unsprinklered) or 2 (sprinklered), while the minimum CRF for combustible flooring is 2.2 kW/m^2.
- Generally, lining materials in all other occupied spaces (including household units) in this category of MDH building are required to achieve Group Number 3 (sprinklered or unsprinklered).
- If the occupied space is a firecell accommodating more than 50 people, the minimum CRF for flooring is 2.2 kW/m^2 (unsprinklered) or 1.2 kW/m^2 (sprinklered), while for all other occupied

Table A1 **Specified performances for some substrate and coating combinations**

Coating (coating in good condition and well adhered to substrate)	Substrate	Performance (with or without coating)
Waterborne or solvent borne paint coatings ≤ 0.4 mm thick Polymeric films ≤ 0.2 mm thick	Concrete and masonry ≥ 15 mm thick Sheet metal ≥ 0.4 mm thick, or Fibre-cement board ≥ 6.0 mm thick Glass	G1-S
Waterborne or solvent borne paint coatings ≤ 0.4 mm thick	Gypsum plasterboard with or without paper facing ≥ 9.5 mm thick ≥ 400 kg/m^3 core density < 5% wt organic contribution to board	G2-S
Waterborne or solvent borne paint coatings, varnish or stain ≤ 0.4 mm thick ≤ 100 g/m^2	Solid wood or wood product ≥ 9.0 mm thick ≥ 600 kg/m^3 for particle boards, or ≥ 400 kg/m^3 for all other wood and wood products	G3
Note: The requirements of this table do not apply to metal faced panels with polymeric substrate.		

Figure 3. Specified performances for some substrate and coating combinations. (Source C/VM2 Table A1)

spaces (excluding household units), the requirement is 1.2 kW/m^2.

Refer to C/AS1 and C/AS2 for full details and exemptions to these requirements.

Surface finish requirements for suspended flexible fabrics and ducts may also apply in MDH – designers are advised to check the provisions in C/AS2.

Active fire protection in MDH

Greater residential density often means a building requires a means to notify nearby occupants and building users in the event of a fire. Active fire protection systems constantly monitor the building to detect and suppress fire or smoke and notify building occupants when an event occurs.

Active fire protection C/AS1 and C/AS2 compliance

In some forms of MDH, such as row houses, domestic smoke alarms (type 1) may meet the Acceptable Solution requirements for C/AS1 multi-unit construction.

However, when the escape path exceeds a certain distance, more robust alarm systems are required. Likewise, the allowable escape route length increases as alarm systems increase in sophistication. These range from manually activated systems (type 2) to full-coverage systems with smoke and heat detectors and a general alarm for the entire building (type 4).

Building fire alarm systems must comply with NZS 4512:2010 *Fire detection and alarm systems in buildings*, which has specific coverage, installation, robustness, inspection, testing and maintenance requirements.

MDH fire designers should also consider false alarms, which can lead to occupant complacency and additional costs for Fire and Emergency response. Systems that allow smoke detectors in individual household units to sound a hushable local alarm and alert building management (type 5) help mitigate false alarms. However, this comes at the cost of increased fire risk relative to type 4 systems.

Sprinklers

Sprinklers have an excellent track record for reducing fire risk, so the Acceptable Solutions make several concessions when they are installed. These include allowing longer escape routes, reducing passive fire protection requirements and allowing more flexibility in the flame-spread characteristics of lining surfaces.

As sprinklers are essentially heat detectors, in addition to fire control, they also serve as an effective secondary fire-detection system.

Fire sprinkler systems must comply with the requirements of the following applicable standards in order for the Acceptable Solution concessions to apply:

- Sprinkler systems for a single household unit can be designed to NZS 4517:2010 *Fire sprinkler systems for houses*.
- Sprinkler systems in residential buildings up to 4 storeys and a floor area up to 2,000 m^2 can be designed to NZS 4515:2009.
- The above and all other automatic fire sprinkler systems can be designed to NZS 4541:2013 *Automatic fire sprinkler systems*.

These standards are listed in order of increasing cost, complexity and water supply requirements and inspection, testing and maintenance requirements.

Larger MDH developments

Larger MDH developments may require more sophisticated fire safety systems. These are usually specified systems that must be listed on the building's compliance schedule and are subject to an annual building warrant of fitness inspection.

Increased residential density brings additional challenges for Fire and Emergency. A larger number of people may have their life safety threatened, and access can become an issue. The time required to investigate the location of a fire and set up fire-fighting hoses also increases as building size increases.

Larger MDH developments must provide a suitable staging area for fire appliances that is within 20 m of the building and has unobstructed access.

These types of MDH also require fire-fighting hoses capable of reaching any point of the floor area in the building. If the length of hose required is greater than 75 m, the building must also provide a hydrant system.

If an alarm or sprinkler system is installed, the development must have a control panel in close proximity to the appliance staging area.

Note: Cited versions of standards are based on the current Acceptable Solutions at the time of publication. The specific version to be used should be verified at the time of use.

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