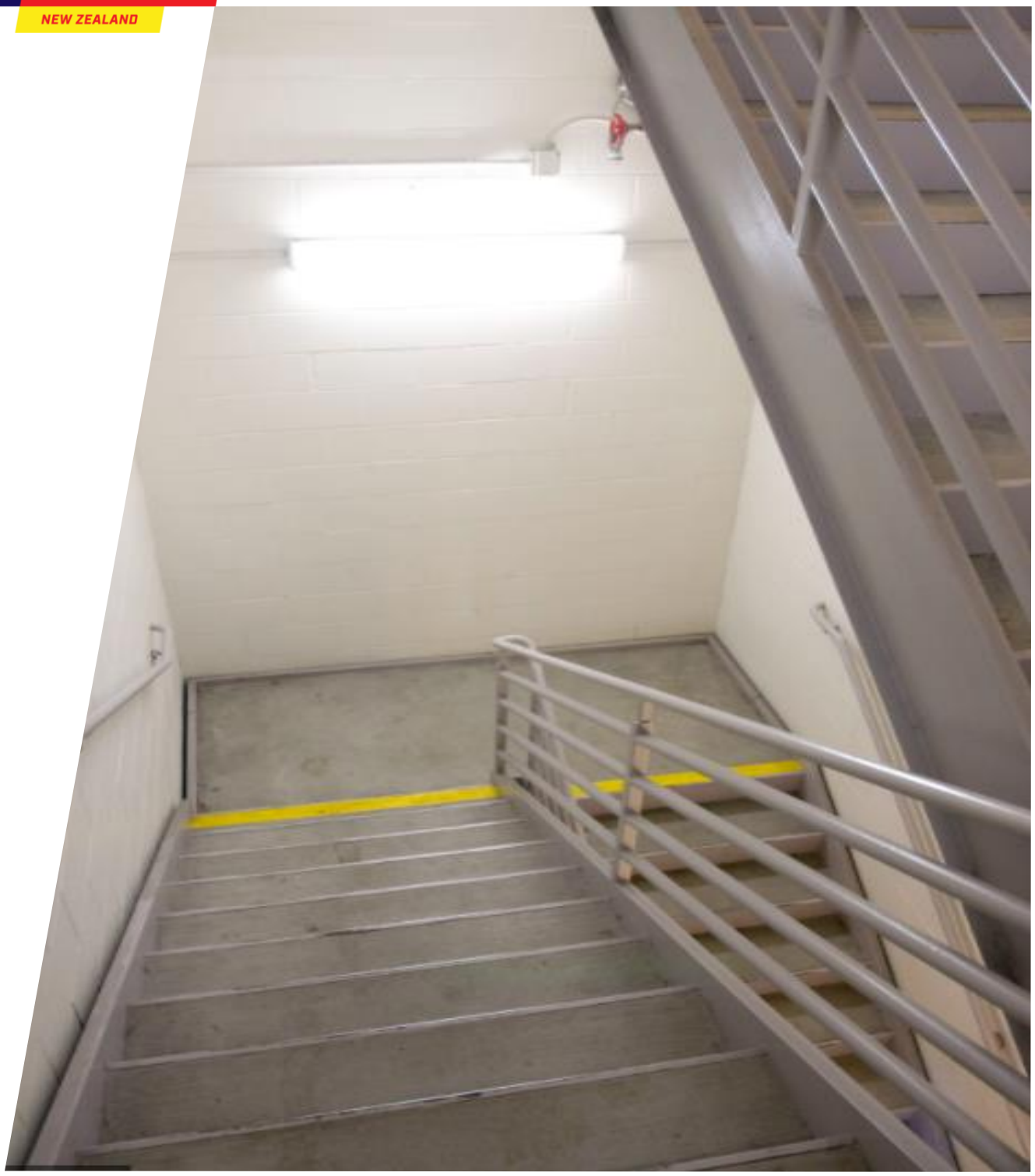
Designers guide to firefighting operations

Stairs in buildings

F5-07 GD



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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

It's critical that your building design protects some of the stairs from fire and smoke. This allows occupants to evacuate safely and supports our intervention.

Use this guide to:

- identify how stair design affects our operations
- identify and address the misalignment between the 'Deemed to comply' documents and Fire and Emergency's operating procedures for using stairs in a fire
- design stairs to help protect people using them during a fire.

This guide specifically covers **protected stairs,** which are fully fire separated from all the levels that they serve. It doesn't cover open stairs, although we acknowledge that some buildings have them.

Who this chapter is for

This chapter is for building owners, designers and other building practitioners and contractors. It provides guidance from Fire and Emergency's perspective on the design, construction and features of stairs in buildings.

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 mandatory/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 define NZ Building Code performance requirements of the Building Act. C5 is the performance requirement for Access and safety for firefighting operations.

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, Building Code and C/AS2 Acceptable solutions.

Aerial vehicle	A specialised emergency vehicle that has an aerial device that hydraulically rises to suppress fire and/or effect rescue as well as support other operations.
Appliance	An emergency vehicle that provides capability to Fire and Emergency's mandated functions.
Breathing apparatus (BA)	A device firefighters wear 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 is 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.
Chimney effect	Also known as the 'stack effect', this is the movement of air into and out of buildings resulting from air buoyancy. Buoyancy occurs due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences. The result is either a positive or negative buoyancy force. The greater the thermal difference and the height of the structure, the greater the buoyancy force.
Counterflow	Counterflow can occur on the stairs during the evacuation from buildings when the downward flow of evacuating occupants passes the upward flow of firefighters heading to the fire floor.
Fire engineering brief (FEB)	A formal process outlined in the International Fire Engineering Guidelines for all stakeholders to define and agree on the basis and scope of work for the fire engineering analysis.
Fire floor	The floor of the building on which the fire is reported by automatic systems or observed/reported by occupants or other persons. The fire floor may change with new information, and the initial reports by occupants may be inaccurate, if the observation is of the effects of fire (e.g. smoke spread), rather than the fire itself.
Fire resistance rating (FRR)	Building Code Clause C regarding protection from fire defines FRR as: [t]he term used to describe the minimum fire resistance required 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.
Firefighter access point	The place where firefighters gain access to a building. This must comply with NZ 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.

Forward control point (FCP)	A safe position inside the building from which to carry out firefighting operations. This is usually one to two floors below the lowest floor of the building that is affected by smoke and/or fire. The location becomes the last point to assemble personnel awaiting deployment. If the extent of the fire is unknown, or the fire develops and extends vertically, it creates a situation where the boundaries between the zones become dynamic.
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.

3. Our operations

The importance of protecting stairs

In multi-storey buildings, stairs are critical for building occupants evacuating, and firefighters carrying out operations. Unfortunately, these two activities can sometimes conflict. Recent incidents across the world have led to a greater focus on protecting stairs and ensuring that they are fit for purpose.

This is reflected in the tactics we use to fight fires in multi-storey buildings, as well as in the equipment we deploy at these incidents.

However, building design features are the most important factor in protecting the stairs. The recommendations and considerations below will help you ensure that the stairs in your building are adequately protected and remain fit for purpose during a fire.

4. Challenges

4.1. Design requirements

Performance requirements

Clauses C1–6 of the Building Code set out how buildings are expected to perform in a fire. Clauses C4 and C5 are particularly relevant when designing stairs:

- Clause C4 sets out how buildings must be designed and built to allow people to escape during emergencies.
- C5 sets out how they must be designed and built to give firefighters access as quickly and safely as possible.

You can comply with these by following a deemed-to-comply prescriptive solution or through an engineered approach.

Deemed-to-comply – Acceptable Solution

If you are establishing compliance by using Acceptable solutions C/AS2, Parts 3 “Means of escape” and 4 “Control of internal fire and smoke spread” provide specific considerations on protecting stairs.

No additional criteria are imposed in Part 6 “Firefighting” of the document – the requirements of Part 6 have not been significantly reviewed for some time and no longer reflect how we operate in multi-storey buildings.

Deemed-to-comply – Verification Method

The Verification Method is a hybrid design approach which relies on engineering assessment limited to a set of scenarios with well-defined parameters. As is the case with the Acceptable Solution, the Verification Method does not prescribe design requirements that reflect our needs.

Alternative solution

When the design is based on an alternative solution, you are responsible for demonstrating how it meets the objectives outlined above.

Clause C5.6 of the Building Code requires the building to be “designed and constructed in a manner that will allow firefighters, taking into account the firefighters’ personal protective equipment and standard training” to reach and search the area of fire origin and to get out safely. To comply with this clause, you should understand how we use stairs, and consider how other factors might affect our intervention. Your design should include provision to counter those factors and ensure that it meets the objective.

4.2. Location, labelling and access

Location

In multi-storey buildings, our first challenge is often to find the stairs. The stair locations are typically well identified from inside the building, which helps occupants find them in an emergency. However, from outside the building, they're not always easy to identify.

- The fire alarm panel at the attendance point should clearly show the stairs' location, as required by NZS 4512:2010, paragraph 402.8.2. However, in larger or more complex buildings, this may not be sufficient, particularly where there are many doors on the perimeter of the building.
- You should provide additional labelling/signage on the doors which provide access into the stairs. These signs should be large enough to read clearly.
- Where stairs don't serve all floors, signage should also be used to identify the floors served.

Note: This also applies to hydrant systems within stairs refer to F5-05 GD FFO Building hydrant systems for further detail.

Labelling

If a building has more than one set of stairs, not identifying them clearly can cause confusion and delays. Easily understood labelling terminology is important to support clear communications. Without it, our resources (including firefighters and equipment) may not be deployed to the intended location.

If stairs aren't clearly labelled, we will often default to the orientation of the building (e.g. 'west stair', or 'southeast stair'). However, this is not always practical, particularly where stairs are in close proximity or even interlocked, such as scissor stairs.

Solutions include:

- numbers, e.g. 'Stair 1', 'Stair 2'
- letters, e.g. 'Stair A', 'Stair B'.

Note: You can also use colours to reinforce the selected identifier (e.g. letters or numbers) but using colours on their own to identify stairs may not be suitable.

Figure 1 – An example of stair labelling

Once you've chosen a labelling method, it's important to use it consistently. This includes labelling the stairs accordingly on the fire alarm panel diagram, on any drawings provided and within the stairs themselves.

We also need each floor level to be clearly identified within the stairs.

The combination of a stair identifier and floor numbering makes it easier to quickly identify the correct location.

Figure 2 – Example of stair signage

Access into the stairs

Security requirements can make it difficult to gain access into the stairs.

Dedicated egress stairs typically exit directly to the outside of the building. The exit door is usually kept locked for security reasons. If occupants use the stairs every day, there may be a security mechanism allowing access from outside.

We prefer the stair exit door to be interfaced with the building fire alarm. This means that when the alarm activates, the door is released and can be freely opened from outside.

We understand that this may be a security concern. In cases where it is problematic, you will need to consider alternative ways for us to gain access. For possible solutions, refer to the section 'Site access and security features' in F5-02 GD FFO Emergency vehicles access. We also recommend that you contact us at designers.guide@fireandemergency.nz to discuss solutions.

Access onto the floors

Once we have entered the stairs, we must be able to access all floors. Some buildings have no restrictions, and all levels are freely accessible from the stairs. In others, particularly multi-tenanted commercial buildings, stair doors have security locks, so tenants only have access to their own floors.

The compliance documents to the New Zealand Building Code do not consistently require the stair doors to open during an emergency evacuation. It is common for us to find that the internal stair doors are locked.

Forced entry is an option, however we view it as a last resort because of the additional damage caused. We prefer that if the building has security features, the building design should include the means to override these features. For external access, we prefer all doors to release automatically when a fire alarm activates. Other options include:

- providing a set of master keys/swipe cards at the attendance point so we can get onto all floors without compromising building security
- a manual release for the security doors. This acts in the same way as an automatic release interfaced with the fire alarm, but relies on us to operate it manually, ensuring that security isn't compromised before we arrive.

Knowing what to expect

When we're preparing to enter a floor from the stairs, we're not always sure of the situation on the other side of the door. This can complicate our operations and put us at risk.

As we're generally unfamiliar with the building's layout, providing a floor plan for each level at the corresponding stair landing can help. We can use this information to better understand the floor layout and identify the quickest way to the fire. In smoky conditions, this helps us find our way. We can also use the information to prioritise the order in which we search various areas.

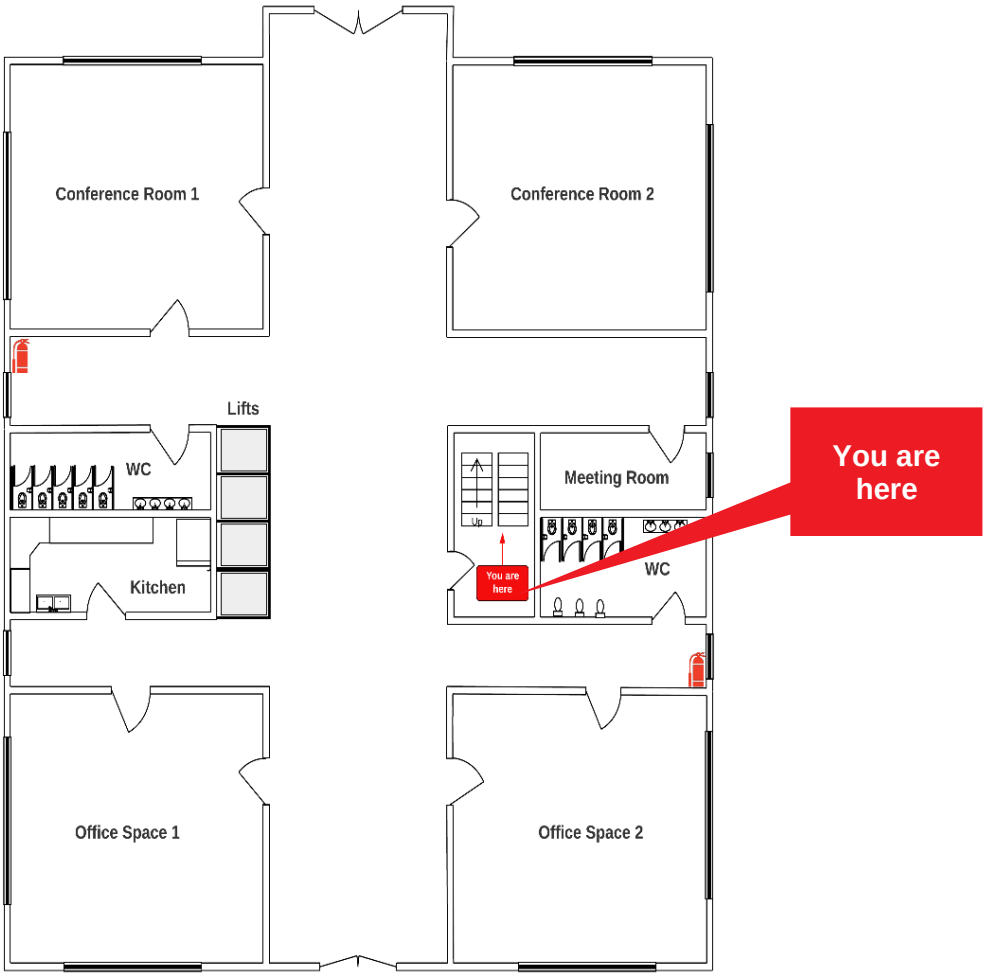

Figure 3 – Example of a floor layout plan located in the stairs

We often don't know the conditions on the floor. Providing a vision panel on the stair door allows us to glimpse what to expect before entering. This allows us to prepare, which makes us safer.

4.3. Evacuation

Counterflow

Occupants use the stairs to exit. Firefighters use the stairs to enter and reach the fire. As we travel in the opposite direction, this creates counterflow, which delays occupants from evacuating, and firefighter intervention.

Counterflow may not be entirely avoidable but building design can limit its effects on both evacuation and our operations.

The following sections outline factors that affect counterflow.

Bulk of firefighters

With full PPE and equipment, we take up more physical space than the average building occupant.

Figure 4 – Shows firefighter equipment load

Building height

The higher the building, the longer it takes for occupants to make their way down. This makes it more likely that they'll still be evacuating when we start climbing the stairs.

Number of occupants

Large occupancies require additional exit provisions. However, there are practical limitations in multi-storey buildings. It may not be possible to provide more stairs to accommodate more people. This in turn results in longer evacuation times.

Evacuation strategy

The evacuation strategy for multi-storey buildings can prioritise the 'at-risk' occupants. These are the occupants immediately affected by the fire, who will exit first. Evacuating the rest of the building then becomes less time critical.

This strategy limits the number of occupants using the stairs at the same time. The occupants are more spread out in the stairs, reducing congestion. There is also more space available for us to travel in the opposite direction. For further guidance, see F5-10 GD FFO Evacuation and rescues.

Availability of alternative stairs

Where multiple stairs are available, it may be possible to direct people to specific stairs and dedicate one stair to firefighting operations. This limits the interaction between evacuating occupants and firefighters. It is typically not possible to include a dedicated firefighting stair in the design, so this approach is implemented as part of our response to the incident.

For this approach to work, we need a way to communicate with building occupants (e.g. through a public address system) and clear labelling of the stairs (refer above) to deliver clear messaging.

Width of the stair

Prescriptive guidance on stair size only considers the exit needs. No additional provisions are made for counterflow. Widening the stairs gives occupants more space to spread out. This reduces congestion and makes our access easier.

Occupants requiring assistance

In an emergency, occupants of multi-storey buildings are directed towards the stairs. This may include occupants who can't use the stairs on their own and need help. These occupants may enter the stair, which acts as a place of relative safety, but may not be able to continue evacuating.

If stair landings and lobbies are used by occupants requiring assistance, this may delay us and prevent us from setting up our operations.

4.4. How we use stairs

Fatigue

Even for fit and healthy people, climbing stairs is tiring exercise. It's particularly hard while wearing full personal protective equipment (PPE) and carrying our tools. In taller buildings, the time and energy required to reach a fire on an upper floor is a major challenge for us.

While the stairs remain a critical part of the firefighting strategy, other means of reaching the upper levels should be considered, such as firefighting lifts. Refer to F5-08 GD FFO Lifts for more information.

Operational use

Our standard operating procedure for multi-storey buildings is centred around the stairs. Firefighters will establish a forward control point (FCP) one or two floors below the fire. The Entry Control Officer (ECO) will use this FCP as a location for monitoring breathing apparatus (BA) operations. The ECO is responsible for keeping track of firefighters who are committed and wearing BA, and for organising emergency teams.

The ECO's location becomes the interface between firefighters who are operating under the protection of their BA set and those who are not. The latter includes incoming 'fresh' teams and outgoing teams. In practice, this means that we assume that any firefighter past the ECO location is protected from exposure to fire and smoke. By contrast, those at the FCP (and below) are not fully protected.

If the FCP (or any part of the stair below) becomes compromised, the ECO will be forced to relocate to a lower level. This is a significant issue because the working duration of the BA is limited. The further the ECO is from the fire, the more air firefighters will use travelling between them, and the less air they can use to perform their role. They'll also use up more air climbing stairs while carrying heavy equipment, which increases their breathing rates. Eventually, firefighters reach a practical limit where they don't have enough air to reach the fire before they must turn back. Fire and Emergency plans comprehensive and controlled testing to determine which floor this is on average.

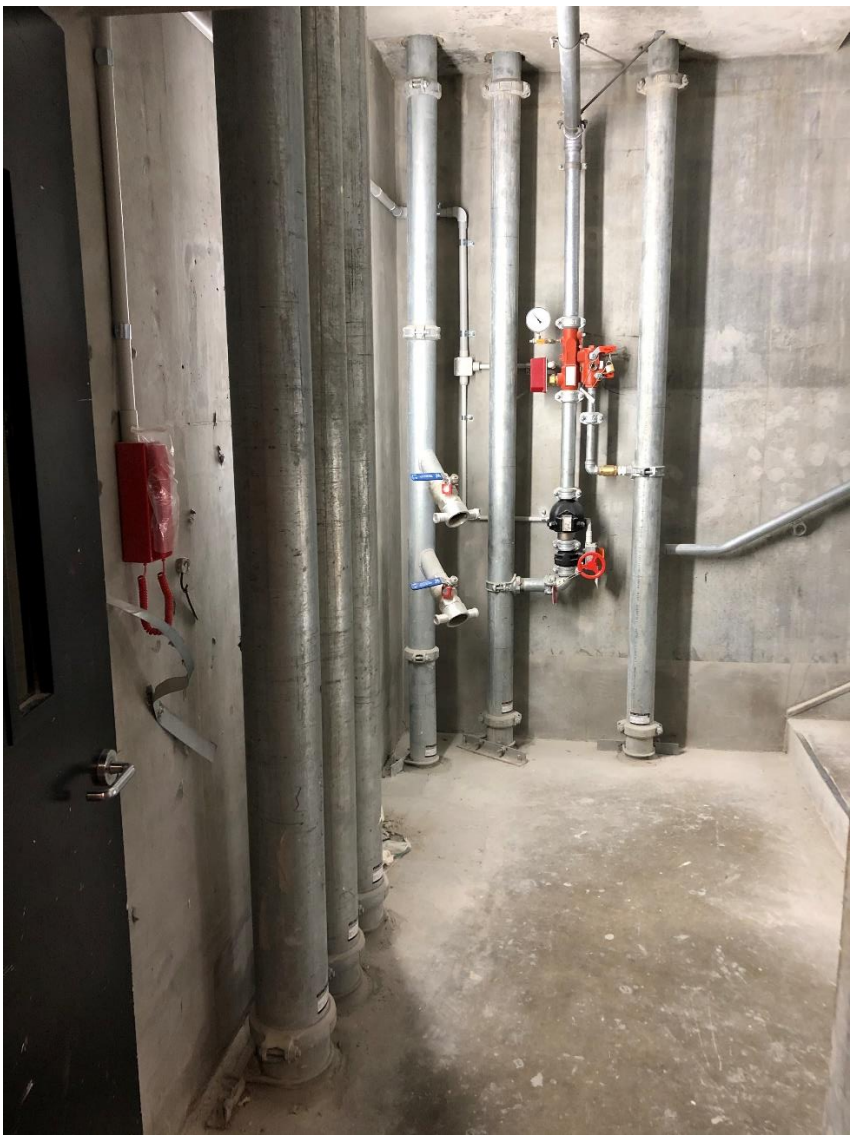

Figure 5 – A well-designed stair with hydrant outlets, sprinkler subsidiary valve and WIP phone all co-located

Integrity of the stair

Stairways are vulnerable to smoke because occupants and firefighters must open doors to access the stairs, when exiting and entering the building, respectively. During firefighting operations, fire hoses pass through doorways and stop doors from closing fully. For these reasons, it's important for building designs to include adequate provisions to protect the stairs.

4.5. Stairs with complicating factors

Scissor stairs

Scissor stairs are a common space-saving solution in tall buildings. However, they are challenging for us because they connect to the floor plate on alternate landings. This means that the location of the access point into the stair varies from floor to floor.

Clear labelling as discussed above, needs to be very specific to reflect what is provided within each stair. This includes whether the stair accesses all levels or has a building hydrant system.

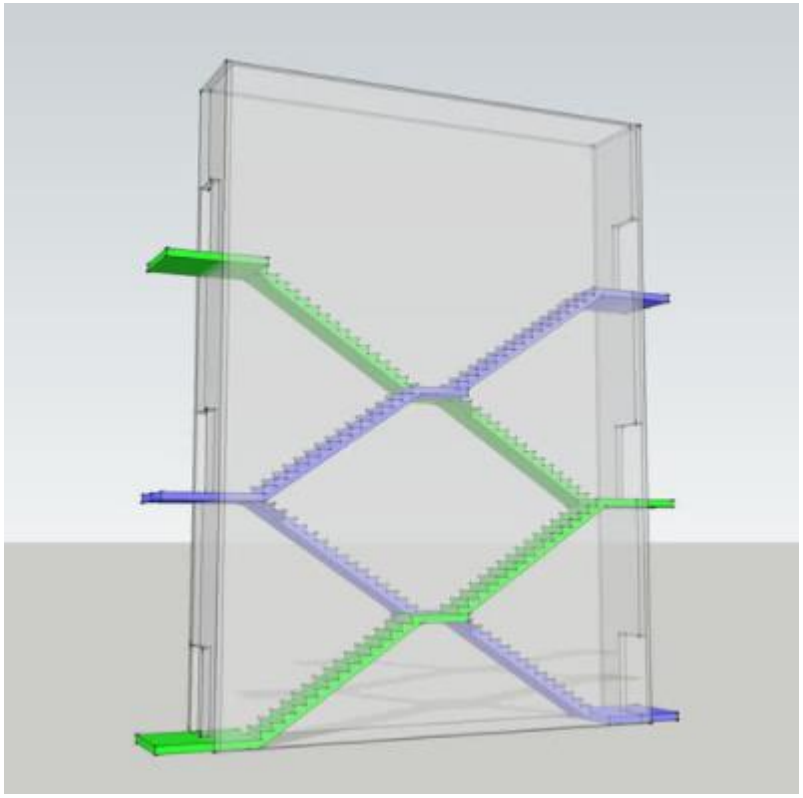

Figure 6 – Example of scissor stair layout

Basement stairs

Stairs to below-ground levels can present an additional challenge related to smoke movement. Heat and smoke can build up in basement levels without adequate external ventilation. When we open the stair door, the smoke and heat tend to flow from the basement into the stairs. This can compromise access and endanger firefighters. If the stair also serves levels above ground, this can affect the egress route for the upper portion of the building, which becomes smoke logged.

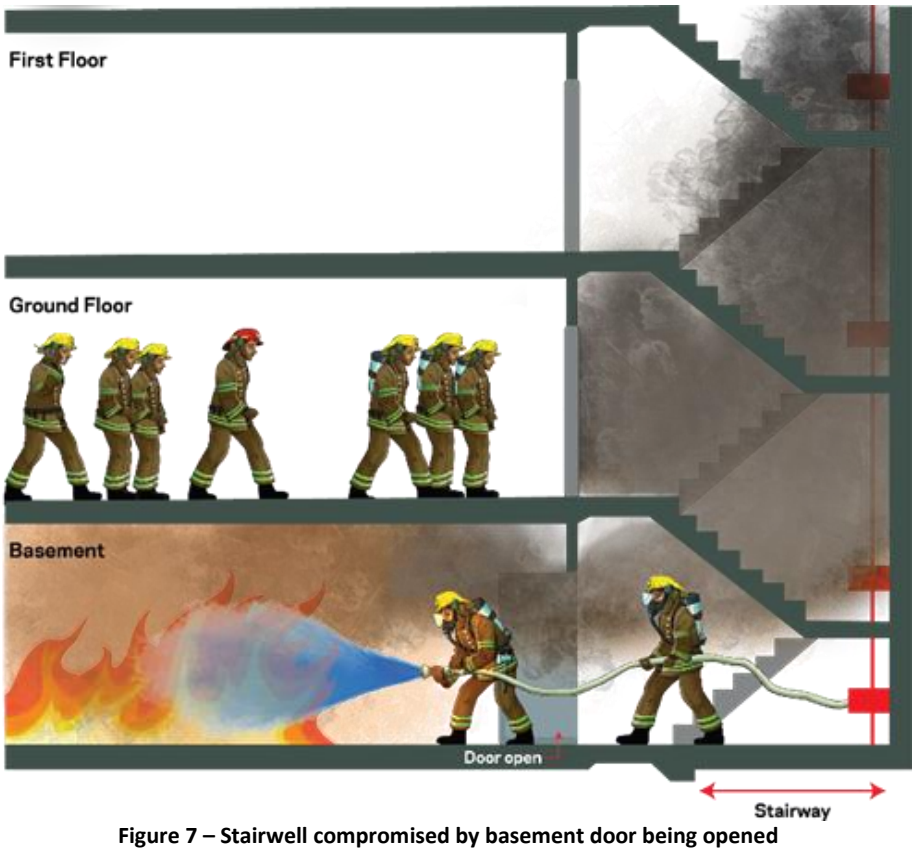

Figure 7 – Stairwell compromised by basement door being opened

Height

In tall buildings, as smoke travels in the stair, it cools when it mixes with fresh air and from heat exchange with the stair surfaces. In sprinklered buildings, sprinkler operation can accentuate the cooling.

When the temperature of the smoke matches that of the ambient air, the smoke is no longer buoyant, and stops rising. Over time, gravity can even cause the heavier smoke particles to drop. This phenomenon is not unique to stairs, but it is a common issue in taller buildings.

For this reason, we can't assume that the smoke will always rise in a stair. Computer modelling results should be considered very carefully in this context as they generally ignore the effect of sprinklers and can over-predict the temperature of the smoke and its resulting buoyancy.

4.6. Systems for protecting the stairs

Fire-resisting enclosure

Stairs used for firefighting access must be protected from fire with fire-resisting walls and doors. We rely on the stairs to safeguard our exit route in the worst-case scenario. The stair enclosure must withstand severe fire conditions.

Features intended to protect the stairs can degrade over time. New services penetrations installed later can also compromise stair protection. Holes or gaps in the construction around the stair can lead to smoke logging and even help fire to spread.

Smoke lobbies

Smoke lobbies are intended to form a buffer between the fire and stair. They provide additional volume and an extra door to prevent smoke from getting into the stair.

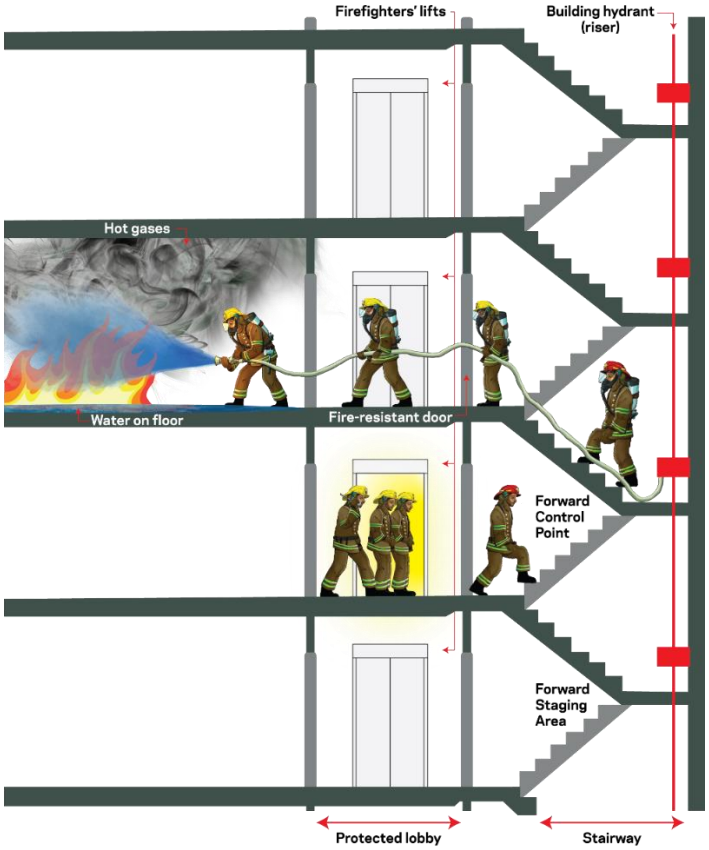

Figure 8 – Diagram showing fire protected lobbies on floors

For lobbies to be effective, they need to provide sufficient volume and be free of fire load and ignition sources.

Stairway pressurisation

If the design relies on positive pressure differential to keep the stair clear, this must be a design feature. Although we carry portable fans, these are not powerful enough to positively pressurise an entire stairway.

Pressurisation systems are typically designed and commissioned to AS/NZS 1668:1:2015. However, while the standard outlines the test criteria for commissioning the system, the design should reflect the intended use. Compliance with the standard does not always ensure fitness for purpose.

For example, when designing the system, the designer should refer to the evacuation strategy to find out how many doors will be assumed to be open during the evacuation. In a building designed for all occupants to exit at once, the system should be capable of coping when most of the doors are open at the same time. In a building designed for staged evacuation, the evacuation is likely to be ongoing beyond our arrival. The system should therefore be capable of protecting the stair when doors are open for both firefighting operations and occupants to evacuate.

Stairway ventilation

Some building designs include using ventilation to clear smoke from stairs. This can be through natural or mechanical means. Ventilation systems are typically designed to remove any smoke entering the stair when occupants are evacuating. This type of system can cope with residual smoke after the door to the floor has closed but may not be sufficient to keep the stair clear when the door is open.

When we enter, we generally prop the door open as we have to run the fire hose through it. This lets smoke into the stairway. If a ventilation system is operating, this can accentuate the chimney effect and actively draw heat and smoke into the stair. This increases the risk we are exposed to as we enter the fire floor.

To reduce this risk, ventilation systems serving stairs should have manual controls. This lets us manage the system and decide how best to use it to support our tactics. Such controls should be located in the fire control centre if provided (refer to F5-09 GD FFO Fire control centres) or at the fire alarm panel (refer to F5-04 GD FFO Fire alarm panels).

5. Recommendations

Fire and Emergency recommended approach	• We need you to consider how you could ensure that stairs are fit for purpose in the course of your work. • The points discussed above, and recommendations below cover both design and building management procedures.
Design considerations	• Recognise that 'deemed to comply' solutions only provide for a minimum level design which may not meet our needs, particularly in taller buildings. • Understand how stairs will support our intervention and adjust your design accordingly. • Engage with us early in the design process so we can provide input and discuss our operational needs.
Stairway identification and access	• Clearly identify stairs, including their locations and firefighter access points. • Label stairs consistently to assist identification and reduce confusion. • Label all floors inside the stairs. • Make provisions for us to override security features. • Provide drawings of the floor layout inside the stairs. • Provide vision panel in stair doors.
Evacuation	• Design to minimise the impact of counterflow on our operations. • If possible, dedicate a stair for firefighting intervention. • Make adequate provisions for occupants requiring assistance that do not conflict with our access.
How we use stairs	• Provide other means of access in taller buildings to counter fatigue. • Ensure the design adequately protects the stairs so we can operate. • Consider how our operations will affect the building, e.g. if we have to force entry to the stairs.
Compliance with standards	• Mitigate the additional complexity caused by less common stair arrangements such as scissor stairs. • Protect stairs serving basements and separate them from upper levels. • Stairs in taller buildings may require additional protection.
Systems for the protection of stairs	• Design pressurisation systems with the intended use of the stairs in mind – compliance with the standard may not always be adequate. • Design active systems for smoke control in conjunction with other building features to ensure they don't increase the risk or inadvertently compromise the stairs. • Design stair enclosures to sufficiently resist fire by ensuring that the right systems are installed. • Provide smoke lobbies, particularly if no active system is included to prevent smoke entering the stairs. • Ensure all design features intended to protect the stairs (active and passive), are adequately maintained and that any new works do not compromise existing performance.

5.1. Completing the firefighting facilities checklist

Completing the checklist

When completing F5 SC Part C: 3 Access to building of the firefighting facilities checklist (FFFC), you should state what access is provided to the building from the attendance point. This will allow us to understand the proposed design and ensure that access meets the needs for firefighting operations.

Remember that all facilities are put in place for us to use in emergency situations and should be located in consultation with us, email designers.guide@fireandemergency.nz

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
- New Zealand Building Code (Building Regulations 1992 > New Zealand Building Code > C Protection from fire)

6.3. Standards

- NZS 4332:1997 Non-domestic passenger and goods lifts
- NZS 4510:2008 Fire hydrant systems for buildings
- NZS 4512:2021 Fire detection and alarm systems in buildings
- NZS 4541:2020 Automatic fire sprinkler systems
- AS/NZS 1668.1:2015 The use of ventilation and air conditioning in buildings – Part 1: Fire and smoke control in buildings
- BS9999:2017 Fire safety in the design, management and use of buildings
- BS EN81-72:2020 Safety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts – Part 72: Firefighters lifts

6.4. References

- Australian Building Codes Board, International fire engineering guidelines, Edition 2005, Canberra, Australia.
- New Zealand Building Code Compliance C Protection from fire
- New Zealand Building Code handbook, third edition, amendment 13

Document information

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Record of amendments

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December 2021	Format update and SME content review
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