Designers' guide to firefighting operations

Buildings with multi-tiered vehicle stacking

F5-13 GD

Document Title: Buildings with multi-tiered vehicle stacking

Published: 23 July 2025

Document review date: 23 July 2028

Status of this document

This document is issued by Fire and Emergency New Zealand.

Recommendations for change

The document, its content and specific processes are not to be altered except through Fire and Emergency New Zealand document management processes.

Requests or recommendations for changes to this material should be sent to National Manager Response Capability.

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1. Context

Scope	Multi-tiered vehicle stacking within buildings presents challenges to our emergency operations and it is important that you consider these when designing your building. This chapter describes the specific issues that affect firefighting operations in multi-tiered car-stacking devices and sets out ways to design your building to protect occupants and firefighters. This guide helps to identify and overcome any limitations of the Acceptable Solutions (C/AS2) and the Verification Method (VM) design methodologies when considering the challenges associated with multi-tiered vehicle stacking.
Who this chapter is for	This chapter is for building owners, designers and other building practitioners and contractors. It outlines our position on appropriate life safety design for buildings with multi-tiered vehicle stackers, and how we recommend you design them to support our operations.
What is not included in this chapter	This chapter gives building industry stakeholders an overview of aspects of our operations that relate to them. However, it is not an exhaustive guide to our operations, nor does it replace any statutory requirements. We recommend you read it alongside other chapters in the guide.
Legislative framework	We aim to reduce the risk to both firefighters and building occupants through encouraging appropriate building design which allows us to achieve our statutory objective (under the Fire and Emergency New Zealand Act 2017) to reduce the incidence of unwanted fire and the associated risk to life and property. Our functions include responding to and suppressing fires and attending to other types of emergencies that may occur in a building. Read this guide alongside the: • mandatory requirements of the New Zealand Building Code (Building Code); • requirements of New Zealand Standards (Standards); and • Building Act 2004. This guide **does not** replace any part of the Building Code or Standards or other mandatory building requirements. The Building Code, Fire Safety – C Protection from fire, clauses C1–C6 defines Building Code performance requirements of the Building Act 2004. C5 is the performance requirement on 'Access and Safety for Firefighting Operations'. Although it is possible to design a building featuring a car stacker using the compliance documents to the Building Code, you should note that these contain no specific requirements or provisions to address the challenges associated with car stackers. We recommend that you apply the guidance in this chapter and the other Designers guide documents, and where appropriate, engage with us early in the design process.

2. Definitions

The following definitions apply for the purposes of this chapter. Defined terms used throughout this document are consistent with the Building Act 2004, New Zealand Building Code (NZBC) and Acceptable solutions C/AS2.

Appliance	An emergency vehicle that provides capability to Fire and Emergency's mandated functions.
Attendance point	The hardstanding area where the first attending Fire and Emergency vehicle will stop and set up. There is usually only one attendance point located at the building's primary entry point. The attendance point should comply with clause 6.2.1 of C/AS2, and must comply with Clause C5.3 of the Building Code. This will give access to within 20m of: ○ indications of fire location ○ controls for fire safety systems ○ inlets for fire sprinkler or hydrant systems. The attendance point is the initial tasking and safety briefing point for crews before they deploy to any other access point. It must have facilities that give firefighters clear information, in compliance with Building Code C5.7. For unusually large or complicated building layouts, a second (or more) attendance point may be appropriate. This must be discussed and agreed with Fire and Emergency Operations. For a full description of the attendance point, refer to F5-02 GD FFO Emergency vehicle access.
Breathing apparatus (BA)	A device worn by firefighters to provide breathable air in an atmosphere that is immediately dangerous to life or health. Also known as self-contained breathing apparatus (SCBA) or compressed air breathing apparatus (CABA).
Building hydrant system	Fixed water main pipe system normally already charged with water and supplemented by Fire and Emergency pumps. This should not be confused with an in-ground hydrant connected to the town mains.
Car park	Space or spaces within a building used for parking motor vehicles including private household units.
Car-stacking facility	Place where cars are stacked above one another inside a building and can be one or several floors. A car-stacking facility can also be found outdoors.
Car-stacking parking building	A car park building with a multi-tiered vehicle-stacking device or system.
Fire control entre (FCC)	The principal location where the status of a fire detection system, an alarm system, and a communications and control system are displayed, and from which all systems can be manually controlled. Standards and publications refer to the Fire Control Centre as 'central control station', 'emergency command centre', 'fire service centre' or 'fire control room', (although different standards exist among these).

Fire engineering brief (FEB)

A formal process as outlined in the International Fire Engineering Guidelines for all stakeholders to define and agree on the basis and scope of work for fire engineering analysis.

Fire resistance rating (FRR)

Building Code clause C regarding protection from fire defines FRR as:

> The term used to describe the minimum fire resistance of primary and secondary elements as determined in the standard test for fire resistance, or in accordance with specific calculation method verified by experimental data from standard fire resistance tests. It comprises three numbers giving the time in minutes for which each of the criteria stability, integrity and insulation are satisfied and is presented always in this order.

Firecell

Building Code clause C regarding protection from fire defines firecell as:

> Any space, including a group of contiguous spaces on the same or different levels within a building, which is enclosed by any combination of fire separations, external walls, roofs, and floors.

Firefighter access point

The place where firefighters gain access to a building. This must comply with New Zealand Building Code Clause C5.6.

> Buildings must be designed and constructed in a manner that will allow firefighters, taking into account the firefighters' personal protective equipment and standard training, to:
>
> (a) reach the floor of fire origin,
>
> (b) search the general area of fire origin, and
>
> (c) protect their means of egress.

Hard-standing area (for Fire and Emergency vehicles)

A hard (roading) surface capable of withstanding the fully laden weight of a fire appliance from which fire operations for a structure are conducted. A hardstanding must be big enough for the fire appliance to enter, exit and manoeuvre and for firefighters to move around it to connect hose and safely access equipment. In most cases, the hardstanding will be the main road if the structure is close to it.

To be operationally useful, hardstanding must be within 135 metres of a firefighting water supply.

Additionally, for the health and safety of our personnel, hardstanding areas:

- must not be located under a canopy, or other part of the structure on fire.
- must not be located close to significant hazards such as dangerous goods, gas cylinders or similar.
- must have a path of retreat for the appliance and crew if the incident deteriorates.
- must be located outside the hazard zone of the firecell on fire. This hazard zone will include consideration of the following:
  - a horizontal collapse zone requirement of 1.5 times the height of external walls of the firecell on fire
  - radiant heat from flame projection or external walls exposing the pump operator and appliance
  - the impact of the fire safety features within the building (for example, sprinklers).

A full description of the hardstanding area can be found in F5-02 GD FFO Emergency vehicle access.

Lift

A moving compartment (also known as the lift car) housed in a shaft, for raising and lowering people or things, to different levels in a building. For the purposes of this document, the terms 'lift' and 'elevator' are interchangeable.

Multi-tiered vehicle-stacking device/system

A mechanical device/system that stores vehicles either above or below others in a stacking arrangement. The process of stacking can be done manually; however most large car-stacking facilities are automated. A full description of car stackers can be found within F5-13 GD FFO Multi-tiered vehicle stacking buildings.

3. Car-stacking systems

Car stackers to overcome limited space

Traditionally, vehicles have been parked one to a parking space, whether in dedicated parking buildings or on designated parking levels in a multi-purpose building.

However, population growth has increased pressure for more parking spaces as space is at a premium. Multi-tiered vehicle stacking devices (car stacking) allows multiple vehicles to park in a traditional single space.

Although common overseas, car stacking is relatively new to New Zealand, but it's becoming more popular with developers and business owners here because it uses limited space efficiently.

3.1. Types of multi-tiered vehicle stacking systems

Car-stacking systems

Multi-tiered vehicle stacking devices have simple, medium, and complex systems. They can range from manually operated devices to fully automated intelligent vehicle-stacking systems.

There are three types of car stacking:

- manual – a simple, manually controlled system with two cars stacked in one available car space
- semi-automatic – two- to three-level system that is partially automated
- automatic – a multi-storey, unoccupied, fully autonomous car retrieval system.

Type 1: Manual systems

A single-movement, manually controlled hoist or ramp system for two vehicles. Ideal for residential apartments with limited space; however, these may also be installed in single garages of residential houses.

Cars are parked (one at a time) onto the platform; the hoist mechanism is then manually operated using an individual switch.

Figure 1 – Manual car stacker system

Type 2: Semi-automatic systems

A semi-automatic two-to three-level stacking system.

Operation is similar to manual systems but may be semi-automated. Some systems have a pit, with cars stacked above and below ground level.

Figure 2 – Examples of semi-automatic car stackers

Type 3: Automatic systems

Fully automated, multi-tiered vehicle parking involving three or more basement and/or upper levels of a building.

The driver parks the car in the receiving bay and leaves the area. The automatic car-stacking machine parks and retrieves the car from its pre-loaded location.

The automated parking machine can be a car lift or an automatic hoist operating in the central core (void) on tracks with access to all parking bays.

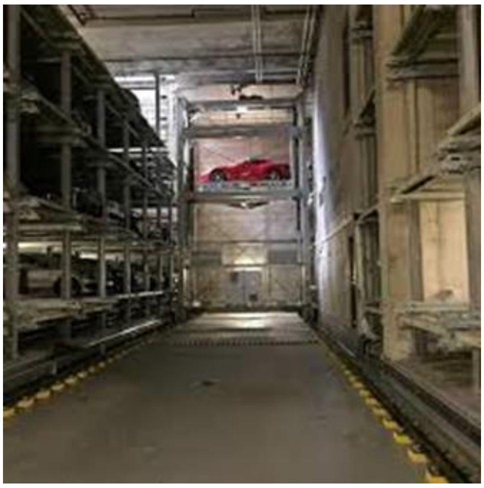

Figure 3 – Fully automated car stacker

4. Challenges

4.1. Firefighting considerations

Safety issues

Car stacking in buildings adds another challenge to firefighting operations either at height or below ground due to:

- restricted access
- moving machinery
- unusual and dangerous layouts
- limited or no ventilation.

We encourage developers and designers to engage with us early so you can include appropriate hazard mitigation in your plans to protect building occupants, firefighters and property.

Firefighting operations risks

Firefighting operations in traditional buildings with car parking are often challenging due to the untenable conditions. Poor or no visibility, combined with excessive heat build-up in an area that often has a low-level ceiling height all make it much harder to find the vehicles on fire.

Firefighting in buildings with car stacking is even riskier and more complex because:

- more cars are parked closer together in a very confined space
- car stackers are often located in basements

- firefighters need specialised equipment.

In buildings with car stackers, building design and the performance of fire safety systems are critical to us managing an incident successfully. In addition, high levels of uncertainty make our operations more complex, so we need to plan them carefully, which delays intervention. To minimise the effects of this delay, buildings should have early detection systems and intervention systems that start working before firefighters arrive.

Additional considerations for car stackers in basement levels

The usual challenges associated with basement levels are relevant. These include the lack of ventilation, causing reduced visibility and increased heat.

You must consider these issues when designing access to basement levels. Stairs that aren't adequately protected can easily become compromised as smoke trapped in the basement travels into the stairway when firefighters intervene. For more information, see F5-07 GD FFO Stairs in buildings.

Outdoor car-stacking facilities

Outdoor car-stacking facilities have different needs for firefighting operations as they have no walls. The main priority for firefighting operations in outdoor car-stacking facilities is protecting the nearby buildings and having sufficient firefighting water supplies.

4.2. Design issues and considerations

Location

Car stackers are generally designed to suit basement areas in buildings, but they can also be found in a totally enclosed area above ground.

The large number of cars within a confined space is more dangerous for firefighters due to the higher fuel loading and limited access. Vehicle fires can spread very quickly to the surrounding vehicles, creating a faster, hotter fire and making conditions untenable more quickly.

Heat release rate (HRR)

Fire modelling can be used to support design elements that relate to firefighting operations (e.g. structural fire resistance, firefighter tenability, sizing of smoke extract systems, etc.).

Standard modern vehicles have a much higher fuel loading than older cars. The increased use of plastics and foam inside the passenger compartment means the average heat release rate (HRR) for a modern car is also significantly higher than older generations. However, fuel loading analysis for car park buildings is often based on the older HRR rather than the modern car HRR.

This factor increases exponentially in car-stacking devices, where the fuel loading of closely stacked vehicles is generally underestimated in regulation and design.

Fire statistics

According to the Australasian Fire and Emergency Service Authorities Council (AFAC), Australian statistics have shown that vehicle fires cause approximately 60 percent of fires in car park buildings. A quarter of these vehicle fires start in stationary vehicles.

You should consider this figure if you are designing a building with a car stacker.

Fire spread

Broken Hill Proprietaries Ltd (BHP) and the British Research Establishment (BRE) vehicle fire tests in car parking buildings show that fire can spread quickly from car to car. These conditions create fast-generating and larger HRRs.

This is further compounded in car stackers as fires can also spread vertically between cars. This should be reflected in the default choice of fire growth rate for the building design, as growth that is assumed for a single car is not appropriate in this context.

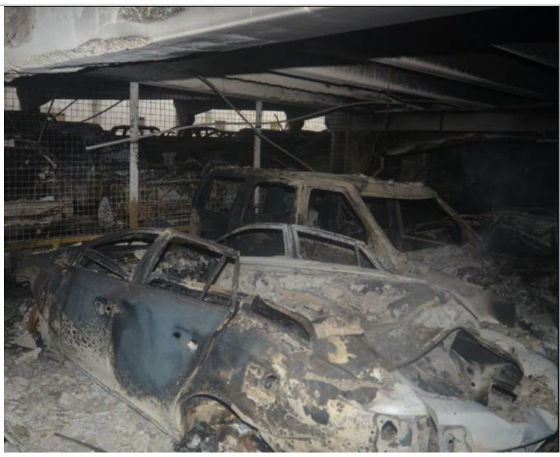

Figure 4 – The aftermath of a fire involving closely stored cars.

Exposed steel structure	Most car-stacking devices are made of steel. They are not fire-rated or given fire protection features to protect the exposed steel work. It is also important to note whether the floor plate of each parking space is complete, a mesh type, or fully open, as this affects how much burning material drops down in a fire.
Fuel types	Vehicle stacking devices house many vehicles and these will contain many different fuels, including diesel, LPG, hydrogen, battery and other types. Vehicles also contain large quantities of plastics (including as fuel tanks) and foam material in vehicle interiors creates pool fires as materials decompose and drip during the fire. Car fires produce denser smoke that reduces visibility more quickly, which is a significant risk to firefighting operations and occupants needing to evacuate safely. For these reasons, you should carefully consider the parameters for fire modelling in buildings with car-stacking devices.
Smoke ventilation/ exhaust systems	The rapid build-up of heat combined with thick dense smoke are a challenge for firefighters, particularly in basement fires. It is important for designers to provide adequate ventilation or exhaust extraction systems designed specifically to exhaust heat, smoke and other fire products.

5. Recommendations

Recommended approach for any buildings with car stacking	The Australasian Fire Service Authorities Council (AFAC) has published a position on multi-tiered vehicle stacking devices. Fire and Emergency New Zealand is an AFAC member and we fully support the AFAC position. To comply with the Building Code, designers need to consider firefighting operations. We recommend that designers meet with us as early as possible in the Fire Engineering Brief (FEB) process to discuss our requirements. Before meeting with us, we recommend the following:
Suppression systems	• A reliable automatic fire suppression system (sprinkler) covering the entire building complex, for early intervention and fire control. A system that fully complies with NZS 4541:2020 Automatic fire sprinklers will reduce the likelihood of fire spreading.
Detection systems	• A fire detection system that fully complies with NZS 4512:2021 Fire detection and alarm systems in buildings provides early warning for building occupants. A

	detection system monitored by Fire and Emergency will also ensure an early response. • We're also committed to reducing false alarms, so it's important to select the most suitable detection system that is fit for purpose. See F5-04 GD FFO Fire alarm panels for further guidance.
Building hydrant system	• You should assume that we will need to access a car stacker to achieve complete extinguishment. This means that these areas are not exempt from the requirements of the Building Code, Clause C5.5. • To access a car-stacking area, firefighters must enter from protected safe path stairs, with a fully operating firefighting hose line safely connected to our vehicles at the attendance point. See F5-07 GD FFO Stairs in buildings for more detail. • Where hose run distances from the attendance point cannot be achieved, you should install a building hydrant system in accordance with NZS 4510:2008 Fire hydrant systems for buildings with the outlet inside the safe path stairwell. See F5-05 GD FFO Building hydrant systems for more detail. **Note re NZS 4510:2008 and NZS 4510:2022:** NZS 4510:2022 Fire hydrant systems has superseded NZS 4510:2008 Fire hydrant systems for buildings. Fire and Emergency therefore encourages all designers and building industry practitioners to use NZS 4510:2022. However, C/AS2 Acceptable solutions (C/AS2) still cites NZS 4510:2008, so until MBIE updates C/AS2 replacing NZS 4510:2008 with NZS 4510:2022, NZS 4510:2008 may still be used.
Access and safe path	• Firefighters need good access into any car-stacking area. For a car stacker at ground level, this may be as simple as direct access from outside. For car stackers in basements, this is normally from a safe place via a pressurised safe path stairwell. • Where the car stacker area exceeds 500 m^2 or where car stacker facilities are located more than 10 m below the attendance point (refer to F5-02 GD FFO Emergency Vehicle Access), we recommend you provide at least two access paths. • Stair pressurisation in accordance with AS 1668.1:2015 The use of ventilation and air conditioning in buildings – Part 1: Fire and smoke control in buildings – firefighters must be able to enter and operate from a safe path stairwell to the lowest part of the building or basement. • Provide approved glass viewing panels in the safe path stairwell to help firefighters find the fire and see the conditions in the car stacker prior to entering.
Ventilation	• Basement fires are difficult to locate as visibility is lost very early, often before we arrive. Heat and smoke cannot easily escape, particularly from the basement area. An automatic smoke ventilation or smoke exhaust/extract system in a building with car stacking will assist with firefighting operations. • Our fire crews must have full access and ability to control the ventilation/extraction system (refer to F5-09 GD FFO Fire control centres).

Figure 5 – Conditions in test fires utilising stacked cars

Services control

- Multi-tiered vehicle stacking devices are powered by electricity, with some having a dedicated standby power supply. Firefighting operations must be able to isolate vehicle-stacking devices and any other power supply to the car-stacking areas.
- We require access to, and full control of, power, including any emergency supply to the devices. You should also provide access to controls of all other utilities in the building.
- Ideally, all services controls should be in a building's fire control centre (FCC) where one is present, see F5-09 GD FFO Fire control centres for more information.

Other design factors

- We are committed to providing a safe solution for firefighting operations in buildings with car stacking, so it's critical to engage with us early in the design process.
- The car park deck/floor must be constructed of non-perforated and non-combustible material. Solid floor pans reduce vertical fire spread between vehicles.
- Any fire design used for modelling should form a realistic representation of the fuel loads in a modern car.
- Car-stacking devices may need a higher FRR due to the greater risk from the higher fuel load in a restricted space.

Outdoor car-stacking facilities

- Radiated heat on neighbouring buildings should be considered using a credible 'worst-case scenario'.
- Water supply considerations are essential.

6. Related information

6.1. Designers' guide to firefighting operations

- F5 01 GD FFO Introduction
- F5-02 GD FFO Emergency vehicles access
- F5-03 GD FFO Radio communications
- F5-04 GD FFO Fire alarm panels
- F5-05 GD FFO Building hydrant systems
- F5-06 GD FFO Automatic sprinkler systems
- F5-07 GD FFO Stairs in buildings

- F5-08 GD FFO Lifts
- F5-09 GD FFO Fire Control Centres
- F5-10 GD FFO Evacuation and rescues
- F5-11 GD FFO Water supplies
- F5-12 GD FFO Construction, refurbishment and demolition sites
- F5-13 GD FFO Multi-tiered vehicle stacking buildings
- F5-14 GD FFO Firefighting shafts in taller buildings

6.2. Legislation

- Fire and Emergency New Zealand Act 2017
- Building Act 2004
- Building Regulations 1992 > NZ building code > Fire safety

6.3. Standards

- AS 1668.1:2015 The use of ventilation and air conditioning in buildings – Part 1: Fire and smoke control in buildings
- SNZ PAS 4509:2008 New Zealand Fire Service firefighting water supplies code of practice
- NZS 4510:2008 Fire hydrant systems for buildings
- NZS 4510:2022 Fire hydrant systems
- NZS 4512:2021 Fire detection and alarm systems in buildings
- NZS 4541:2020 Automatic fire sprinkler systems

6.4. References

- C/AS2 Acceptable Solutions
- Collier, PCR (2011). BRANZ Study Report SR 255 (2011) *Car Parks – Fires involving modern cars and stacking systems*
- BRE Fire and Security (2009) Client Report number 256618 *Sprinkler protected car stacker fire test*
- AFAC Guideline (2018) Version 2 – *Fire safety requirements for automated vehicle parking systems*

Notes

- When considering a building in New Zealand, the various references to Australian Standards should be taken as the equivalent NZ Standard where one exists.
- The legislation and Standards referred to in this guide (including the above links) are relevant at the time that this document was published. Note however that the legislation/links may have been updated since the publication of this document.

Document information

Owner	National Manager Response Capability
Last reviewed	23 July 2025
Review period	Every three years

Record of amendments

Date	Brief description of amendment
July 2025	Added note clarifying use of superseded hydrant standard.
May 2025	Updated definitions: Attendance point, Hardstanding area. Review period changed to three years.
March 2022	Format update and SME content review
March 2018	Initial version